LYN ALDEN

BROKEN MONEY

Why Our Financial System is Failing Us and How We Can Make it Better

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ISBN 979-8-9886663-0-1 (hardcover)
ISBN 979-8-9886663-1-8 (paperback)
ISBN 979-8-9886663-2-5 (ebook)

Published by Timestamp Press

Printed by Amazon

Cover design by Jbookdesigns

ACKNOWLEDGEMENTS

Writing a book of this scale is a huge undertaking and is only possible with enormous support.

Firstly, I want to thank those who were directly involved in the creation of this book. My husband, Mohamed Badran, provided invaluable structural editing and early feedback to ensure a clear reading experience. Joakim Book performed extensive editing and research assistance as a professional monetary historian, which helped elevate the quality immensely.

There are over 400 citations in the book, and countless people in the past and present whose work has influenced its creation. Importantly, I consider some of the cited works that I *disagree* with to be as important from a research perspective as those I agree with, because they help test the ideas and sharpen the conclusions. Since I can’t mention them all here, I encourage the reader to look through the footnotes and bibliography, and I am grateful for all the published materials that people have created that I’ve been able to cite here or that I’ve drawn inspiration from.

In addition to all of the historical famous writers that influence everything, some contemporary writers, investors, humanitarians, and/or business leaders whose work has been among the most heavily cited or influential for this book include Alex Gladstein, Ray Dalio, Stanley Druckenmiller, Barry Eichengreen, George Selgin, Luke Gromen, Saifedean Ammous, Nick Szabo, Adam Back, Elizabeth Stark, Michael Saylor, Jeff Booth, John Pfeffer, Caitlin Long, Gigi, Nic Carter, Obi Nwosu, Yan Pritzker, and Anita Posch.

All profits from the first thousand copies sold will be donated to the Human Rights Foundation, which in addition to helping people has also been a useful source of research in my work.

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INTRODUCTION

In September 2022, a wave of normal people robbed banks in Lebanon.

What made these events more newsworthy than typical bank robberies was that most of these people were only robbing the banks to get their *own money* back. Due to a financial crisis in Lebanon, banks were not letting people access their own cash deposits for a long time.

One of the “bank robbers” that made headlines was a young woman who worked as an interior decorator. She held up a bank in Beirut using what later turned out to be a realistic-looking fake gun, to withdraw her family’s savings for the treatment of her cancer-stricken sister, since the savings had been frozen by the bank. This was perhaps the most striking example, but there were several other bank robberies during this period by people who just wanted their own deposits back, and some of them used real weapons.

These events in Lebanon are specific to a certain country and time, but they are part of a global story.

Nigeria, a country with over 200 million people, has experienced 13% annualized inflation over the past decade.[1] They launched a central bank digital currency called the eNaira in 2021, which so far has had extremely low adoption, while cryptocurrencies (especially bitcoin and U.S. dollar stablecoins) have seen an order of magnitude higher adoption rate within the country despite being cut off from the country’s banking system. The Nigerian government subsequently deployed a set of policies meant to reduce the availability of physical cash and push people toward digital payments, which contributed to a period of political turmoil and riots.

Egypt abruptly cut its currency’s value in half relative to the U.S. dollar in autumn 2016, which eviscerated years of savings for a population of approximately 100 million people. In 2022 and 2023, the country again performed multiple sharp devaluations of its currency relative to the dollar, resulting in yet another halving of the exchange rate. I know people in Egypt that buy physical U.S. dollars on the black market and hold them as protection from this ongoing problem. They pay significant conversion fees to do this, while earning no interest on the paper dollars they hold. And when these devaluations occur, it immediately puts the onus on all employees in the country to try to negotiate higher salaries to recoup some of their lost purchasing power, since their ongoing salaries are denominated in the devalued local currency.

Türkiye and Argentina, both members of the G20 nations and with a combined population of over 130 million people, have been dealing with runaway inflation in recent years. Türkiye reached 85% year-over-year inflation in 2022 and Argentina reached well over 100% inflation in 2023.[2]

In the 1990s, Brazil experienced outright hyperinflation while it was the fifth most populous country in the world. When people imagine hyperinflation, they often picture 1920s Germany or certain failed states today, but a surprisingly large number of countries went through it at one point or another during the latter half of the 20th century. Just since the 1980s or later, people in Brazil, Argentina, Yugoslavia, Zimbabwe, Venezuela, Poland, Kazakhstan, Peru, Belarus, Bulgaria, Ukraine, Lebanon, and several other countries have experienced hyperinflation. Other countries such as Israel, Mexico, Vietnam, Ecuador, Costa Rica, and Türkiye experienced triple-digit inflation (i.e., nearly hyperinflation) within that period.

From 2016 to 2021, many sovereign bond markets in wealthy nations across Europe and Japan were offering near-zero or even negative nominal yields, and there was over $18 trillion worth of negative-yielding bonds at the peak.[3] People had to pay for the privilege of lending to governments and to large corporations rather than receiving interest for doing so. The incentives of the financial system were therefore turned upside down. And then over the next few years, a global inflation wave severely reduced the purchasing power of the holders of those bonds.

Throughout the 2010s, multiple senior members of the U.S. Federal Reserve repeatedly said that the economy was below their average inflation target for too long and that they wanted higher inflation. During a congressional hearing in early 2021 when the headline U.S. inflation rate was 1.7%, the chairman of the Federal Reserve was asked by a congressman about the 25% year-over-year surge in the broad money supply (the highest since the 1940s) that had occurred due to recent fiscal stimulus efforts, and any potential implications it might have for inflation or the value of the dollar. The chairman dismissed these concerns, saying that such a surge in the amount of broad money likely wouldn't have important economic implications and that we may have to "unlearn" the idea that monetary aggregates have an important impact on the economy.[4]

As price inflation began to seriously emerge later in 2021, the chairman initially brushed it off as being transitory and the Federal Reserve continued expanding the base money supply with quantitative easing. But then, as four-decade high rates of inflation emerged during 2022, the chairman and other leaders of the Federal Reserve panicked and completely changed their monetary policy, citing price inflation as the biggest problem to deal with. In their attempt to quell inflation, they raised rates so aggressively — and reduced the base money supply at a record pace over the next year — that they ended up creating over a trillion dollars' worth of unrealized losses for banks on their Treasury securities and other low-risk assets. By sucking deposits out of the banking system at such an aggressive rate, they contributed to some of the largest bank failures in American history. By 2023, banks across the country had severely impaired capital ratios due to the sharply rising interest rates. For the first time in modern history even the Federal Reserve itself was running an operating loss due to paying such high interest rates on its liabilities relative to what it was earning on its assets.[5] These Federal Reserve decisions affect the monetary conditions for 330 million Americans and billions of people in foreign countries and yet are made manually and subjectively by a group of just twelve people.

There are approximately 160[6] different currencies in the world, each with a local monopoly over their own jurisdiction, and most of them have little or no acceptance outside of that jurisdiction. The global financial order is practically a barter system in this regard. A handful of top currencies are held as reserve currencies by other central banks and enjoy some degree of foreign acceptance, but they lose value slowly over time and have interest rates that haven't kept up with inflation for years. Most of the other currencies are more prone to sharp devaluations, persistent periods of double-digit inflation, and occasional hyperinflations, while enjoying little or no foreign acceptance. For people in countries that are in the second group, they often try to get their hands on foreign currencies such as dollars to protect their savings, and generally can't trust their local banks to hold them.

It can be a challenge to save money even in the most stable monetary jurisdictions, and if someone happens to be born in the "wrong" jurisdiction, it's an incredible uphill battle.

How did we get to this point? Why isn't our money *better* than this?

The global financial system has been broken for developing countries throughout modern history, and in recent decades it has built up serious imbalances even for developed countries. It's no longer solid at its foundation, in part because its core technology is outdated.

I contend that the rise of populism throughout the United States, Europe, and several developing countries ever since the 2008 global financial crisis is in large part due to this fact. People on both the left and the right of the political spectrum can sense that something is wrong, that things are "rigged" against them, but can't quite put their finger on why. A big piece of the puzzle is that the financial system as we know it isn't working anymore.

We've seen in prior decades that global financial orders gradually fall apart due to the buildup of economic imbalances, the occurrence of geopolitical realignments, and the introduction of new technologies. When that happens, the old order gets partially or completely reconstructed and rebuilt into a new order, and examples of such occurrences are provided in this book. Most signs suggest that the financial order that we have been in since the 1970s is reaching its later years and is beginning its process of reconstruction and realignment.

This is a book about money through the lens of technological developments. It covers the evolution of money in the past, why the current technology and institutions we use for money are failing us in the present, and some of the possible solutions to the monetary problems that we now face. It's written in plain language and is modular in its design, so that readers can focus on the parts that interest them the most.

Part 1 of the book walks the reader through ancient ledgers and commodity monies, to analyze why money emerged naturally and why certain monies outcompeted others. This helps us discern what the ideal properties of money are, and why these properties tend to reemerge time and time again independently throughout history. It also explores the relationship between social credit and commodity money to provide a reconciliation for two economic schools of thought that are often in opposition.

Part 2 is about early proto-banking services and the rise of full-service banks. It examines how various technological developments sped up monetary transactions and abstracted them away from the slower process of physical monetary settlements, which came with many benefits but also some drawbacks. It finishes by discussing how the increasing speed gap between transactions and settlements at the dawn of the telecommunication age gave considerable power to banks and central banks, since they became the primary entities capable of quickly transmitting money around the world.

Part 3 describes the global financial system as it has been structured since the early 20th century, including the geopolitics behind its creation and how it has changed over time. It covers the period of failing gold pegs around the time of World War I, the Bretton Woods system that existed from the 1940s to the early 1970s, and the Eurodollar/Petrodollar system that replaced it from the 1970s to the present. Finally, it explains how some troublesome aspects of the current version of the system have led to structural imbalances around the world in recent decades.

Part 4 analyzes the details of how money is created within the modern financial system and how debt inherently destabilizes the system over time. It then examines some of the imbalances and problematic incentives caused by constantly devaluing monetary units, as savers try to maintain purchasing power by buying other non-monetary assets instead. It shows how lawmakers have been empowered with a flexible public ledger to engage in warfare without taxation, to perform selective bailouts through the devaluation of other peoples' savings, and in general to finance expenses in opaque ways.

Part 5 looks at digital monetary innovations in the 21st century, including Bitcoin, stablecoins, smart contracts, and central bank digital currencies. This is the most speculative part in the book, because it's about the present and future, rather than about the past. It describes some of the new technologies that are available to us, and specifically looks at the various trade-offs and risks that these technologies come with alongside the opportunities that they can provide.

Part 6 explores the ethics of money and communication, which are the two components of commerce. It discusses the role of cryptography in general (a critical piece of modern banking and internet infrastructure), open vs closed financial networks, and the intersection of financial technology and human rights.

At its core, money is a ledger. Commodity money serves as a ledger governed by nature. Bank money serves as a ledger governed by nation states. Open-source money serves as a ledger governed by users. As the book explores, the evolution of technology changes the prevailing power structures and incentives surrounding money from era to era.

My background consists of a blend of engineering and finance, and I use a systems engineering approach when analyzing various aspects of the global financial system. Systems engineering is a multidisciplinary field that focuses on the design, integration, operation, and maintenance of complex systems over their life cycles. I treat the global financial system as the engineered system that it really is, and I have found that this method of analysis arrives at fresh conclusions that sometimes challenge conventional economic thinking.

My goal for writing this book is to help people better understand how money works, and why the global financial system is not functioning as well as it used to. The book is not just about why our financial system is not working well this year or this decade, but rather it is a deeper analysis of what money is, how we got to where we are now, and what the current foundational problems are.

I don’t have all the answers and can’t tell you what the world of finance will look like in the decades ahead, but what I aim to do in this book is to share what I’ve researched so that it may empower readers to find more answers for themselves. Politics can affect things locally and temporarily, but technology can affect things globally and permanently, which is why I analyze money primarily through the lens of technology.

This is not a gold book, not a banking book, not a bitcoin book, and not a political book. Instead, it is an exploration of monetary technologies in their myriad forms of the past, present, and future and touches on all of these topics and more, so that we might better understand where we came from and which paths we may take going forward.

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[1] IMF, "Consumer Prices, End of Period," Datamapper.

[2] Zeynep Dierks, "CPI Inflation Rate in Turkey," *Statista*, March 3, 2023; Patrick Gillespie, "Argentina Inflation Surpasses 100% as Economic Recession Looms," *Bloomberg*, March 14, 2023.

[3] Cormac Mullen and John Ainger, "World's Negative-Yielding Debt Pile Hits $18 Trillion Record," *Bloomberg*, December 11, 2020.

[4] Howard Schneider, "Powell's Econ 101: Jobs Not inflation. And Forget About the Money Supply," *Reuters*, February 23, 2021.

[5] Erica Jiang et al., "Monetary Tightening and U.S. Bank Fragility in 2023."

[6] XE.com. "ISO 4217 Currency Codes."

PART ONE

WHAT IS MONEY?

"The precursors of money, along with language, enabled early modern humans to solve problems of cooperation that other animals cannot — including problems of reciprocal altruism, kin altruism, and the mitigation of aggression. These precursors shared with non-fiat currencies very specific characteristics — they were not merely symbolic or decorative objects."[7]

-Nick Szabo

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[7] Nick Szabo, "Shelling Out: The Origins of Money."

CHAPTER 1

LEDGERS AS THE FOUNDATION OF MONEY

Many people think that money as a concept starts with something like coins or shells, but the story really begins before that. It begins as a ledger.

A ledger is a summary of transactions and is used to keep track of who owns what. The oldest known written ledgers date back over 5,000 years to ancient Mesopotamia in the form of clay tablets. According to Encyclopedia Britannica, Sumerian is the oldest known type of writing in existence, and the oldest known instances of Sumerian writing were clay ledgers that kept track of commodities.[8] They showed pictures of various commodities and had dots next to them that represented quantities. In other words, the first ideas that humans are known to have written down with their early proto-scripts were lists of ownership, credit, or transactions.[9]

But ledgers as a concept can be even simpler than that. And prior to the invention of writing, they must have existed to some degree in memory and in oral form. Anytime somebody owed something to someone else, either formally or informally, they were inherently maintaining a basic oral ledger.

At the simplest level, with a modern example, let’s imagine two child siblings named Alice and Bobby. They are old enough that their parents task them with chores, and as they grow and start to lead more complex lives, occasionally they need to rearrange their schedules. Alice, for example, might need to skip chores one night so that she can go out with her friends. To do this, she can offer to her brother Bobby that if he covers her chores today, she'll cover his chores tomorrow. As he accepts the offer, they have just created a basic mental ledger and a form of credit. Alice now owes Bobby a specific set of chores. This is enforceable only through trust and reputation: If Alice does not repay her debts, then Bobby will likely refuse future trades. If it remains simple enough, their little ledger will be a verbal one only, but if their schedules get complex enough and they trade around chores on a regular basis, they might use a calendar as a written ledger. There is no specific monetary unit associated with this ledger — it's just a barter system. The only units involved are individual chores. The ledger merely keeps track of individual chores that are swapped over time, as a form of credit.

We can also imagine a group of hunters, perhaps tens of thousands of years ago in a tribe somewhere, counting how many kills they each had made, or loosely keeping track of who did whom a favor. Tribes throughout the world had (and still have) various ways of selecting leaders formally or informally, and the process is often meritocratic to some degree. Whether intending to or not, people approximately keep track of deeds and reputations of others, to see who provides the group with a surplus and who is a burden.

Early human social groups generally consisted of dozens of individuals, forming a band. Various bands within a geographic area, with a closely related culture, would then often recognize themselves as being part of a larger interconnected tribal culture. Within a group where everyone knows each other, money isn't needed, aside from oral and memory-based ledgers. Favors can be loosely tracked, and it is usually clear who is pulling their weight and who isn't. Groups of this nature would typically consist of kinships and friendships, so the exact "score" didn't need to be tracked. The ledger would be approximate, loose, and flexible.[10]

Back in my engineering days, a subset of my colleagues and I often went out to lunch together. We loosely kept track of who drove the small group each time, so that we could roughly balance it out. It wasn't written down, and it wasn't exact, but there was indeed a rough mental ledger that we collectively kept track of. The same was true for driving co-workers to the mechanic or to the airport and having the favor returned later (before ride-sharing apps were commonplace), or lending someone a bit of cash in a moment where they were short on it (for example, when splitting a cash restaurant bill, which used to happen more often back in those days). These favors were never phrased in terms of "I'll do this for you now, but you have to reciprocate in the future.” Rather, such a favor was happily provided as a gift when asked for, and then it would be assumed that if a reciprocal favor was asked for later, that it would be happily returned.

Considerable research by anthropologists on hunter-gatherer tribes has found similar gift-oriented behavior as a recurring theme. While cultures of course vary substantially, individuals that know each other generally give gifts or favors and then naturally expect sharing in return.[11] That’s a big piece of what friendship is.[12]

The situation becomes more difficult once we start interacting with people we don’t know well, and that we either don’t trust or that we may never see again. If two groups encounter each other in a primal environment, for example, it introduces the risk of violence, but it also opens the possibility for trade.

Spot trading is an obvious first step to transacting with people we don’t know well. Rather than extend them a form of informal gift credit like we would do with our family and friends, we ideally want to finalize any transaction *on the spot*, since there’s a high likelihood that we’ll never meet them again. Two groups encounter each other, both of which have resources but also some capacity for violence, if need be, and through basic language or gestures they complete a trade. Perhaps one band has an excess of spears but needs furs, and the other band has an excess of furs but needs spears. They can trade furs for spears on the spot, and both groups are better off. Anthropologists have documented multiple instances of ritualized trade between different hunter-gatherer groups, often involving the prospect for mating as well.

If there is not already an established ritual process between relatively equal groups in the region, and instead some parties come across each other more haphazardly, there is a high probability that a trading attempt will fail, due to not fulfilling the “double coincidence of wants.” A double coincidence of wants is an economic description that means that for the trade to be successful, each party must have an excess of what the other wants. If both parties are short on spears, the trade will fail. If both parties are short on furs, the trade will fail. There are more combinations that lead to a failed trade than a successful one.

It’s much easier to trade with our friendly band members than to trade with strangers, because with family and friends we have the luxury of trust and time, which we can consider a form of flexible social credit. Someone can ask me for a favor, and I can do it for them, even if there is absolutely nothing that I want from them now. I could have all the excess food, furs, and tools I need, and yet when someone I know has a shortage of something or needs me to spend time helping them with something, I can do them a favor and provide it.[13]

In addition to it feeling good, the reason I would extend this gift-credit to someone I know is because I anticipate that eventually there will be a time when I need something. Maybe I will become ill or injured or pregnant and unable to collect food for some time and will then rely on the person I am giving a favor to now. By providing a surplus of favors, I increase my social standing and thus my social safety in the group. The same logic applies in modern times when helping friends, neighbors, and family. Of course, I likely won't be thinking so mechanistically when I perform a favor; I may simply do it because I'm biologically wired to feel good when I help someone out, due to thousands of generations of biological selection for this trait that led my ancestors to survive and thrive as intelligent and generous social animals. But in the back of my mind, the conscious mental calculations are inevitably there as well: By doing this favor I am strengthening the whole group, including myself, and I am banking some personal insurance or social savings for myself and/or my close kin in the future. I'm expending current work or resources during my time of abundance and in return I am collecting some savings in our collective social ledger. This social credit, this informal mental ledger, is the friend-and-kin group solution to the "double coincidence of wants" problem. With flexible social credit, we can easily help each other when one person needs something even if the other person currently needs nothing.

In a 2010 study called "Wealth Transmission and Inequality Among Hunter-Gatherers," that referenced a wide variety of existing literature, the researchers noted that social insurance can in some cases be based on the reputation of the person in need and the quality of their social network:

> Most adults in hunter-gatherer societies actively contribute to food production and processing, as well as tool manufacture and maintenance. In addition, child care and provisioning is generally a parental duty. Most of these forms of labor require considerable strength and stamina, visual acuity, and other aspects of good health. As a result, we expect somatic wealth to be of prime importance to success and well-being. On the other hand, those who suffer periodically from suboptimal somatic endowments can usually rely on aid from others in the form of food-sharing, assistance with child care, and protection in disputes. This social insurance is normative and widely available, but some evidence suggests that the quality of such aid will vary according to the "relational wealth" (reputation, size and quality of the social network) of the needy individual or household (Gurven, et al. 2000; Wiessner 2002; Nolin 2008).[14]

Early in the famous movie *The Godfather*, a man asks Vito the mob boss for a favor, and Vito agrees to do it for him. The price Vito asks for in return, rather than money, is an unspecified favor sometime in the future. In other words, he wants flexible social credit. This is because this man needs something from Vito, Vito needs absolutely nothing from this man now, and yet Vito knows the man and recognizes that the man is part of his wider community. Vito is in the business of collecting favors and then calling them in when it is advantageous to him. Later in the movie, Vito indeed calls in the favor; he develops a need that this man is uniquely suited to provide, and it was a need that Vito didn't have early in the movie. Vito's story is of a man who tries to maximize his family's relational wealth by maintaining an extensive ledger of favors, with these favors serving as a form of credit-based currency in the mob's shadow economy.

Going back to our trading example between separate bands of people, since they lack this option of flexible social credit or ledgers (they don't trust each other and might never see each other again after this meetup), what could they bring to a trade that they expect to have a very high likelihood of being wanted by the other party? If I was in their situation, could I think of something to bring that almost everyone wants, all the time? In other words, is there a good that is the most sell-able? For many tribes, an early answer was shells.

Shells, especially ones that were carved and polished into jewelry beads, emerged as money-like assets thousands of years ago in multiple different regions. The utility was aesthetic: They could be fashioned into bracelets, made into belts, used as earrings, sewn into clothing, or hung in the hair. The advantage of shells in trade is that they are small, scarce, and long-lasting. And the specific advantage of putting them onto wearable strands is that they don't have to be carried in the hands, which makes them portable.

In his 2002 essay, "Shelling Out: The Origins of Money," Nick Szabo elaborates with extensive detail on the reasons why shells and other collectible proto-money likely came to be. As he summarized in his abstract:

> The precursors of money, along with language, enabled early modern humans to solve problems of cooperation that other animals cannot — including problems of reciprocal altruism, kin altruism, and the mitigation of aggression. These precursors shared with non-fiat currencies very specific characteristics — they were not merely symbolic or decorative objects.[15]

On the Pacific coast of North America, tribes collected dentalium, which refers to long shells that look like teeth. They served a role as money and were traded as far inland as North Dakota. As naturally occurring tubes with openings on each end, dentalium were strung together in long strands, and certain tribesmen would have tattoos on their arms that they used as reference lengths when measuring strands in transactions. Some tribes specialized in collecting these from deep waters.[16]

On the Atlantic coast, a different type of shell called wampum was used. These were made from clam shells and required extensive polishing and using a bow drill to create small holes in them for stringing together. The creators of these shells typically didn't consider them to be "money" as such. The beads were honored for having once been living creatures and were often used for ceremonial purposes, like crafting into priceless belts to honor treaties and other big events. But other tribes, and even colonialists, did begin to use these as money, or stores of value and status. Inland tribal groups collected them extensively.[17]

In parts of Africa and Asia bordering around the Indian Ocean, cowrie shells were used as money for similar reasons. International traders would bring cowrie shells with them for trade, and there is extensive documented history of this practice up through recent centuries.[18]

Although shells were among the most common proto-monies, there were other types of bead monies as well. Beads made from ostrich eggs, or strings of teeth from large predatory animals like lions or wolves, sometimes filled a similar role. In "Shelling Out," one of Szabo's examples is of the !Kung:

> Like most hunter-gatherers, the !Kung spend most of the year in small, dispersed bands and a few weeks of the year in an aggregate with several other bands. Aggregation is like a fair with added features — trade is accomplished, alliances are cemented, partnerships strengthened, and marriages transacted. Preparation for aggregation is filled with the manufacture of tradeable items, partly utilitarian but mostly of a collectible nature. The exchange system, called by the !Kung hxaro, involves a substantial trade in beaded jewelry, including ostrich-shell pendants quite similar to those found in Africa 40,000 years ago.

As one might expect, the African continent is home to the oldest known beads. At the Blombos Cave archeological site in South Africa, small snail shells with tiny holes in them were found and were estimated to be 75,000 years old. The U.S. National Science Foundation reported on this find in 2004:

> Perforated shells found at South Africa's Blombos Cave appear to have been strung as beads about 75,000 years ago — making them 30,000 years older than any previously identified personal ornaments. Archaeologists excavating the site on the coast of the Indian Ocean discovered 41 shells, all with holes and wear marks in similar positions, in a layer of sediment deposited during the Middle Stone Age (MSA).

> “The Blombos Cave beads present absolute evidence for perhaps the earliest storage of information outside the human brain,” says Christopher Henshilwood, program director of the Blombos Cave Project and professor at the Centre for Development Studies of the University of Bergen in Norway.
>
> The shells, found in clusters of up to 17 beads, are from a tiny mollusk scavenger, Nassarius kraussianus, which lives in estuaries. They must have been brought to the cave site from the nearest rivers, 20 kilometers east or west on the coast. The shells appear to have been selected for size and deliberately perforated, suggesting they were made into beads at the site or before transport to the cave. Traces of red ochre indicate that either the shell beads themselves or the surfaces against which they were worn were coated with this widely used iron oxide pigment.[19]

Food decays, and so in a world without freezers, people don’t have an incentive to keep much more food than they need. Similarly, spears and furs are bulky to carry around; beyond a certain point, there isn’t much value to having too many extra spears and furs. Trading with other tribes with these things is difficult because each side needs to have precisely what the other side wants. But having carved and polished shell beads fixes the problem. They don’t rot and they aren’t bulky, so it’s fine (and even desirable) to collect extra of them whenever peoples’ other needs are met. They’re nearly universally desired in a world with that basic level of technology. Even if someone doesn’t like wearing them, their spouse or sibling or friend might. And they know members of most other tribes like them, which opens future trading opportunities.

Creating carved and polished shell beads was a very labor-intensive process. The shells first had to be collected by hand on the coast, and then depending on the type, they were carved, polished, and manually drilled into with a bow drill so that a thread could be run through them to affix them together or onto something else, making them into a useful ornament. Once made, these shell beads lasted a long time, and had a lot of value relative to their size and weight due to their attractiveness and the amount of work that it took to make them. If someone trades excess food for some shell beads, or spends surplus time creating shell beads, they could hold onto the shell beads for months or years until they come across something that they want or need and trade them for that thing. And in the meantime, they are wearable and aesthetically pleasing.

In other words, the shell beads serve as something that can be accumulated, that can augment or replace the need for flexible social credit, and that can replace the oral ledger — at least when it comes to dealing with people that are not trusted or might never be seen again. Shell beads, as a nearly universally desirable and durable good, allow someone to trade with people even if they need nothing from them, because they can always just request shell beads that act as a placeholder until they do come across something they need or want. And they can always use more shells than whatever number they currently have, because they represent portable, stored-up value that they can trade away for resources in the future, either with their own bandmates or with other groups. Compared to food that decays, or furs and spears that are too bulky to hoard or carry, these small wearable shells arguably represent the invention of long-term savings technology — meaning a way to convert surplus time or resources into a financial battery. People can keep some strands of shell beads on their wrists, some on their neck, some on their ankles, some in their hair, some as a belt, etc. People can put them on their kids or give them to their spouse. Each small piece of shell jewelry is intrinsically desirable and represents quite a bit of work.

In this role as the most sell-able ("salable") good, each strand of shell beads acts like one of Vito's unspecified future favors. Someone or some group that has collected a lot of shell beads by spending surplus time and resources to accumulate them (or who inherited them from the prior generation who did) now has plenty of value to offer if they need more immediate resources in the future. And unlike a favor, a strand of shell beads represents final settlement; its ongoing value does not depend on the memory of the one who received the favor.

In addition to someone simply enjoying wearing shell beads for their own aesthetic sake, shell beads were often a sign of status. Someone with a lot of shell beads had a lot of wealth, literally and socially. In this tribal context, if we see someone covered in beautiful shell belts, bracelets, necklaces, and sewn into their clothes, we can assume they must have provided a lot of value to others in the past to have accumulated so many shell beads, or that they are closely connected to other people that have. They are literally wearing a bunch of valuable stored-up favors on their person, and thus have enjoyed a significant period of surplus resources. This seems like a good person to get to know, to respect, and possibly to mate with. They're socially signaling that they've had a past filled with abundance.

In the study mentioned previously — "Wealth Transmission and Inequality Among Hunter-Gatherers" — the researchers noted that moveable property was usually individually owned in hunter-gatherer societies, while land tended to be more communally owned:

> Moveable material property, such as tools, clothing, and valuables, is generally treated as individual property and is often transmitted to descendant kin. In most foraging societies, however, such property

> can usually be manufactured by any adult of the appropriate gender, or obtained fairly readily; exceptions include items involving highly specialized manufacture or obtained through limited trade contacts, as well as wealth and prestige goods in some sedentary and less egalitarian societies.[20]

Notably, “items involving highly specialized manufacture” and “prestige goods” are identified as among the types of property that are not readily obtainable. In other words, they have actual scarcity to them. The researchers went on to conclude that, while generally communal in many aspects, hunter-gatherer societies in general are not necessarily as egalitarian as we may imagine them to be:

> Indeed, as detailed in the introductory paper in this forum by Bowles et al., $\beta=0.25$ implies that a child born into the top wealth decile of the population is 5 times more likely to remain in the top wealth decile than a child whose parents were in the bottom decile. Even a β of 0.1 implies that a child born into the top wealth decile is twice as likely to remain there as is one born into the bottom decile. These results suggest that in hunter-gatherer populations, even those with extensive food-sharing and other leveling devices (Cashdan 1982), the offspring of those better off will tend to remain so, and conversely.[21]

Unlike a literal ledger, no party in the transaction knows what the full ledger of shell beads looks like. If you and I are involved in a transaction, neither of us knows exactly how many shell beads exist in our region. But we do know their properties and how hard they are to make, and we know how often we see them worn by others, which helps us judge their rarity and what we could consider trading for them.

Shell beads, and commodity monies more broadly, serve as nature’s decentralized ledger. By handing shells to someone else in exchange for something of value, we update the state of the ledger, and it is by physical possession that the full state of the ledger is maintained and updated. All participants understand and interact with parts of this natural ledger, but none of us know the full ledger state.

Who controls this ledger? For the most part, the answer to that question is “nature.” And in practical terms, that means no human or group controls it. Making shell beads requires expending energy and time — in the right way with the right materials — which means nobody can cheat. Some coastal participants could spend their surplus time directly making shell beads, whereas other inland participants could spend their time accumulating other surplus resources, and then trading some of those surplus resources for shell beads. Either way, shell beads were a measure of surplus time and resources, a measure of savings and value, and often with a lot of ceremony attached to the process.

For the remaining part, or the edge case, the answer to who controls the ledger is that whoever has the most advanced technology controls the ledger. This commodity money ledger system works if all participants are somewhat equal in productive capability, which was the case for much of the world for thousands of years. If an extremely advanced civilization comes from across the ocean and has specialized metal tools, and they figure out how the shell money system works, then they can probably make an order of magnitude more shell beads per unit of work than anyone else. They can therefore devalue everyone's shells by flooding the market with them, and they can collect a lot of resources in the process because it will take time for the tribes to realize that this new civilization can churn out shells much faster than anyone else, and that shell beads in general are becoming less rare and less valuable over a period of months or years due to this rapidly expanding supply.

As we'll see in the next chapter, the story of commodity money is a story about technological progress. Various commodity monies serve as honest and fair ledger systems up until technology reaches a point where one group gains an unequal advantage, which then forces everyone else to adapt or lose.

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8 Ignace Gelb, "Sumerian Language."

9 William Goetzmann, *Money Changes Everything: How Finance Made Civilization Possible*, 15–25.

10 Justin Pack, *Money and Thoughtlessness*, 51–70.

11 See for instance Marcel Mauss, *The Gift*; Marshall Sahlins, *Stone Age Economics*; and Paul Einzig, *Primitive Money*.

12 Elise Berman, "Avoiding Sharing."

13 Paul Seabright, *The Company of Strangers: A Natural History of Economic Life*, 2–5, 91–105.

14 Eric Smith et al., "Wealth Transmission and Inequality Among Hunter-Gatherers," 21.

15 Szabo, "Shelling Out."

16 Dror Goldberg, "Famous Myths of 'Fiat Money'," 962–963.

17 Marc Shell, *Wampum and the Origins of American Money*.

18 Bin Yang, "The Rise and Fall of the Cowrie Shell: The Asian Story."

19 National Science Foundation, "Shell Beads from South African Cave Show Modern Human Behavior 75,000 Years Ago."

20 Smith et al., "Wealth Transmission," 21.

21 Smith et al., "Wealth Transmission," 31.

CHAPTER 2

THE EVOLUTION OF COMMODITIES AS MONEY

As the prior chapter explored, humans in small kinship and friendship groups don't need money; they can organize resources among themselves manually, with informal oral ledgers at most. They can keep track of who offers a repeated surplus to the group and who always seems to be operating at a deficit. Within small groups, people naturally "solve the problem of barter" with flexible social credit before the problem of barter even comes up.

However, groups that regularly trade with outside groups, or develop farming and begin to reach larger static populations than the typical tribal size, inevitably start identifying and making use of some form of money, which gives them a more liquid, divisible, portable, and widely accepted accounting unit for storing and exchanging value with people they don't know. In addition to still using social credit systems, they also rely on nature's ledger, so that they can sidestep the double coincidence of wants that would otherwise reduce the success rate of trading.

The usage of collectible proto-monies, since they take so much labor to produce, often seems arbitrary to outsiders of that culture. Why spend so much time making shell beads, for example? Isn't that a waste of resources, in a harsh, low-technology, hunter-gatherer environment where every resource is valuable and where more than a third of children don't even make it to adulthood? Shouldn't surplus time be spent on something else? The answer is that this work is a good use of resources during periods of abundance, and ends up more than paying for itself, because a standardized and credible medium of exchange and store of value makes all other economic transactions more efficient.

As an economy becomes more complex, there are a greater number of possible combinations of barter between different types of goods and services. For example, if an economy produces five different products, then there are 10 different unique trading pairs. If an economy produces 20 different products, then there are 190 unique trading pairs. An economy with 100 different products has 4,950 unique trading pairs. At this point, most types of barter other than for the basics would be wildly inefficient.

So, if a society requires more complex or trustless interactions than flexible social credit will allow, then that society requires some standard unit of account — or money — that serves as one side of the trading pair with every other good or service.

Specifically, among the assets that a society trades, one or two of the most scarce, divisible, durable, portable, and liquid tend to rise to the top. An apple farmer that needs some tools (a blacksmith), meat (a cattle rancher), repair work (a carpenter), and medicine for her children (a doctor), can't spend the time going around finding individuals that have what she needs, that also happen to want a ton of apples at that moment. An extensive barter system like this between neighbors doesn't develop naturally. Instead, she simply needs to be able to sell her (highly seasonal and short-lived) apples for some durable and widely accepted savings unit that she can use to buy those things with over time as she needs them.

In 1776, Adam Smith discussed the emergence of money as a solution to the barter problem in his *Wealth of Nations.* Credit theorists object to this example and order of events around the topic of barter in general, but that objection and the broader debate around it are addressed in detail in Chapter 4 of this book. After Smith's exploration of the topic, commodity money as a detailed topic tends to be heavily emphasized by those in the Austrian school of economics, founded by Carl Menger in the 1800s, and further advanced by Ludwig von Mises, Friedrich Hayek, and many others.

In this way of thinking, money should be divisible, portable, durable, fungible, verifiable, and scarce. It also usually (but not always) has some utility. Different types of money can be thought of as having different “scores” along those metrics:

- Divisible means that the money can be sub-divided into various sizes that are suitable for different sizes of purchases.
- Portable means that the money is easy to move across distances, which means it must pack a lot of value into a small weight.
- Durable means that the money is easy to save across time; it does not rot or rust or break easily.
- Fungible means that individual units of the money don’t differ significantly from each other; one is as good as any other.
- Verifiable means that the seller of the goods or services for the money can easily check that the money really is what it appears to be.
- Scarce means that the money supply does not increase quickly.
- Utility means that the money is intrinsically desirable in some way; it can be consumed or has aesthetic value, for example.

Summing those attributes together, money is the “most salable good” available in a society, meaning it’s the good that is the most sell-able — the most capable of being sold. Money is the good that is most universal, in the sense that people want it, or realize they can trade for it and then easily and reliably trade it for something else that they do want. In his article “On the Origin of Money,” Menger described that an ideal money transports value across both space and time, meaning that it can be transported across distances efficiently or saved for spending in the future.[22] In addition, a key aspect of salability is liquidity, meaning that someone should be able to buy or sell large amounts of it relatively easily, and without losing much value to wide price spreads or lack of sufficient trading volumes. Liquidity in many ways is a measure of acceptability: The more widely accepted and widely held something is, the more liquid the trading for it tends to be.

Scarcity is often what determines the winner between two competing commodity monies. However, it’s not just about how rare the asset is. In fact, extreme rarity can be bad for liquidity and make a commodity into a bad (unsalable) form of money. An important concept to be familiar with here is the stock-to-flow ratio, which measures how much supply there currently exists in the region or world (the stock), divided by how much new supply can be produced in a year (the flow).

For example, gold miners add about 1.5% new gold to the estimated existing above-ground gold supply each year,[23] and unlike most other commodities, most of the gold does not get consumed; it gets repeatedly melted and stored in various shapes and places.

Gold does not rot, rust, or corrode as readily as most other materials do. It is chemically inert and therefore barely forms any compounds. It can be re-melted countless times and can even be dissolved in certain types of acid and then filtered back out. It can be blown up and scattered, but those pieces don't rust into nothingness like other materials would, and therefore the pieces are retrievable. Other than trace amounts that are thrown out in electronic circuit boards or sunk to the bottom of the ocean in shipwrecks, most gold ever mined is still in human control (and even those lost gold amounts are technically retrievable, at the right price). It's practically indestructible.[24]

The combination of continuously mining gold and rarely losing any of the mined gold has resulted in gold having a stock-to-flow ratio of about 100/1.5 = 67 on average, which is the highest stock-to-flow ratio of any commodity. The world collectively owns 67 years' worth of average annual production, based on estimates by the World Gold Council. The supply growth rate has varied between 1% and 2% over the past century, which is a remarkably low and narrow band.[25] Even in the 1970s when gold went up by an order of magnitude in terms of its dollar price, it couldn't affect the annual supply growth as a percentage of existing holdings by much at all. Prior to that point, the only periods where the refined gold supply increased at an accelerated rate were when industrial societies found a new continent and explored easy deposits, or if they invented new techniques for profitably extracting previously uneconomical deposits.

If an asset has a monetary premium on top of its pure utility value, then market participants are strongly incentivized to try to make more of it. Only assets that are highly resistant to increases in supply relative to the total existing supply can withstand this challenge, and thus can become and remain widely accepted money on a global scale.

On the other hand, if an asset is so rare that barely anyone has it, then it may be extremely valuable if it has utility, but it has little use as money; it's not liquid and widely held or accepted, and so the frictional costs of buying and selling it are high. Certain atomic elements like rhodium for example are rarer than gold but have low stock-to-flow ratios because they are consumed by industry as quickly as they are mined. A rhodium coin or bar can be purchased as a niche collectible or store of value, but it's not useful as widely accepted societal money and therefore doesn't arise as such naturally. The same is true for meteorites or other unusually rare things. As of 2022 there have been 1,878[26] known meteorites discovered in the United States, and there are tens of thousands that have been found in other jurisdictions, which makes meteorites rare and valuable collectibles but not good money. Things like rhodium bars or meteorites simply don't have enough liquidity or divisibility to be useful as money.

So, a long-lasting, high stock-to-flow ratio tends to be the best way to measure scarcity for something to be considered money — along with the other attributes on the list above — rather than absolute rarity. A commodity with a high stock-to-flow ratio is hard to produce, and yet a lot of it has already *been* produced and is widely distributed and held, because it either isn't rapidly consumed or isn't consumed at all. That's a relatively uncommon set of attributes and what allows something to be money rather than merely a collectible.

Throughout history various stones, beads, feathers, shells, salt, furs, fabrics, sugar, coconuts, livestock, copper, silver, gold, and other things have served as money. They each have different "scores" for the various attributes of money and tend to have certain strengths and weaknesses. It was often the case that at least two monies were widely used at a time because no single money could fulfill every role perfectly.

Salt for example is divisible, durable, verifiable, fungible, and has important utility, but is not very valuable per unit of weight and not very rare, so doesn't score very well for portability and scarcity. The word "salary" comes from the Latin word *salarium* which referred to a salt-denominated income.

Gold is the best among just about every metric and is the commodity with the highest stock-to-flow ratio by far. The one weakness it has compared to other commodities is that it's not very divisible. Even a small gold coin is more valuable than most purchases and is worth a tremendous amount of labor. It's the king of commodities. Gold, as an ideal form of ornamentation, is basically a more technologically advanced version of shell beads. Its most common application is to serve as wearable or displayable wealth across many different cultures. It is money that we can easily bring with us and that we can use to signal our social status to others.

For a large portion of human history, silver has been the winner in terms of everyday usage. It has the second-best score after gold across the board for most monetary attributes, including the second highest stock-to-flow ratio, but beats gold in terms of divisibility, since small silver coins are ideal for daily transactions. It's the queen of commodities. And like in the game of chess, the king may be the most important piece, but the queen is the most useful piece.

As a result, gold was often held by the wealthy as a long-term store (and display) of value and as a medium of exchange for very large purchases, while silver was the more tactical money, used as a store of value and a medium of exchange by most working people. A bimetallic money system was common in many regions of the world due to gold's limited divisibility, despite the challenges that come with that multi-money approach.

Why did gold and silver defeat all other commodity monies to reach the modern era as usable money? The answer is that these were the two that could maintain high enough stock-to-flow ratios against the rise of human technology, even with a substantial monetary premium placed on them. They could retain their rarity over time, while also being widely accepted, widely held, durable, portable, divisible, and re-combinable.

The purchasing power of a commodity money can be conceptually divided into two parts: utility value and a monetary premium above that utility value. The utility value is the actual usage of that commodity for an economic purpose (consumption or production), while the monetary premium is an additional value that it has because so many people hold it as a form of savings, for lack of anything better to hold. The difference between a normal commodity and a commodity money is that people holding units of a commodity money are not just using it for its end purpose; they are holding it as savings because it's a highly salable good that they can easily resell in the future. Non-monetary commodities such as crude oil are for the most part measured only in terms of their utility value. There is practical demand and there is production supply, and relatively few others are holding oil for any significant amount of time. The dominant commodity monies of a region such as gold, however, have excess demand on them from widespread holding by people who are not end users, which greatly increases the total market value of that commodity. People hold a gold coin not because they want to do anything with the coin, but because they know that gold has many purposes and that by holding some, they are saving value in something that has a lot of liquidity and global acceptability.

This monetary premium (this excess price above the utility purpose) serves as a massive and permanent advertisement for people to try to figure out how to make more of that commodity. Only the scarcest commodities, meaning those with the highest stock-to-flow ratios, can withstand this advertisement over the long run. Monetary premiums can be applied to other assets as well, such as waterfront properties or fine art, because they are often held more so as a form of savings than to be enjoyed for their own sake. The downside with that approach is that such non-monetary assets inherently lack the portability, liquidity, fungibility, and divisibility of gold and other monies.

Many people consider money to be a shared delusion. In this way of thinking, a society can pick anything it wants as money, as long as most of its members believe in it. Paperclips could be money, for example, if we all agree that they are. While this seems true at first, it's not sustainable. If the supply of that money can be rapidly expanded, then everyone's savings can be rapidly diluted. And a monetary premium provides a lot of incentive for people to make more of it, if possible. Therefore, if a money is not selected wisely within a society, it only takes a small number of individuals to break free from their society's shared delusion to realize that its money isn't scarce, and make a lot more of it to extract value from everyone else. Alternatively, people from a different society can exploit that society's shared delusion. Therefore, the only types of money that can maintain usage in a society for a long period of time are ones with a significant degree of genuine scarcity to them.

Shell money lasted thousands of years in various regions, but eventually became unworkable against the industrial revolution. Furs, livestock, salt, tobacco, and other monies also served their useful roles at various times, but the ever-growing technical prowess of civilization eventually made those unworkable as money as well. They worked until technology disallowed them from continuing to work. The following sections walk through several examples for this concept.

SHELLS

As previously described, shell money was used for long stretches of time in parts of the Americas, Africa, and Asia. In some areas it was used more ceremonially, and in other areas it was used more literally in the transactional sense as money.

The wampum variety of shell beads that was common on the east coast of North America was the more ceremonial variety by the original tribes that developed it.

Nonetheless, New England colonialists incorporated it into their money system in the early 1600s, with a fixed exchange rate of a certain number of shells equaling their coins.[27] Purple wampum was rarer and thus was given twice the value of white wampum.

Eventually the fixed exchange rate laws were repealed, and wampum was valued on a market basis. John Campbell opened the Campbell Wampum Mill in New Jersey in 1812, and with modern drilling techniques, they were able to mass produce wampum beads at a much faster pace than they could previously be produced at.[28] John Jacob Astor of the American Fur Company purchased this industrially produced wampum and used it to trade for furs with indigenous populations in Canada.

In the long arc of time, shell money in all its forms and geographies across the world became unworkable against the power of industry. Metal tools and other technologies made shell money an unsuitable medium for storing value. In some areas to this day, the tradition of making wampum by hand is kept alive by descendants of the indigenous people that used it, returning it to its more ceremonial and nuanced purposes as a way of preserving cultural tradition.

TOBACCO

In the early 1600s, Virginia, Maryland, and North Carolina began using tobacco as money, including as government-decreed legal tender. Over time, however, problems began to emerge with that system that were similar to the industrialization of wampum shells.

Since tobacco had a monetary premium placed on it above its utility value, there was a massive incentive to plant more of it and to try to capture (and therefore eventually erode) that monetary premium.[29] Unlike gold, tobacco doesn’t have enough natural scarcity to prevent that monetary premium from being exploited and dissipated. The natural result of this monetary premium was a major increase in the supply of tobacco, and this led to major price inflation for goods and services in tobacco-denominated terms. In response to this excess supply of tobacco, colonial governments enacted restrictions on the planting of tobacco, such as by limiting production to certain groups, to create artificial scarcity in what is otherwise not scarce on its own.[30] In other words, only groups favored by the government could act as the “tobacco money printer.” This is clearly an imperfect solution, and a hard one to maintain indefinitely.

Another problem was that tobacco is not perfectly fungible. There are higher and lower qualities of tobacco. If all tobacco is valued at a certain exchange rate, then there is a strong incentive to spend the lowest quality tobacco locally, and to sell the high-quality tobacco overseas where it is more appropriately valued. As a result, warehousing began to occur, where tobacco would be stored and graded, with standardized paper claims issued against it. They therefore created a "tobacco standard" system. For the holder of the paper receipt, this created counterparty risk in addition to the existing risk associated with the devaluation of the underlying tobacco.[31]

Overall, the problem with tobacco was that it could not withstand the invitation to produce more of it, and a monetary premium is a major invitation to try to create more of something. It's a very heavy burden for any commodity to carry. Gold has been able to withstand that challenge for thousands of years, but tobacco could not. Tobacco served a useful role for some time in the southern colonies because they were small and poorly developed in their early years and lacked sufficient specie, but the tobacco monetary system no longer made sense once they grew larger and more developed. Various attempts by government to prolong the useful life of this money delayed its inevitable demise for a period, but eventually the system became clearly unworkable relative to sounder types of money and was discarded entirely.[32]

COCOA

Throughout parts of central and southern America, civilizations used cocoa as money. This practice was in effect when Europeans arrived, and murals show that it dated back many centuries earlier.[33] Cocoa beans are small, relatively fungible, and can be stored for a decent amount of time. Most importantly, people love the taste! These traits made cocoa a decent form of money.[34]

Like many pre-industrial societies, these civilizations engaged in flexible social credit and barter, and that practice trends toward using one or two highly salable goods as a method to improve trading. One or two scarce and liquid goods tend to become money in contexts where credit is not sufficient. Aztecs also had copper money, with units being molded into the shape of a decorative hoe or decorative dull axe. Thousands of cocoa beans could be traded for one of these copper units, if someone needed to engage in larger transactions or store liquid wealth in a small and portable unit for a longer period.[35]

When Europeans arrived in the Americas, they engaged in the use of cocoa and copper as money, but like other places in the world, this practice was eventually displaced by more scarce forms of money.

RAI STONES

Inhabitants of an island in the South Pacific called Yap used enormous stones as money. These “rai stones” (or “fei stones”) were carved into circular discs of stone with a hole in the center, and came in various sizes, ranging from a few inches in diameter to over ten feet in diameter. Many of them were at least a couple feet across, and thus weighed hundreds of pounds. The biggest were over ten feet across and weighed thousands of pounds.[36]

Interestingly, I’ve seen this example used by both an Austrian economist and an MMT economist. The reason that’s interesting is because those two schools of thought have very different conceptions of what money is. Austrian economists tend to emphasize money as a commodity, whereas Chartalists (and MMT economists in their current form) tend to emphasize money as a public ledger.[37] These views can be reconciled by understanding that commodity monies are being used as a ledger, with nature serving as the administrator of that ledger. That reconciliation is discussed more in Chapter 4.

What made these rai stones unique was that they were made from a special type of limestone that was not found on the island. Yap islanders would travel 250 miles to a neighboring island called Palau to quarry the limestone and bring it back to Yap.

They would send a team of many people to that far-away island, quarry the rock in giant slabs, and bring it back on wooden boats. Imagine bringing a multi-thousand-pound stone across 250 miles of open ocean on a wooden boat. Some people died in this process over the years. It required a tremendous amount of time, effort, and danger.

Once made into rai stones on Yap, the big ones wouldn’t move. This is a small island, and all the stones were catalogued by oral tradition. An owner could trade one for some other important goods and services, and rather than moving the stone, this would take the form of announcing to the community that this other person owned the stone now.[38]

In that sense, rai stones were a literal ledger system, and not really that different from our current monetary system. The ledger keeps track of who owns what, and this particular ledger happened to be orally distributed, which of course can only work in a small community.

By the time this was documented by Europeans, there were thousands of rai stones on Yap, representing generations of quarrying, transporting, and making them. Rai stones thus had a high stock-to-flow ratio, which is a main reason for why they could be used as money.

In the late 1800s, an Irishman named David O'Keefe came across the island and figured this out. And, with his better technology, he could easily quarry stone from Palau and bring it to Yap to make rai stones, and thus could become the richest man on the island, able to get locals to work for him and trade him various goods. An article for the *Smithsonian Magazine* by Mike Dash called "David O'Keefe: The King of Hard Currency" summarized it as follows:

> As the Irishman got to know Yap better, he realized that there was one commodity, and only one, that the local people coveted—the "stone money" for which the island was renowned and that was used in almost all high-value transactions on Yap. These coins were quarried from aragonite, a special sort of limestone that glistens in the light and was valuable because it was not found on the island. O'Keefe's genius was to recognize that, by importing the stones for his new friends, he could exchange them for labor on Yap's coconut plantations. The Yapese were not much interested in sweating for the trader's trinkets that were common currency elsewhere in the Pacific (nor should they have been, a visitor conceded, when "all food, drink and clothing is readily available, so there is no barter and no debt"), but they would work like demons for stone money.[39]

In essence, better technology eventually broke the stock-to-flow ratio of rai stones by dramatically increasing the flow. Foreigners like O'Keefe, armed with more advanced technology, could bring any number of them to the island, become the wealthiest people on the island, and therefore increase the supply and reduce the economic value of the stones over time.

However, locals were smart too, and they eventually mitigated that process. They began to assign more value to older stones (ones that were verifiably quarried by hand decades or centuries ago), because that subset remained scarce. Similar to how no matter how much new art is produced, Vincent van Gogh isn't making any more, and so his paintings tend to increase in price rather than get debased by new supply from other artists. Nonetheless, the writing was on the wall; rai stones weren't a great system for money anymore.

Things then took a darker turn. As further described in Dash's *Smithsonian* article:

> With O'Keefe dead and the Germans thoroughly entrenched, things began to go badly for the Yapese after 1901. The new rulers conscripted the islanders to dig a canal across the archipelago, and, when the Yapese proved unwilling, began commandeering their stone money, defacing the coins with black painted crosses and telling their subjects that they could only be redeemed through labor. Worst of all, the Germans introduced a law forbidding the Yapese from traveling more than 200 miles from their island. This put an immediate halt to the quarrying of fei, though the currency continued to be used even after the islands were seized by the Japanese, and then occupied by the United States in 1945.[40]

Many of the stones were taken and used as makeshift anchors or building materials by Japanese invaders during World War II, reducing the number of stones on the island.

Rai stones were a notable form of money while they lasted because they had no practical utility other than for aesthetics. They were a way to display and record wealth, and little else. In essence, it was one of the earliest versions of a formal public ledger, since many of the stones didn't move and only oral records (or later, physical marks by Germans) dictated who owned them.

FEATHERS

Feathers were often used as money-like objects by tribes around the world. Majestic birds such as eagles or parrots, with unusually large or beautiful feathers, were collected by many cultures.

Sometimes these would have a more ceremonial value, such as eagle feathers used as headdresses among tribal leaders. Other times they would be collected more informally, simply for their beauty and interest, and then occasionally used in trades.[41] A downside of feathers is that they are not very durable; over time it's easy to wear a feather down and ruin it — especially if you're always on the move.

In the Solomon Islands, a form of feather currency was manufactured by tribal craftsmen into belt-like rolls. Each roll would consist of red feathers from hundreds of tiny scarlet honeyeaters, along with sap and other substances. This resulted in a more durable and unique form of feather money. Due to its nature, however, such a form of money is inherently limited in its fungibility and liquidity to a small jurisdiction, both geographically and culturally.

AFRICAN BEADS

Trade beads were used in parts of west Africa as money for many centuries, stretching back at least to the 1300s and prior. Various rare materials could be used, such as coral, amber, and glass. Venetian glass beads gradually made their way down to sub-Saharan west Africa through trade. One of the earliest documented references we have for this comes from Ibn Battatu, the famous Moroccan traveler of the 14th century whose exploratory trips took him all over Africa and Asia.

Emil Sandstedt, in his book *Money Dethroned: A Historical Journey* quoted Ibn Battatu, regarding Battatu's observation of West African money practices:

> A traveller in this country carries no provisions, whether plain food or seasonings, and neither gold nor silver. He takes nothing but pieces of salt and glass ornaments, which the people call beads, and some aromatic goods.[42]

These were pastoral societies, often on the move, and the ability to wear your money in the form of strands of beautiful beads was useful. These beads maintained a high stock-to-flow ratio because they were kept and traded as money, while being hard to produce with their level of technology.

Eventually, Europeans began traveling and accessing West Africa more frequently, noticed this usage of trade beads, and exploited them. Europeans had glass-making technology and could produce beautiful beads with modest effort. So, they could trade tons of these beads for commodities and other goods (and unfortunately for human slaves as well).[43]

Due to this technological asymmetry, Europeans devalued these glass beads by increasing their supply throughout West Africa and extracted a lot of value from those societies in the process. West Africans kept trading scarce local goods, ranging from important commodities to invaluable human lives, for glass beads that had far more abundance than they realized.[44] As a result, they traded away their real valuables for fake valuables. Picking the wrong type of money like this can have dire consequences.

It wasn't quite as easy as one might suspect for the Europeans to accomplish this trick, however, because the Africans' preferences for certain types of beads would change over time, and different tribes had different preferences. This seemed to be like the experience with the rai stones, where once new supplies of rai stones started coming in faster due to industrial technology, the people of Yap began valuing old ones more than new ones. In this case, the West African tastes seemed to change based on aesthetics and scarcity. However, this practice also gave that form of money a lower score for fungibility, which reduced its reliability as a medium of exchange. Like rai stones, trade beads couldn't ultimately maintain their high stock-to-flow ratio in the face of technological progress, and therefore eventually were displaced as money.

JAPANESE INVASION MONEY

Although not a commodity money per se, Imperial Japan used weak money to acquire the scarce goods and services of regions that it had power over.

During World War II, when Imperial Japan invaded regions throughout Asia, they would confiscate hard currency from the locals and issue special paper currency in its place, which was referred to as "invasion money."[45] These conquered peoples would be forced to save and use a currency that had no backing or supply scarcity and that ultimately lost all its value over time. This was a way for Japan to extract savings of their subjects while maintaining a temporary unit of account in those regions for economic transactions to continue to occur.

To a less extreme extent — as I describe later in this book — this is sadly what happens throughout many developing countries today: people constantly save in their local fiat currency that, every generation or so, gets dramatically debased, with their savings being siphoned off to the rulers and wealthy class.

GRAIN

In ancient Babylon, the silver shekel was used as a key monetary unit, but grain was also frequently used as a form of payment. Grain served as a food staple for the region, was often used to pay daily wages, and frequently served as a unit of account for other transactions.[46]

The Code of Hammurabi, which is nearly four thousand years old, enforced grain as legal tender:

> 108. If a wine-seller do not receive grain as the price of a drink, but if she receive money by the great stone, or make the measure of drink smaller for corn, they shall call that wine-seller to account, and throw her into the water.
>
> 111. If a wine-seller give 60 KA of drink on credit, at the time of harvest she shall receive 50 KA of grain.
>
> 114. If a man do not hold a debt of grain or money against a man, and seize him for debt, for each seizure he shall pay one-third mana of silver.
>
> 115. If a man hold a debt of grain or money against a man, and he seize him for debt, and the one

> seized die in the house of him who seized him, that case has no penalty.[47]

The difficulty of using an agricultural product for money is that the money supply changes dramatically throughout the year. Harvest season creates a lot of new grain money, and then throughout the rest of the year that grain supply is drawn down from people turning it into bread and beer. Farmers often relied on debt to make their payments, and then used their harvest (if successful) to pay off the debts to their creditors they had incurred throughout the non-harvest seasons.

In many societies like this, failed harvests could mean financial ruin for the farmer. The farmer and/or their family members could become debt-slaves. However, various kings would periodically forgive debts, or institute limitations on creditors either by excusing the debtor for certain events or by limiting the amount of servitude required to pay off debts.

> 48: If a man owe a debt, and a storm inundates his field and carry away the produce, or through lack of water grain have not grown in the field, in that year he shall not make any return of grain to the creditor, he shall alter his contract-tablet and he shall not pay interest that year.
>
> 117: If a man be in debt and sell his wife, son or daughter, or bind them over to service, for three years they shall work in the house of their purchaser or master; in the fourth year they shall be given their freedom.[48]

Babylon provided among the earliest known examples of formalized weights and measures, formalized commodity money, formalized written credit, formalized custody contracts, and formalized legal tender. Kings set the foundational rules of commerce and addressed any structural imbalances in the system as they occurred throughout their reign, while temples served as the administrative systems for formalized commerce to occur.

VIDEO GAME MONEY

One of the fascinating outcomes of massively multiplayer online games is that they result in various unintended economic experiments. They basically re-run various economic environments with new rulesets, and this leads to case studies on emergent aspects of economies.

One well-known example of this was the emergent monetary formation in the online game *Diablo II*, which was an extremely popular multiplayer action-fantasy game released in the year 2000 that sold millions of copies (including to me as a teenager). Several people have analyzed the in-game economy over the years, but it was the author of *21 Lessons*,[49] Gigi, who brought it to my attention with an article in 2022.[50]

Diablo II had an in-game currency which (as we would expect in a fantasy setting) was called "gold." However, gold was programmed in such a way that inadvertently prevented it from being the best form of money in the game. Firstly, gold was abundant at high levels of play, but your game character could only carry a limited amount of it on their person. Secondly, whenever your game character died, you would lose a portion of the gold you were carrying, yet you could get all your other items back. Naturally with these limitations on gold, players wanted to store their wealth in valuable items instead.

Additionally, because it was a multiplayer game with many rare items (and ways to craft certain greater items from lesser items), players naturally wanted to trade with each other. There were druids, barbarians, paladins, sorceresses, and other classes of characters. Within those classes, each character could be customized differently, with multiple potential directions of skill development and gear. Therefore, some rare items that were useful to one player were not useful to another player, and a lively trading economy emerged as a result.

For barter to be successful, it requires satisfying a double coincidence of wants. If a barbarian and a sorceress meet up to trade items, it is likely that they will fail the trade. Perhaps he wants a mighty axe, and she wants a magical staff. Out of the hundreds of items in the game, what are the chances that they each will have specifically what the other wants?

To fulfill this need, a form of money other than in-game "gold" quickly emerged among the players. Naturally, some items inherently made for better money than other items due to their characteristics. Players had limits on how many item slots they may carry, and larger items took up more slots. So, a monetary item needed to be valuable relative to the amount of space it took up. Additionally, a monetary item needed be rather universally desirable; it couldn't be some niche item that only barbarians could use, but rather had to be something that most classes could use.

The answer in the first couple years of the game was that a rare ring called the Stone of Jordan ("SoJ" for short) became the widespread currency of *Diablo II*. The SoJ boosted the mana and all skills of a player who wore it, which made them useful to everyone, and especially to the various spellcaster classes for whom mana was a particularly important resource. A SoJ might or might not be the “best” piece of gear for a given character, but every character could make significant use of them, and for some characters it was indeed a top-tier item to wear. Beyond their use, however, SoJ’s acquired a monetary premium, since many people would collect them as savings, and use them as a highly salable good for trading. They took up the minimum amount of space in terms of character carrying capacity, which gave them a high amount of value density. Rare weapons and gear were denominated in SoJs; a rare magical sword might be worth eight SoJs, and a rare magical bow might be worth five SoJs.

Therefore, a sorceress could acquire some rare items on her journeys, and sell them to other players for SoJs, which she would hold. If one day she meets a barbarian that happens to have the rare magical staff that she wants, she could trade the SoJs for the staff. The barbarian could then eventually find someone who has the mighty axe that he wants and trade the SoJs for it. That’s much easier than trying to line up a direct trade of a specific magical staff for a specific mighty axe.

SoJs emerged naturally as money because they had the best characteristics of money out of the items in the game. They were not intended to be used as money by the game developers, and it’s not as though the players got together in a meeting one day and arbitrarily picked them; through quick analysis and iteration, the fact simply emerged among millions of players that SoJs were the best in-game money. And once they became the game’s money, SoJs had a depth of liquidity that other items didn’t have. Many people had them as savings, and many people would accept them, and thus their salability was higher than that of other items. Most players wouldn’t be able to cite the *The Wealth of Nations* or similar economic literature for their reasoning; they just intuitively understood that having an in-game money was useful to solve the problem of barter in a world without credit, and that rare, small, widely useful items were ideal for it.

The one shortcoming of SoJs is that they were quite valuable and not divisible. So, there were also items called “perfect skulls” that emerged as lesser money. They were small and widely useful, but not as rare. Five perfect skulls could be traded for a SoJ, and a varying number of SoJs could be traded for varying legendary magic weapons and gear. In other words, SoJs were like banknotes for big purchases, and perfect skulls were like coins for small purchases or change.

Eventually, players found bugs in the game that allowed them to duplicate SoJs, and so SoJs began flooding the market, and devaluing. The game developers attempted to identify the bugs and delete duplicated items, and so players would open the game and find that some of their SoJs had disappeared. SoJs ceased being good money beyond that point, like how many commodity monies were rendered obsolete by advances in technology. The "technology" of buggy duplication rendered SoJs into bad money.

When the *Diablo II* expansion came out, the game developers introduced additional items including runes. Runes could be inserted into various gear to make the gear more powerful and could be combined in specific ways to create entirely new gear. Runes were small, valuable, and widely useful, and there were different types with different rarities, which in practice could serve like differently sized banknotes. They emerged naturally as in-game money from that point on due to their high degree of salability.

This case study (and others like it) is basically an accelerated example of how monies can emerge in a society naturally due to their characteristics that make them the most salable good — and then fall out of favor as conditions change.

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CHAPTER 3

HOW GOLD WON THE COMMODITY WAR

Within any society that uses a form of commodity money, the prior chapters showcased how it is nature that controls the ledger. Nature sets the boundaries for how hard the money is to make, and thus how resistant it is to debasement. Among participants that are of relatively equal technological development, nobody can cheat the ledger. Everyone must expend similar types of work to create new units of the money.

However, when an industrialized society encounters a pre-industrialized society, the industrialized society effectively controls the ledger of the pre-industrialized society. They have the technological capability to dilute the commodity money that the pre-industrialized society uses, whereas the reverse isn't true. The understanding of this capability takes time to spread through the pre-industrialized society, which unfortunately gives the industrialized society time to exploit the pre-industrialized society for their valuable resources.

The success or failure of various commodity monies therefore has a natural filtering aspect to it, with less-scarce monies gradually falling out of existence and the most-scarce monies remaining in existence. As the various human groups of our world encountered each other over time, the number of commodity monies in usage dwindled down to just a few.

Saving wealth in a non-ideal form of money and being unable to properly measure or understand the supply growth of the money that you use, can have dire consequences individually or as a society. This problem unfortunately extends into physical banknotes and electronic ledger systems as well, and indeed is amplified by those technologies, and this problem is described later in this book. After thousands of years, two commodities beat all the others in terms of maintaining their monetary attributes across multiple geographies: gold and silver. Only they were able to retain a high enough stock-to-flow ratio to serve as money and maintain a monetary premium, despite civilizations constantly improving their technological capabilities throughout the world over the ages.[51]

Humans figured out how to make or acquire basically all the beads, shells, stones, feathers, salt, furs, livestock, grains, and industrial metals we need with our improved tools, and so we reduced their stock-to-flow ratios and they all fell out of use as money. However, despite all our technological progress, we still can't reduce the stock-to-flow ratios of gold and silver by any meaningful degree — except for rare instances in which the industrialized world found new unmined continents to draw from, or invented new techniques like the gold cyanide extraction process.[52] Gold has maintained a stock-to-flow ratio of between 25x and 100x throughout modern history, generally averaging around 50x or above, and briefly falling no lower than 16x during the Gold Rush in the mid-19th century[53]. In other words, apart from the discovery of new continents or other one-time events, we historically can't increase the supply of gold by more than about 2% per year on a sustained basis, even when the price goes up more than tenfold in a decade like it did in the 1970s.[54] Silver generally has a stock-to-flow ratio of 10x or more, which is still rather high.

Most other commodities have a stock-to-flow ratio that is below 1 or 2. Even the rarest elements, like platinum and rhodium, have rather low stock-to-flow ratios due to how rapidly they are consumed by industry.

Humanity has gotten better at mining gold with new technologies, but it's inherently rare and we've already tapped into the easiest surface deposits. Only the deep and hard-to-reach deposits remain, which acts like an ongoing difficulty adjustment against our technological progress. One day we might eventually break this cycle with drone-based asteroid mining or deep-sea mining or some similar science fiction level of technology, but until that day comes, gold retains its high stock-to-flow ratio. Those environments are so inhospitable that the expense to acquire gold there would likely be extremely high.

Basically, whenever any commodity money encountered gold and silver in the competition for money, it was always gold and silver that won. Other commodities could remain money for periods of time in specific regions, but gold and silver demonstrated the ability to compete globally as money and win each time. This is because whenever civilizations and monies would encounter each other, the holders of gold and silver had enough technological capability to devalue other forms of money, but the holders of shells, beads, livestock, salt, fabrics, and lesser metals could not devalue gold and silver.

PRECIOUS METAL COINAGE

Authorities further enhanced gold and silver as money by creating standard units, generally in the form of coins. The minting of precious metal coins emerged in many regions, with Lydia (present-day Türkiye) being one of the earliest known civilizations to produce them, back in the 6th century B.C.

The advantage of coins issued by some widely recognized authority (which at the time would typically be a kingdom or empire) is that they can standardize units in terms of size, weight, and fineness, which makes commerce easier to settle. Arbitrary amounts of gold and silver would have to be weighed so that the metal could be used in individual transactions, whereas standardized unit sizes remove that step from the transaction process. The face of an emperor stamped on the coin, perhaps also with ridges along the edges to prevent shaving of the metal, adds a degree of verifiability regarding the quality and content of the coin. Even to this day, if you buy modern sovereign gold coins such as American Eagles, you’ll have to pay a premium for them per ounce relative to a bigger chunk of gold, and people do so because they know they are getting real gold and they know they can easily sell them in the future.

Furthermore, a kingdom would typically assign legal tender status to such coins, and they would trade somewhat above their pure metal content and above the value of similar foreign coins in their jurisdiction due to having this assured acceptance and liquidity. In other words, we can think of legal tender precious metal coins as having three layers of value. The first layer of value is the content of the precious metal itself. The second layer of value is the verification and convenience premium that coinage provides compared to raw bits of metal, which applies to both domestic and foreign coins to varying degrees. The third layer of value is a liquidity premium that only domestic coins have due to their wide (and often mandated) acceptance and recognition by merchants in the jurisdiction as legal tender. Wages and prices denominated in coined units tended to be somewhat "sticky," meaning that they took some time to change throughout society even if the supply of precious metals or coin supply varied within a short period of time.

These layers of value were repeatedly abused over the ages. Governments, finding their budgets unable to balance due to war or greed or mismanagement would eventually give in to the temptation of debasement. For example, a king can collect 1,000 pure gold coins in taxes, melt them down and make new coins that are each 90% gold (with the other 10% being made from some cheap filler metal), and spend 1,111 gold coins back into the economy with the same total amount of gold. They look rather unchanged to most people; wages and prices are rather slow to change; and the king may even force them to be accepted at their prior unit of account, such as by determining the unit in which he pays his soldiers. Years later, if the king still has deficits, he could re-melt his incoming tax revenue and make them 80% gold and spend 1,250 of them back into the economy. And if that's still not enough, he (or his successors) could reduce them to 70% gold, and so forth.

At first, these slightly debased 90% gold coins would often be accepted for the face value that they previously had, especially if enforced through legal decree. This is because the unit itself is partially abstracted from the underlying metal.[55] As the coins circulated for longer and in greater numbers due to dilution, it would become obvious and much harder to enforce their prior value. Prices would go up and peoples' wages and savings would decline in value, as they pay taxes from their savings of purer money and earn their ongoing income in this newly debased money. Wages would push higher over time as people needed more coins to pay their expenses. Merchants would try to hold the purest gold coins and sell the diluted gold coins, and thus the fungibility of the whole monetary base would weaken, since coins would no longer be standardized at this point. Foreign merchants, outside of the jurisdiction of the government that mints the coins, would be quick to demand higher prices in these debased gold coins in exchange for their goods and services, valuing them more strictly for their metal content. The purest coins would eventually go out of circulation, from a combination of the king re-collecting them from taxes, from people hoarding them, or from foreign merchants taking them out of the jurisdiction.

Debasing coinage like this typically took years and decades. The silver Roman denarius, for example, was introduced as a small silver coin of over 95% purity in 211 B.C. It was then reduced in size but remained over 95% silver. Briefly under the reign of Tiberius it was increased in purity, but by around 64 A.D. it further decreased in size and was less than 94% silver. It then remained at the same size for centuries but gradually declined in purity a few percentage points here and there. By the end it began to fall rapidly and was only around 5% silver by the year 274. Various wages, including government-paid wages, would not immediately change to take into account the slightly debased denarius each time, and so the emperor could get more value for his silver when initiating a devaluation.[56] Over time, with more supply of coins on the market, prices would eventually push upwards, and soldiers would demand higher wages.

Eventually through the world, improvements in banking, which are described later in this book, reduced the need for coins, and improved gold's limited divisibility. People could deposit their gold into banks and receive paper credit representing redeemable claims on that gold. Banks, knowing that not everyone would redeem their gold at once, went ahead and issued more claims than the gold they held, beginning the practice of fractional reserve banking.[57] The banking system then consolidated into central banking over time in various countries, with nationwide slips of paper representing a claim to a certain amount of gold.[58]

During that era from the late 19th century to the early 20th century, gold finally won out over silver in terms of usage as money. Silver lost some of its monetary premium and therefore devalued relative to gold, compared to the thousands of years prior.

In his book *Globalizing Capital: A History of the International Monetary System*, Barry Eichengreen explains why a gold standard won out over silver: it was mostly an accident. In 1717, England's Master of the Mint (who was none other than Sir Isaac Newton himself) set the official silver-to-gold ratio too low, according to Eichengreen.[59] As a result, most silver coins went out of circulation and gold became the unquestioned coin of the realm.[60] Then, with the United Kingdom rising to dominance as the strongest empire in the 19th century, the network effects of the gold standard, rather than the silver standard, spread around the world, with most countries putting their currencies on a gold standard. Countries that stuck to the silver standard for too long, such as India and China, saw their currency weaken as demand for silver dropped in North America and Europe.

On the other hand, Saifedean Ammous, in his book *The Bitcoin Standard,* emphasizes the improved divisibility of gold due to banking technology.[61] As previously mentioned, gold scores equal or higher than silver in most of the attributes of money, except for divisibility. Silver is better than gold for divisibility, which made silver the more day-to-day money for thousands of years while gold was mostly used by kings, merchants, and religious orders. The technology of banking systems and paper banknotes in various denominations backed by gold improved gold's effective divisibility. And then, in addition to exchanging paper, people could eventually "send" money over telecommunication lines to other parts of the world, using banks and their ledgers as custodial intermediaries. This was the gold standard — the backing of paper currencies and financial communication systems with gold. There was less reason to use silver at that point, with gold being the scarcer and more durable metal with a higher stock-to-flow ratio, and now basically just as divisible as silver thanks to this second-layer abstraction.

I think there is an element of truth in both explanations, although I consider the explanation of Ammous to be more complete, starting with a deeper axiom regarding the nature of money itself. Banknotes made gold more divisible and thus the harder money won out over time, but network effects from political decisions can impact the timing and specific geographic spread of these sorts of changes.

Even after both gold and silver were demonetized by the global banking system in the second half of the 20^{th} century, gold held its newly retained monetary premium over silver as an ideal form of savings. Gold used to trade at a 10x to 16x multiple of silver's value for thousands of years in multiple different geographies.[62] Over the past century, however, the gold-to-silver price ratio has averaged around 50. Silver structurally lost a lot of its historical monetary premium relative to gold shortly after the introduction and deployment of bank ledgers linked by intercontinental telecommunication systems in the 1860s, and I don't think that's a coincidence.

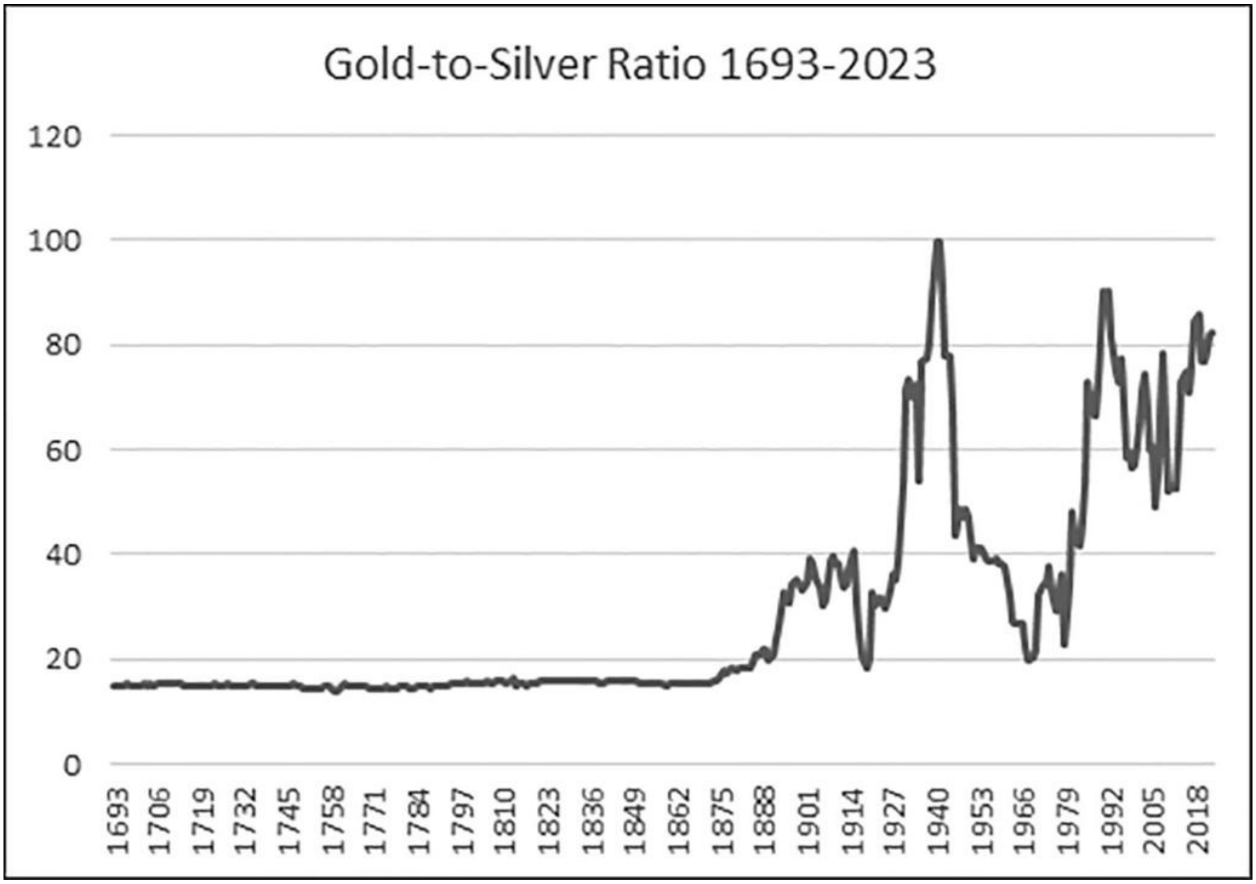

Figure 3-A[63]

As gold and silver went out of use as a medium of exchange, silver's superior divisibility became nearly irrelevant. Gold's properties as a scarcer and more durable metal with a higher stock-to-flow ratio became the more relevant attributes for saving, and therefore gold likely absorbed some of silver's monetary premium. Central banks around the world still hold gold in their vaults, and many of them still buy more gold each year as part of their foreign exchange reserves. Holdings at that scale involve hundreds — or even thousands — of tons, and therefore gold's much denser value than silver comes in handy for these large and long-term savers. Therefore, although government-issued currency is no longer backed by a specific amount of gold, gold remains an indirect and important piece of the global monetary system as a central bank reserve asset. There is no better naturally occurring commodity to replace it.

If the best form of money has an inherent limitation — such as gold's limited divisibility — then it allows for multiple types of money to coexist. Bimetallic and even trimetallic standards were necessary for long stretches of time to fix gold's divisibility limitations. On the other hand, if the best form of money does not have a limitation, then the best money tends to become more dominant and crowd out all others. With neither gold or silver widely used as a medium of exchange anymore, but with both still being used as a long-term store of value, gold is the more attractive choice for most larger holders due to its better durability, higher stock-to-flow ratio, and more value per mass and volume.

To this day, both gold and silver maintain a significant degree of monetary recognition worldwide. While not widely accepted for payments, if I were to take some gold coins or gold jewelry with me to almost any country in the world, I could find a dealer or merchant to buy them from me in local currency at a reasonable market price, and usually without much difficulty. Physical gold in the form of coin, bar, or jewelry has remained one of the best ways people have available to them if they want to store value in a dense, liquid, and fungible bearer asset form with no counterparty risk.

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CHAPTER 4

A UNIFIED THEORY OF MONEY

Descriptions regarding the definition and origin of money tend to separate themselves into two primary economic camps, with various sub-camps around them.

One primary camp is the commodity theory of money, and in the opposing primary camp is the credit theory of money. The prior chapters of this book referenced both, and this chapter discusses more specifically how the two theories can be reconciled.

In Western economic literature, the commodity theory of money stretches back at least to Aristotle's *Politics* in Ancient Greece; was elaborated upon and popularized in Adam Smith's *Wealth of Nations* in 1776; and then was developed in more detail by Carl Menger, Ludwig von Mises, and other economists that formed the basis of the Austrian school of economics in the 19th and 20th centuries. The primary concept presented by this theory of money is that barter is inefficient due to needing to satisfy the double coincidence of wants, and therefore a highly salable good that is resistant to debasement (e.g., gold or silver) naturally arises in a society as a unit of account, medium of exchange, and store of value to reduce the frictions of commerce. In his book *Principles of Economics*, Carl Menger argued:

> Money is not an invention of the state. It is not the product of a legislative act. Even the sanction of political authority is not necessary for its existence. Certain commodities came to be money quite

> naturally, as the result of economic relationships that were independent of the power of the state.[64]

The credit theory of money is more recent in terms of full exposition, stretching back to Henry Dunning Macleod and Georg Friedrich Knapp in the second half of the 19th century, and is often put forth as a counter to the commodity theory of money. Alfred Mitchell-Innes concisely elaborated on this theory of money in the early 1900s, and John Maynard Keynes was influenced by this theory and incorporated it into his economic prescriptions.[65] Modern Monetary Theory, which was formulated by Abba Lerner in the 1940s[66] and revitalized in the 1990s by economists such as Warren Mosler, Bill Mitchell, and Larry Randall Wray, further expanded on this way of thinking.[67] It was then followed by the popularity of anthropologist David Graeber's writings on the history of debt, which generally took a favorable view of the credit theory relative to the commodity theory. The key theme of the credit theory of money is that credit is at the core of what money is, rather than commodities being at its core. In "The Credit Theory of Money," the second of his influential essays in the 1910s, Alfred Mitchell-Innes summarized:

> Shortly, the Credit Theory is this: that a sale and purchase is the exchange of a commodity for credit. From this main theory springs the sub-theory that the value of credit or money does not depend on the value of any metal or metals, but on the right which the creditor acquires to "payment," that is to say, to satisfaction for the credit, and on the obligation of the debtor to "pay" his debt and conversely on the right of the debtor to release himself from his debt by the tender of an equivalent debt owed by the creditor, and the obligation of the creditor to accept this tender in satisfaction of his credit.
>
> Such is the fundamental theory, but in practice it is not necessary for a debtor to acquire credits on the same persons to whom he is debtor. We are all both buyers and sellers, so that we are all at the same time both debtors and creditors of each other, and by the wonderfully efficient machinery of the banks to which we sell our credits, and which thus become the clearing houses of commerce, the debts and credits of the whole community are centralized and set off against each other. In practice, therefore, any good credit will pay any debt.[68]

What complicates the rivalry between these camps and the discussion around them today is that they are inherently prone to politicization. Economists with a preference toward a small role for government tend to gravitate toward the concept of money being a bottom-up emergent phenomenon. To the extent that the state may be involved in issuing currency at all, proponents of this view will generally argue that the state's creation of currency should be constrained by something of natural scarcity, such as by the backing and redemption of specific amounts of gold. On the other hand, economists with a preference toward a larger role for government tend to gravitate toward the concept of money being a top-down product of the state, or at least something that is inherently tied to sociopolitical organization in its many forms. The state, according to many proponents of this line of reasoning, should not be bound by natural scarcity and should instead have a high degree of flexibility for the supply of the currency that it issues, to achieve its various goals.

As the first chapter in this book about hunter-gatherer societies discussed, both the concept of commodity proto-monies and the concept of credit stretch back to the earliest and most basic human interactions. Both the commodity theory of money and the credit theory of money contribute to a holistic understanding of the definition and origins of money at a foundational level. By comparing these different lines of reasoning, we can define money in the most broad and precise way possible.

SETTING THE TIMELINES STRAIGHT

To reconcile these two opposing theories of money and identify the underlying foundation, we must begin by exploring their differences, and what each theory seems to get right and wrong.

For this exercise, we can go back to the *Wealth of Nations*, where Adam Smith described the problem of barter and why a highly salable commodity money naturally arises to solve that problem:

> But when the division of labour first began to take place, this power of exchanging must frequently have been very much clogged and embarrassed in its operations. One man, we shall suppose, has more of a certain commodity than he himself has occasion for, while another has less. The former, consequently, would be glad to dispose of; and the latter to purchase, a part of this superfluity. But if this latter should chance to have nothing that the former stands in need of, no exchange can be made between them. The butcher has more meat in his shop than he himself can consume, and the brewer and the baker would each of them be willing to purchase a part of it. But they have nothing to offer in exchange, except the different productions of their respective trades, and the butcher is already provided with all the bread and beer which he has immediate occasion for. No exchange can, in this case, be made between them. He cannot be their merchant, nor they his customers; and they are all of them thus mutually less serviceable to one another. In order to avoid the inconveniency of such situations, every prudent man in every period of society, after the first establishment of the division of labour, must naturally have endeavoured to manage his affairs in such a manner, as to have at all times by him, besides the peculiar produce of his own industry, a certain quantity of some one commodity or other, such as he imagined few people would be likely to refuse in exchange for the produce of their industry. Many different commodities, it is probable, were successively both thought of and employed for this purpose. In the rude ages of society, cattle are said to have been the common instrument of commerce; and, though they must have been a most inconvenient one, yet, in old times, we find things were frequently valued according to the number of cattle which had been given in exchange for them. The armour of Diomede, says Homer, cost only nine oxen; but that of Glaucus cost a hundred oxen. Salt is said to be the common instrument of commerce and exchanges in Abyssinia; a species of shells in some parts of the coast of India; dried cod at Newfoundland; tobacco in Virginia; sugar in some of

> our West India colonies; hides or dressed leather in some other countries; and there is at this day a village in Scotland, where it is not uncommon, I am told, for a workman to carry nails instead of money to the baker's shop or the ale-house.
>
> In all countries, however, men seem at last to have been determined by irresistible reasons to give the preference, for this employment, to metals above every other commodity. Metals can not only be kept with as little loss as any other commodity, scarce any thing being less perishable than they are, but they can likewise, without any loss, be divided into any number of parts, as by fusion those parts can easily be re-united again; a quality which no other equally durable commodities possess, and which, more than any other quality, renders them fit to be the instruments of commerce and circulation.[69]

As we look back on this excerpt centuries later, Smith's overall description aged well, and he got quite a bit correct. First, he described commodity money as a naturally emergent phenomenon to address the difficulty of satisfying the double coincidence of wants in a world of labor specialization. Second, he reasoned why precious metals specifically stood the test of the time for this function better than other commodities — their unique properties. It wasn't by accident, in other words, that cultures all around the world trended toward gold and silver as the ideal forms of commodity money.

Amusingly, the bottom-up natural emergence of SoJ rings as money in *Diablo II*, as described in Chapter 2, served as an observable experiment of Smith's proposal regarding the origin of money. This, along with similar examples, allowed the process to be witnessed first-hand rather than merely theorized upon. The game developers of *Diablo II* created their in-game environment, and millions of players assessed that environment and quickly and naturally gravitated toward SoJ rings as the primary form of savings, payments, and unit of account to avoid needing to satisfy the double coincidence of wants (i.e., the problem of barter) when exchanging high-value items, which was not the intention of the developers. A key limitation of this environment was that the game was played by people around the world who mostly didn't know each other, and thus the mechanism of credit could not generally be used. In a world of strangers with little or no existence of credit, commodity money indeed emerges naturally from individual participants in the marketplace, and the commodity money that rises to the top is whatever has the best attributes for being money.[70]

However, anthropological evidence from after Smith's time has shown that he likely got one notable thing backwards: Barter between specialized workers did not predate money in the way that he assumed. There was never a time where it was common for specialized workers like butchers and brewers and bakers to find their potential exchange to be “clogged and embarrassed” due to the concept of money not having been developed yet. The concept of money in some form had already been developed by the time that specialized forms of labor like butchers and brewers and bakers came into existence. Specifically, flexible social credit had already partially avoided the need to satisfy the double coincidence of wants between people who knew each other. The concept of credit is older than coinage and rivals the age of the earliest collectible proto-monies such as shells.[71]

In the broadest possible interpretation, the idea of debt and credit stretches back earlier than our species. When one ape picks insects off the back of another, and then they reverse positions to reciprocate, that represents a very short-term form of debt and credit. The ape who received the treatment first could fail to reciprocate. Humans of course expanded this greatly in terms of complexity and duration of the types of credit and debt that are available within a social structure.

Alfred Mitchell-Innes, in his 1913 essay “What is Money?” reversed Smith’s order of events in the following way:

> Adam Smith’s position depends on the truth of the proposition that, if the baker or the brewer wants meat from the butcher, but has (the latter being sufficiently provided with bread and beer) nothing to offer in exchange, no exchange can be made between them. If this were true, the doctrine of a medium of exchange would, perhaps, be correct. But is it true?
>
> Assuming the baker and the brewer to be honest men, and honesty is no modern virtue, the butcher could take from them an acknowledgment that they had bought from him so much meat, and all we have to assume is that the community would recognize the obligation of the baker and the brewer to redeem these acknowledgments in bread or beer at the relative values current in the village market, whenever they might be presented to them, and we at once have a good and sufficient currency. A sale, according to this theory, is not the exchange of a commodity for some intermediate commodity called the “medium of exchange,” but the exchange of a commodity for a credit.
>
> There is absolutely no reason for assuming the existence of so clumsy a device as a medium of exchange when so simple a system would do all that was required. What we have to prove is not a strange general agreement to accept gold and silver, but a general sense of the sanctity of an obligation. In other words, the present theory is based on the antiquity of the law of debt.
>
> We are here fortunately on solid historical ground. From the earliest days of which we have historical records, we are in the presence of a law of debt, and when we shall find, as we surely shall, records of ages still earlier than that of the great king Hamurabi, who compiled his code of the laws of Babylonia 2000 years B.C., we shall, I doubt not, still find traces of the same law. The sanctity of an obligation is, indeed, the foundation of all societies not only in all times, but at all stages of civilization; and the idea that to those whom we are accustomed to call savages, credit is unknown and only barter is used, is without foundation. From the merchant of China to the Redskin of America; from the Arab of the desert to the Hottentot of South Africa or the Maori of New Zealand, debts and credits are equally

> familiar to all, and the breaking of the pledged word, or the refusal to carry put an obligation is held equally disgraceful.[72]

In other words, throughout his essay Mitchell-Innes argues from anthropological evidence that flexible social credit had already partially solved the problem of barter and reduced the frictions of commerce between neighbors at the hunter-gatherer stage — meaning well before the time that specialized labor reached the point that Smith described.

The brewer and baker can get meat by making a promise to pay later, most likely via the products that they produce (e.g., “thanks for the meat, here’s a credit claim for five loaves of bread, which you can trade to someone else if you want to and I’ll honor whoever redeems it.”). Likewise, the butcher can obtain beer and bread by making a promise to pay later, and many of their exchanges can net out. A butcher who owns a claim to some bread due to having sold some meat to the baker could easily sell that claim for bread to someone else. The utilization of credit solves the problem of barter between people who have a degree of continuity and trust between each other, or that both defer to a local authority that can enforce the credit.

Instead, commodity money emerges time and time again mainly to reduce the frictions of commerce between strangers, or to augment and improve systems that rely on flexible social credit by serving as form of final settlement and longer-term savings. People within the same social group can get by up to a certain level of complexity on small and informal human-controlled ledgers, whereas strangers benefit from being able to perform final settlement on the spot. And that’s where commodity money is needed to replace or augment flexible social credit.[73]

If we use ancient Babylon in the time of Hammurabi as one of the earliest examples, they used grain and silver as commodity monies, but also used clay ledgers to maintain the concept of credit. Grains are, after all, highly seasonal commodities. A farmer would get by on credit to buy various things until harvest season, at which time he could (hopefully) settle his debts in one big season by reaping and selling his harvest. In addition, studying hunter-gatherers and archeological evidence shows the widespread use of informal honor-and-kin-based credit systems as well as collectibles such as shell beads being used as proto-money, which means that both credit money and commodity money in various forms existed prior to strong forms of labor specialization.

WHERE THE CREDIT THEORY OF MONEY GOES WRONG

Proponents of the credit theory of money were right to explore the anthropological evidence regarding the concept of credit and to critique early proponents of the commodity theory of money in terms of what they claimed to have been the order of events. Credit is indeed near the origin of commerce and money, rather than something that came along later, and this observation is a useful correction to *The Wealth of Nations*. Human interaction is, at its very core, a series of formal or informal credits and debits to others and is organized by rituals and rules that are tied to our evolutionary instincts, our earliest religions, and our earliest governing structures.

However, proponents of the credit theory of money tend to take their concept too far, often disregarding the importance of commodity money entirely, and generally painting too optimistic of a picture of a society's ability to govern a flexible, credit-based ledger at a large scale over long periods of time.

As an initial point of critique, we can point toward the troubles that niche merchants would have in such a credit-based system. The butcher, brewer, and baker may be able to hand out claims in convenient exchangeable units (such as one pound of beef being equivalent to three pints of beer being equivalent to five loaves of bread), but what about niche high-value service providers like surgeons? If a surgeon buys some bread, does she hand out a claim to draw upon her surgery services later? How many loaves of bread is a surgery worth, and what type of surgery? Surgeries are high-value niche services that are not very fungible or commonly needed. It becomes clear that a small unit of account is required to make trading more convenient, and historically such a unit was often linked to a specific commodity such as a few grams of silver or one meal worth of grain. Otherwise, they'd be reduced to abstract barter, trying to trade around all sorts of different credit claims for goods with no standardized unit of account. Historically, even when credit was used as the actual trading instrument, that credit instrument would usually be denominated in a salable commodity unit that arose naturally due to its properties.

As a second point of critique, we can ask: What happens if someone leaves one community and joins another? There is hardly such a thing as a truly closed community; communities have been interacting with others since the dawn of humanity. For wealth to be transferable between communities, it needs to exist in some more physical or universal form. Credit can work within a community for daily trade, but for anyone that desires to travel further out, they require wealth in a more fundamental form that would be recognized by a new community.[74] Natural monies serve as a linkage between what are otherwise closed and circular credit ecosystems.

As a third point of critique, it should be intuitive that what works on a small scale does not necessarily work on a large scale. Small social credit systems based on honor and individual dealings between known individuals cannot be applied in the same way to nation-states that involve the governance of millions of people who are mostly strangers to each other. The concept of trust only works if you know and trust the person in question. Honor as a concept is incredibly important for human interactions but does not scale well in an impersonal bureaucracy.[75]

Mitchell-Innes argued in his 1914 “Credit Theory” essay that our money would appreciate if we were to de-peg it from gold:

> We imagine that, by maintaining gold at a fixed price, we are keeping up the value of our monetary unit, while, in fact, we are doing just the contrary. The longer we maintain gold at its present price, while the metal continues to be as plentiful as it now is, the more we depreciate our money.[76]

Of course, quite the opposite occurred. As of this writing, the U.S. dollar and the U.K. pound sterling lost over 98% and 99%, respectively, of their exchange rate relative to gold since they were de-pegged from gold in the decades after Mitchell-Innes’ essay. For most countries it was an even bigger drop, and currency devaluation relative to gold happened to every country that ever launched a fiat currency.

Despite this major failure of prediction, the reasoning that Mitchell-Innes used in 1914 to make his claim was not far-fetched on its surface. He argued that it was not arbitrary debasement *per se* that was at the root of the historical devaluation of state-issued money, but rather that it was war, plague, and other destroyers of productivity that led to debasement. If only we could repeatedly emphasize peace and organization, he argued, our state-issued money would resist debasement:

> It is not King Jean or King Philippe or Edward or Henry who have been the depreciators of money, but King War, the great creator of debts, helped by his lieutenants, plague, murrain and ruined crops - whatever, in fact, prevents debts from being punctually discharged. It is not recoinage acts which have been the restorers of the value of money, but Peace, the great creator of credits, and upon the invariable truth of this statement the credit theory of money must largely depend.[77]

On that point, he was largely correct. Aside from examples of unusually corrupt or mentally ill rulers, a king does not generally wake up one day and whimsically decide to devalue his realm's coinage with cheaper metal for no reason. War, plagues, and other destroyers of productivity are indeed at the root of why kings usually end up debasing their money. To remain in power, rulers seek to strengthen their political position, placate their subjects, and smooth over problems that inevitably arise throughout their reign. Currency devaluation is a method that a king can resort to so that he can make increased payments without having to increase taxes for those payments, and therefore the cost instead gets pushed, over time, onto those who accept the newly devalued coins at their old face value despite not having the same metal content or supply scarcity that they used to have.

However, what Mitchell-Innes missed, I contend, was that the ability to debase the money *contributes* to the likelihood of war and several other forms of damaged productivity occurring in the first place. The temptation for a ruler to debase coinage is too great to overcome, because it's usually the path of least resistance when faced with a problem. If the king knows that paying for a war by outright raising taxes would likely lead to revolution, but that paying for the war via gradual debasement of coinage will not, he can justify paying for his war by relying on that second method. If he and his potential war opponent were both stuck with the first method of paying for a war with extra taxes rather than debasement, the war might not happen because their subjects might revolt if it did. The costs of the war would be more transparent and unpopular right away. In contrast to this, the ability to debase coinage to pay for a war allows the war to happen first and the costs to be partially delayed, which increases the probability of war happening and increases the scale to which it may occur. If debasement *can* occur, it eventually *will* occur for any number of reasons. The possibility for debasement exists, always and everywhere and invitingly so, as something a government can turn to whenever it can't spend transparently on what it wants to.

Over the long arc of time, from a saver's perspective it will almost always be better to hold a scarce commodity money directly than to hold the promise made by a kingdom, empire, or nation-state. The former is subject to the firm laws of nature, while the latter is subject to the fallibility of mankind.

We can see the flaw in Mitchell-Innes reasoning more clearly when he describes credit as being the most valuable kind of property in his "What is Money?"

essay:

> A first class credit is the most valuable kind of property. Having no corporeal existence, it has no weight and takes no room. It can easily be transferred, often without any formality whatever. It is movable at will from place to place by a simple order with nothing but the cost of a letter or a telegram. It can be immediately used to supply any material want, and it can be guarded against destruction and theft at little expense. It is the most easily handled of all forms of property and is one of the most permanent. It lives with the debtor and shares his fortunes, and when he dies, it passes to the heirs of his estate. As long as the estate exists, the obligation continues, and under favorable circumstances and in a healthy state of commerce there seems to be no reason why it should ever suffer deterioration.[78]

The flaw is that "under favorable circumstances and in a healthy state of commerce," is quite the assumption to make over the course of a lifetime, let alone over generations. Through the course of life and governance, problems inevitably arise, and various debts are inevitably devalued or discharged or defaulted on. During the past century, during which time currencies have spent most of their time decoupled from the natural scarcity of precious metals, a "first class credit" has been one of the worst possible assets to hold compared to the alternatives. In dozens of countries around the world since Mitchell-Innes' essays, credits and their underlying currencies were outright hyperinflated away. In the most successful countries, who were on the winning side of all major wars and had strong financial institutions, first-class credits generally avoided the fate of hyperinflation but still greatly underperformed real estate, business equity, precious metals, fine art, and fine wine.[79]

In other words, proponents of the credit theory of money, when applying their analysis to a sufficiently large governing body, generally rely on the assumption of having an unbroken chain of highly competent and altruistic administers of the public ledger. That is an assumption that has gone unrewarded time and time again, in culture after culture, century after century. By hand-waiving away precious metals or any sort of natural constraint as an unnecessary or clumsy way to maintain discipline of the public ledger, they miss a key aspect of why commodity monies have stood the test of time for thousands of years: because nobody can instantly make more of them even when they have a seemingly good reason to do so. Plus, they represent final settlement rather than perpetual reliance on the promises of centralized entities.

Interestingly, despite making his various claims about money, Mitchell-Innes was indeed quite aware of the fact that, in all financial history, human-defined monetary units always structurally *depreciate*, and never seem to structurally *appreciate*. As he wrote in "The Credit Theory of Money,"

> But while the monetary unit may depreciate, it never seems to appreciate. A general rise of prices at times rapid and at times slow is the common feature of all financial history; and while a rapid rise may be followed by a fall, the fall seems to be nothing more than a return to a state of equilibrium. I doubt whether there are any instances of a fall to a price lower than that which prevailed before the rise, and anything approaching a persistent fall in prices, denoting a continuous rise of the value of money, appears to be unknown.[80]

In this way, we can compare centralized human-controlled ledgers to the second law of thermodynamics. This law states that entropy (which is basically a scientific term for "disorder") of any closed system can only increase over time; it can never decrease. Nothing short of a perfectly efficient system, with no friction and no heat loss (which doesn't exist) can avoid the continuous growth of entropy. Similarly, nothing short of an unbroken chain of perfect rulers can maintain a flexible monetary system without debasement, and such a perfect chain does not exist. Problems inevitably arise in every realm, and time and time again authorities inevitably turn to the creation of more currency to soften those problems and devalue various debts in a non-transparent way.

David Graeber, who for the most part can be placed in the credit theory camp, observed the relationship between the level of societal trust and the type of money in use in his book *Debt: The First 5000 Years*:

> As a result, while credit systems tend to dominate in periods of relative social peace, or across networks of trust (whether created by states or, in most periods, transnational institutions like merchant guilds or communities of faith), in periods of characterized by widespread war and plunder, they tend to be replaced by precious metal.[81]

In his book, Graeber tended to describe precious metals in negative terms most of the time, and for example made the case that one of the reasons precious metals were used during times of war is because they were plentiful due to plunder. Soldiers from the winning side of a war would plunder all sorts of precious metal savings and ornaments from the vaults and temples of the losing side, and then spend that plunder into broad circulation, either directly or through the creation of more coinage.

However, a more neutral analysis can emphasize the changing level of trust in society. In times of reliable social ledgers and relatively stable supply and demand of goods and services, the role of credit can expand more easily since it is convenient. In contrast, in times of unreliable social ledgers and unstable supply and demand of goods and services, credit is risky and prone to default or devaluation, while precious metals maintain their scarcity and desirability and can therefore be turned to as a preferred medium of exchange and store of value.

A UNIFIED THEORY OF MONEY

Rather than adhere to the commodity theory of money or the credit theory of money to the exclusion of the other, a more complete theory must find the underlying logic or foundation that both theories share. And what they share is that they both represent ways to maintain a ledger, but with different maintainers of the ledger.

In the credit theory of money, humans maintain ledgers using methods that rely on trust. In small groups, this can be done informally, and be based on kinships and friendships and honor-based relationships. In large groups involving strangers, credit-based ledgers are maintained by a centralized administrative state and the rule of law and are historically subject to various resets and devaluations when problems or imbalances inevitably arise.

In the commodity theory of money, humans use a trust-minimized method of letting nature and its physical laws maintain the ledger. The physical exchange of highly salable commodities is what settles the ledger on the spot between non-trusted entities, and the full state of the ledger at any given time is maintained by physical possession. No human authority can debase the money merely with the stroke of a pen. Instead, they must use force to convince people to hand it over, or they must expend the resources to find and produce more of it through mining.

Therefore, the unification of both theories can be described as a “ledger theory of money” since it describes the deeper logic or foundation on which both theories rest. Both flexible social credit and collectible proto-monies stretch back to the dawn of humanity. Both involve groups of various sizes maintaining a ledger between themselves to avoid the need to satisfy the double coincidence of wants, to reduce the friction of beneficial exchange, and to serve as a form of liquid savings. The differences come down to which authority is trusted to maintain the ledger.

In contexts where trust is high, such as within a small group or within a well-functioning centralized state, people feel comfortable using honor-based or written legal ledgers for their payments and savings. These ledger systems tend to have a high level of convenience and efficiency but are prone to long-term degradation and occasional massive defaults or restructurings. In contexts where trust is low, such as between separate groups or when trusted ledgers have recently failed, people rely on trust-minimized ledgers such as commodity monies for payments and savings instead, even at the cost of less convenience and efficiency.

A ledger theory of money observes that most forms of exchange are improved by having a salable unit of account that can be held and transferred over both time and space, and that this unit of account implies the existence of a ledger, either literally or in the abstract. These monetary units and the ledger that defines them rely either on human administrators or on natural laws to maintain their stability across time and space.

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64 Carl Menger, *Principles of Economics*, 262.

65 John Maynard Keynes, "A. Mitchell-Innes. *What Is Money?*"

66 Abba Lerner, "Money as a Creature of the State."

67 Dylan Matthews, "Modern Monetary Theory, explained," *Vox*, April 16, 2019.

68 Alfred Mitchell-Innes, "The Credit Theory of Money," 152.

69 Adam Smith, *Wealth of Nations*, Book I, Chapter IV, 37–39.

70 See for instance Narayana Kocherlakota, "Money is Memory"; Stefano Ugolini, *The Evolution of Central Banking: Theory and History*, 165–175.

71 David Graeber, *Debt: The First 5,000 Years*; George Selgin, "The Myth of the Myth of Barter."

72 Alfred Mitchell-Innes, "What is Money?" 391.

73 Ugolini, *Central Banking*, 169–171.

74 Brian Albrecht and Andrew Young, "Wampum: The Political Economy of an Institutional Tragedy"; Lawrence White, *Better Money: Gold, Fiat, or Bitcoin?*, 17.

75 Seabright, *Company of Strangers*, 86; Avner Greif, "The Fundamental Problem of Exchange," 261–62.

76 Mitchell-Innes, "Credit Theory," 160.

77 Mitchell-Innes, "Credit Theory," 157.

78 Mitchell-Innes, "What is Money?" 392.

79 Òscar Jordà et al., "The Rate of Return on Everything, 1780–2015."

80 Mitchell-Innes, "Credit Theory," 159.

81 Graeber, *Debt*, 215.

PART TWO

THE BIRTH OF BANKS

"The object of commerce is the acquisition of credits. A banker is one who centralises the debts of mankind and cancels them against one another. Banks are the clearing houses of commerce."[82]

-Alfred Mitchell-Innes

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[82] Mitchell-Innes, "Credit Theory," 168.

CHAPTER 5

PROTO-BANKING AND THE HAWALA SYSTEM

Banks as we think of them in their modern form originated in Italian city states at the dawn of the Renaissance, but the history of proto-banks stretches back thousands of years to various regions of the world. Banking, in the broad sense, is a series of legal and technological layers that people developed on top of commodity money.

The Code of Hammurabi, a Babylonian legal text from nearly four thousand years ago, has sections that provide laws for loans and deposits.[83] The Book of Deuteronomy allows the charging of interest on foreigners but not to fellow Israelites.[84] Ancient Greece had a form of proto-bankers over 2,500 years ago called trapezites, named after the trapeza tables they used.[85]

A notable development in the history of formal credit was the suftaja and its various pre-cursors. The suftaja was a letter of credit used throughout North Africa, the Middle East, and along the Silk Road by Muslim and Jewish merchants stretching back at least to the eighth century. It arose as a useful development because merchants needed a way to prevent theft or increase efficiency when moving money over long distances, and/or to be able to delegate the transfer of funds to a messenger on their behalf.[86]

Ghislaine Lydon, a history professor with an emphasis on African and Middle Eastern studies, documented the history of the suftaja in her 2019 research paper,

"Paper Instruments in Early African Economies and the Debated Role of the Suftaja." In the paper, she described the suftaja as the following:

> As a form of debt contract, the suftaja enabled the transfer of funds among merchants located in distant markets who performed services as international money lenders within established trade networks. The suftaja served essentially two purposes. First, it was a means to send payments or settle debts across long distances; a function akin to a wire transfer. Second, like a traveler's check, it facilitated travel unencumbered by hefty and bulky amounts of cash.[87]

She went on to provide an example:

> A merchant is traveling on business by caravan between Awdaghust and Sijilmasa. To safeguard his capital he purchases in Awdaghust a suftaja in exchange for a fee from Merchant A who has a relative and/or business partner, Merchant B, located in Sijilmasa. A priori, merchants A and B have established ex-ante a relationship of trust, involving the exchange of long distance financial and commercial services. The traveler deposits his capital with Merchant A, in the presence of witnesses, pays a fee, and receives in exchange a suftaja. This document, often in the form of a letter, instructs Merchant B to pay to the traveler the exact amount of capital. Upon arrival at destination the traveler cashes in the check. The same device was used to make long-distance payments except that the letter, containing the payment instructions, traveled via messenger. Upon reception, Merchant B executed the payment to a third party. A suftaja payment by Merchant B could settle in full or in part a pre-existing debt owed to Merchant A. Viewed another way, as was often the case among legal scholars discussed below, the traveling merchant or the party seeking to make an international payment, gives a "loan" to Merchant A that was reimbursed or disbursed elsewhere by his associate Merchant B to either a traveler or a fourth party. Since Merchants A and B regularly correspond and transact, their financial balances are cleared in the course of such bilateral exchanges.[88]

Lydon, citing available literature on the subject, dates the word suftaja back to the 8th century when used in this way by Muslim and Jewish merchants in the Middle East and parts of Africa. She also cites numerous examples of Ancient Egyptian papyrus-based debt contracts, stretching back to at least the 3rd century B.C. that are likely to have been precursors to this specific method of exchange. She also cites an example of a 4th century A.D. document used between Uzbekistan and China along the Silk Road that served as a transfer document. And there exists significant literature about the development of the hundi in medieval India, which was their term for a bill of exchange.

As for the common denomination of money in the suftaja, Lydon points toward precious metals:

> The dinar was the most common international denomination among medieval Muslims, and it featured prominently in suftajas. Dinars had minting and market specificities, including Maghribi and Baghdadi variants, and were pegged to the local price of gold.[89]

The development of papyrus-based (and eventually paper-based) bills of exchange in time broadened into a form of proto-banking called the hawala system, which traces back over 1,200 years to early Indian and Arab traders. Although the system approximately followed the timing and geographic spread of Islam, stretching from Africa on one side, up to parts of Europe, through the Middle East, and onward to India on the other side, the system was (and still is) used by both Muslims and non-Muslims.

Hawala is a decentralized network of specialized money brokers, called hawaladars, that operate based on trust and reputation. The system still exists today, using modern technology of emails and phone calls, and processes hundreds of billions of dollars in volumes per year.

The way the system works today is that a “Person A” can go to a “Hawaladar A,” and give them money and a password, specifying a “Person B” that this money should be given to. Separately, Person A tells Person B the password (via email or other communications), and Hawaladar A contacts a “Hawaladar B” in another country where Person B lives and gives them the password (also via email or other communications). Finally, Person B can go to Hawaladar B, tell them the password, and they will be given the money by the hawaladar. The hawaladars charge a small fee for this service. Person A has effectively sent money to Person B internationally, despite no money flowing over the border, and without going through any formal banks. The hawaladars just updated a channel-based ledger between themselves. Hawaladar A now owes Hawaladar B the money, which they can settle later. These hawaladars know and trust each other well despite operating over long distances, or know and trust each other indirectly through fellow hawaladars, and thus they can maintain credit with each other in a way that non-trusted parties can’t.

In earlier times, the communication channels would have been physical, such as one merchant giving another merchant a password or specifically written paper as part of a trade of physical goods, rather than carrying large amounts of coin with them. Hawaladars could also travel with the merchant or spread the password through a network of shorter trips. These days, the communication happens over the internet.

In this system, Person A and Person B don’t have to trust each other, but they do have to trust the hawaladars. The hawaladars also must trust each other, and specifically Hawaladar B must trust that Hawaladar A is good for the money, since Hawaladar B paid out money to person B and is now owed that money by Hawaladar A. The reason this trust-based system works is that the hawaladars are professional merchants and they survive in this profession because of their reputations. If a hawaladar fails to settle a valid transaction, he'll no longer be trusted by fellow hawaladars, and will no longer be part of the network.

Hawaladars can settle money over long distances with each other more safely and more efficiently than regular people can settle money. They deal with large numbers of transactions and can "net" transactions. For a medieval example, Hawaladar A might send a note worth ten gold coins for Person A, and a now owes those ten gold coins to Hawaladar B who paid out the money to Person B. The next week, perhaps Person C comes to that same Hawaladar B, and asks them to send six gold coins to Person D, through Hawaladar A. Hawaladar A now owes only four gold coins to Hawaladar B, since the six gold coins can be netted out from the prior ten gold coins that were sent in the other direction. Perhaps they perform dozens of these back-and-forth transactions per year and settle once at the end of the year via a secure process of one physical settlement. The same example could be denominated in dollars, rupees, or other units.

This system allows payments to move long distances, while the money itself moves much less frequently. Collectively, these hawaladars form a decentralized ledger and channel-based payments system, which normal users of the network can access through their local hawaladar. Nobody knows or keeps track of the full network ledger; there is no master hawaladar that they all report to. Instead, it operates by individual hawaladars keeping accurate books for their individual channels with other hawaladars, along with reputations in the broader region so that each hawaladar is known by many hawaladars.

Within the 21st century, the hawala system has primarily been used for international remittances and is typically done with fiat currency units. It bypasses the formal banking system including international border frictions and provides basic bank-like services for unbanked people. For example, an Indian migrant worker in the United Arab Emirates may wish to send some of his earnings back to his family in India and can use the hawala system to do it.

In some countries today, the hawala system is discouraged or outright illegal since it is a way to transfer funds anonymously and across borders. It has been associated with terrorism in some contexts because terrorists will indeed use whatever tools are available to them, although the system itself stretches back to medieval times. In other countries like the United Arab Emirates the practice is allowed and regulated, and as a result the UAE serves as a hub for the modern-day version of the network.

It has been a challenge for historians to determine the precise etymology and exact chain of events regarding specific words or technologies for paper-based forms of exchange. One of the cited reasons for the lack of clarity is that medieval Muslim scholars often debated and discouraged the usage of suftajas and/or the broader hawala system due to its usage of debt and arbitrage, despite it being centered primarily throughout their regions. Therefore, in many contexts the system was off the record. In a 2007 paper with an extensive list of citations called "Misplaced Blame: Islam, Terrorism, and the Origins of Hawala,"[90] Edwina Thompson cites Richard Grasshoff when classifying the relationship between hawala and suftaja:

> Grasshoff demonstrates that hawala refers to the legal concept of delegation of debt, rather than to a concrete application, while the term suftaja, by contrast, refers to a bill of exchange as one of the possible commercial instruments based on hawala. [...] Technically speaking, it could therefore be argued that customers operate at a level of the suftaja, while dealers more accurately operate a hawala-based system.[91]

Eventually, economic and military contact between Muslim and Christians spread the usage of these and related monetary technologies to Europe. In a report by the Federal Reserve Bank of Atlanta called, "The Evolution of the Check as a Means of Payment: A Historical Survey," the authors Stephen Quinn and William Roberds describe the spread of payment technologies as follows:

> Checks appear to have been in common use in the eastern Mediterranean during the first millennium. By the tenth century, checks were widely used in the Muslim world (Ashtor 1972). In contrast, monetary systems in Europe at this time were extremely primitive. There were few coins of reliable value and no banks, much less checks (Usher 1934; Spufford 1988).
>
> During the Crusades, Europeans came into increased contact with the Muslim world and came to adopt, with modifications, the banking and monetary systems they encountered in the eastern Mediterranean. During the thirteenth century, rudimentary banks appeared in commercial cities such as Barcelona, Florence, Genoa, and Venice. The primary purpose of these banks was to facilitate payments among local merchants rather than to provide credit.[92]

Along these lines, the Catholic order of warrior monks of the 12th century known as the Knights Templar seem to have adopted these practices.[93] The Knights Templar, based in Jerusalem, operated an extensive network that assisted the crusades by Christians against Muslims. European noblemen, intending to travel and fight in the crusades, could deposit valuables with the Knights Templar in Europe, receive a specialized note in return, and then redeem that note for an equivalent amount of value from a different group of Knights Templar upon their arrival in Jerusalem.

As this chapter ends, we'll finish with the question, "who controls the ledger?" The answer as it pertains to these systems is that the hawaladars (and various merchants, templar, and other channel-based proto-bankers) control the ledger. Users of the network must trust individual hawaladars to operate correctly, and individual hawaladars must trust each other.

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[83] Goetzmann, *Money Changes Everything*, 46–48.

[84] Edward Chancellor, *The Price of Time: The Real Story of Interest*, 5–6, 17–20.

[85] Goetzmann, *Money Changes Everything*, 82–83.

[86] Ghislaine Lydon, "Paper Instruments in Early African Economies and the Debated Role of the Suftaja."

[87] Lydon, "Paper Instruments," paragraph 21.

[88] Lydon, "Paper Instruments," paragraph 22.

[89] Lydon, "Paper Instruments," paragraph 29.

[90] Edwina Thomson, "Misplaced Blame: Islam, Terrorism and the Origins of *Hawala*."

[91] Thomson, "Origins of *Hawala*," 294.

[92] Stephen Quinn and William Roberds, "The Evolution of the Check as a Means of Payment: A Historical Survey," 2.

[93] History.com Editors, "Knights Templar," *History.com*, July 13, 2017.

CHAPTER 6

THE INNOVATION OF DOUBLE-ENTRY BOOKKEEPING

In 1494, Luca Pacioli of Italy wrote *Summa de arithmetica*, which among other things included a detailed description of double-entry bookkeeping. This work led him to be known as the "Father of Accounting," since his work helped to revolutionize accounting and banking throughout Europe.[94]

Double-entry bookkeeping splits a ledger into two parts, with those parts being able to reconcile with each other. If someone borrows 10 gold coins from a bank, for example, then those 10 gold coins become a liability for the borrower and an asset for the bank. Both the person and the bank have their half of the ledger that reconcile with each other, where someone's assets equal someone else's liabilities, and this allows for more complex financial systems to arise than were possible before the formulation of this technique. The bank can maintain a complicated set of assets and liabilities and can provide elaborate financial services.

Pacioli, however, didn't invent double-entry bookkeeping. The practice was in its early stages in parts of Italy before he published the work, and some of Pacioli's work was copied from fellow Italian Piero della Francesca. Prior to that, similar techniques were used by Islamic merchants (e.g., the hawala system), and brought to Italy via trade with them as described in the prior chapter. If we go back far enough, we can trace developments back to the Indian numeral system as important developments that eventually made double-entry bookkeeping more workable, and we can trace the earliest accounting back to Mesopotamia as described in this book's first chapter on ledgers. Pacioli's organization and publishing of these techniques became historically important and helped to spread and standardize the practice going forward from that point.

Importantly, these developments helped to improve payment systems in Venice, Florence, and other regions of modern-day Italy. Moneylenders in various forms had existed for thousands of years by this point, but these accountants in Italian city-states took the practice to a whole new level and gave rise to modern banking. The word "bank" is based on the Italian word *banco* which means "bench." Venice and Florence had rather free and open commerce compared to other regions in Europe at the time and traded significantly with Arab merchants. Accountants would sit on benches in the merchants squares and serve as bankers for the merchant class.[95]

The development of banking made it so that merchants didn't have to bring large numbers of coins with them, and this development reduced friction and risk of trade. If two merchants both have an account open with one of the bankers, they could complete a trade by attesting to that banker to update the ledger. The banker merely changes the credits that he has for the two merchants, subtracting some from the buyer and adding some to the seller, minus a fee that he keeps for his services. To the extent that a merchant wants to settle with a banker by withdrawing or depositing physical gold, it can be done less frequently and therefore under more secure conditions. From there, bankers could combine this practice with banknotes, and become large institutions.

Paper financial instruments had already been devised in several regions. As described in the prior chapter, papyrus and paper-based bills of exchange were used as far back as Ancient Egypt and Ancient China and along the Silk Road. These early bills of exchange were generally linked to a specific person. For a simplistic example, I would have a paper receipt that says, "Lyn Alden is entitled to the payment of five ounces of gold from XYZ individual." Only me, or someone who can legally operate on my behalf, can use that paper to withdraw that gold from that specific individual.

Eventually, many of these papers became bearer assets in standardized amounts out of convenience. This meant that whoever the bearer of the paper is, can withdraw the gold.[96] Again, in simplistic terms for the purpose of example, such a paper would say, “The bearer of this banknote is entitled to the withdrawal of five gold ounces from XYZ deposit institution.” Merchants could use these papers in place of physical gold to trade with each other, in addition to maintaining their accounts with banks. Unlike the channel-based suftaja/hawala system, the acceptance of these bearer asset banknotes would be widespread as a general medium of exchange and would be linked to the reputation of a rather large financial institution.[97]

In terms of payment technologies, we can summarize this shift from proto-banking to full-service banking in three primary steps, based around increasing levels of “negotiability.” Negotiable, in financial jargon, means that a paper instrument can be transferred to a different party. In the first step, a simplistic non-negotiable paper instrument can only be redeemed for money by a specific party, as described in the original creation of the paper. In the second step, a paper instrument is made out to a specific party and is intended to be redeemed by them but is negotiable and therefore can be physically signed over to another party who can then redeem it instead. This involves a more complex and trusted financial network between a greater number of counterparties. In the third step, a paper instrument such as a banknote is inherently a bearer asset with nobody’s name on it and can be freely exchanged between parties without any need to sign or otherwise transfer its ownership other than by physical possession. This third form requires and relies on large and widely recognized institutions.[98]

The combination of bank accounts and banknotes, and the expansion of non-negotiable channel-based paper systems into widespread negotiable bearer-based paper systems, greatly enhanced the portability, liquidity, and effective divisibility of gold over time. Thanks to abstraction, the legal ownership of gold could now move much more frequently than the underlying physical gold.[99] It increased the convenience and safety of dealing with large amounts of money, but also opened the possibility for counterparty risk and arbitrage. We can visualize the development of these networks almost like a paper version of the internet: Early channel-based connections eventually grew into an incredibly complex and interconnected set of entities that recognized and operated with each other. All of these paper assets represented claims for gold, but they required trust that the custodian of the gold would maintain it responsibly.[100] In addition, silver coins were still useful at this time because this banking process had considerable overhead costs and was therefore not suitable for everyone to use — particularly those in the bottom half of the wealth spectrum.

In many parts of medieval Europe, double-entry bookkeeping could also be maintained to some degree with tally sticks. If a creditor lent money to a borrower, they could record the details of the loan using a series of marks on a specialized wooden stick, and then break that stick in half lengthwise. The lender and the borrower would each keep their half of the stick so that they could fit the halves back together as proof that neither half was tampered with. Tallies were yet another form of ledger-keeping, and were tamper-resistant, but were physically inefficient from the lender's point of view since they had to maintain possession of many individual tally sticks.[101]

A SLIDE TOWARD FRACTIONAL RESERVE PRACTICES

The most basic type of bank serves as a 100% asset-backed custodian. People deposit gold or another monetary asset, and the custodian bank issues paper claims against it; the bank doesn't do anything else with it other than keep it safe. Custodians generally charge fees for the services they provide.

Related examples today include holding physical gold in a vault, where you'll usually have to pay a recurring vaulting fee. The same is true for a safe deposit box. If you hold an exchange-traded fund filled with stocks, the fund charges an administrative fee. These are various types of full reserve custodial and administrative services. Rather than making money from lending out your assets (and thus risking the possibility that they won't get them back), they mostly just hold them and charge you a fee to cover their overhead and make a profit.

In a free market, bankers will naturally compete for market share by charging different levels of fees. And inevitably, bankers will realize that most of the gold never gets withdrawn at once, and instead it just sits there. Imagine, for example, a banker who realizes that in the past ten years of running a full reserve bank, the biggest aggregate withdrawal that he ever had by customers was 40% of the gold at once. He therefore decides that if he has at least 80% of the depositors' gold on hand, then he should be more than safe. He could put the other 20% of the gold to work by lending it out carefully for interest, earn some profits by doing so, and therefore offer a zero-fee service — which will allow his bank to collect far more deposits. He has invented fractional reserve banking.

If he doesn't tell his customers what he is doing, then it is fraud, since they don't realize that 20% of their gold is being lent out and risked. If he tells them what he is doing and they agree to it, then it's a conscious trade-off. From the perspective of a potential depositor, maybe it seems quite reasonable for the banker to have 80% of the deposits on hand, and the other 20% in the form of illiquid loans to generate some extra income and eliminate fees for the depositor. And if indeed that is what consumers want as a trade-off, then more banks will be forced to fractionally reserve their deposits to eliminate fees as well, with some remaining as 100% reserve fee-based banks to serve the most risk-averse people who see the problems that this can lead to.

If most banks use this method, then there will be more claims for gold throughout the market than there is physical gold. Initially, the economy will likely boom from this expansion of credit, and therefore the region's rulers will like the practice, and probably encourage it.

However, banks can take this too far. If 80% reserves and zero-fee banking is an appealing combination, then how about 60% reserves and rather than merely eliminating fees, the bank gives depositors a small share of the lending profits in the form of interest on their deposits? Surely that will attract tons of deposits, and what are the odds that depositors in aggregate will try to withdraw more than 60% of their gold at once? Bankers in this system will tend to keep pushing the limit, resulting in less reserves as a percentage of deposits, so that depositors can be rewarded (knowingly or unknowingly) for taking on more and more custodial lending risk. There is an inherent aspect of instability in this type of design because it relies on the false promise that demand depositors can pull their funds out at any time, even though if most of them were to try at once, they wouldn't be able to.

It is important to note that an individual fractional reserve bank, assuming it is not insolvent from bad loans, still has as at least as much assets as it does liabilities; it's just that not all the assets are in liquid form that are able to be withdrawn at once. The real problem is that in a financial system that consists of multiple fractional reserve banks, there are far more systemwide deposits than there is underlying gold. Money lent from one institution can be deposited at another institution and immediately (and fractionally) lent from there, resulting in the double-counting, triple-counting, quadruple counting, and so forth, of deposits relative to base money. At that point, people have far more claims for gold than the amount of gold that really exists in the system, and so in some sense, their wealth is illusory. This makes the system inherently unstable and prone to cascading bank runs, where any given bank run can easily lead to many other bank runs happening. A fractional reserve banking system is like a game of musical chairs; it functions for a while but if something ever stops the music, it can all fall apart quickly.

To make it worse, the incentives surrounding bank runs at fractional reserve banks are more problematic than they appear on the surface. Suppose that a bank makes loans as part of its asset mix, and some of those loans are defaulted on. The bank now only has 90% of deposits backed by gold or other assets, having lost the rest on defaulted loans. At first, this might not seem like too big of a problem; the depositors enjoyed years of low fees or even interest-sharing, and now they will take a 10% loss on their deposits due to bad risk management by the bank. Unfortunately, however, the situation won't be that benign if left to its own devices. As soon as some well-connected depositors get a hint that the bank is insolvent, they can pull their money out quickly. When others see that happen, they start to do it as well. If this goes unchecked, then eventually all the deposits will be pulled out, and the laggards who don't pull their deposits out will get nothing. It's not as though everyone takes a 10% loss on their deposits equally; those who pull out quickly can avoid any loss while those who try to pull out last can lose everything since there are no reserves left by that point. Therefore, the inherent incentives encourage bank runs at the earliest sign of insolvency by rewarding those who pull deposits out first. Due to repeated crises, authorities began deploying regulatory and insurance schemes to try to spread out the risk and disincentivize this type of depositor behavior.

These stability problems are more fundamentally solvable by strictly matching the durations of deposits and loans. In this type of system, "demand deposits" and banknotes can be withdrawn or redeemed at any time, and thus need to be fully backed by gold. Meanwhile, certificates of deposit lock up depositor funds for longer durations in the form of an investment contract or "time deposit" and can be used by the bank to make loans of the same duration or less. This method avoids making promises regarding liquidity to demand depositors that might not be able to be kept and prevents the excessive rehypothecation and duration mismatching that fractional reserve banking systems rely on. However, this method has not generally been what societies have turned to in practice. Bankers (along with their regulators and their clients) have instead historically turned to fractional reserve banking, meaning they just live with the underlying duration mismatch and "hope" that not too many demand depositors want their money back at once. The ubiquitous practice of fractional reserve banking has therefore been a large contributor to financial crises occurring so frequently and in every jurisdiction.

Modern banks typically have 5x-10x as much deposits as they have liquid cash reserves (500% or 1,000% leverage), with the rest of their assets consisting of various securities and loans. And most of the liquid cash reserves they do have aren't even in the form of physical cash; it's in abstract central bank reserves.[102] It only takes a small fraction of people pulling their money out to cause a liquidity shortage. In contrast to a gold-backed banking system, in this modern reserve system a central bank can create more base money whenever needed, and thereby fix bank runs by diluting everyone's money.[103]

Figure 6-A shows the historical ratio of U.S. commercial bank deposits to U.S. commercial bank cash. From the 1980s through 2008, the ratio climbed from around 6x to 23x, meaning at its peak there was only 1 dollar in bank cash for every 23 dollars in deposits, which is 2,300% leverage. Banks subsequently encountered the global financial crisis, and the U.S. Federal Reserve created a lot of new bank cash and used it to buy assets from the banks. The ratio of deposits to cash therefore dropped significantly and has been lower ever since, ranging from around 5x to around 6x (meaning the system is "only" 500% or 600% leveraged).

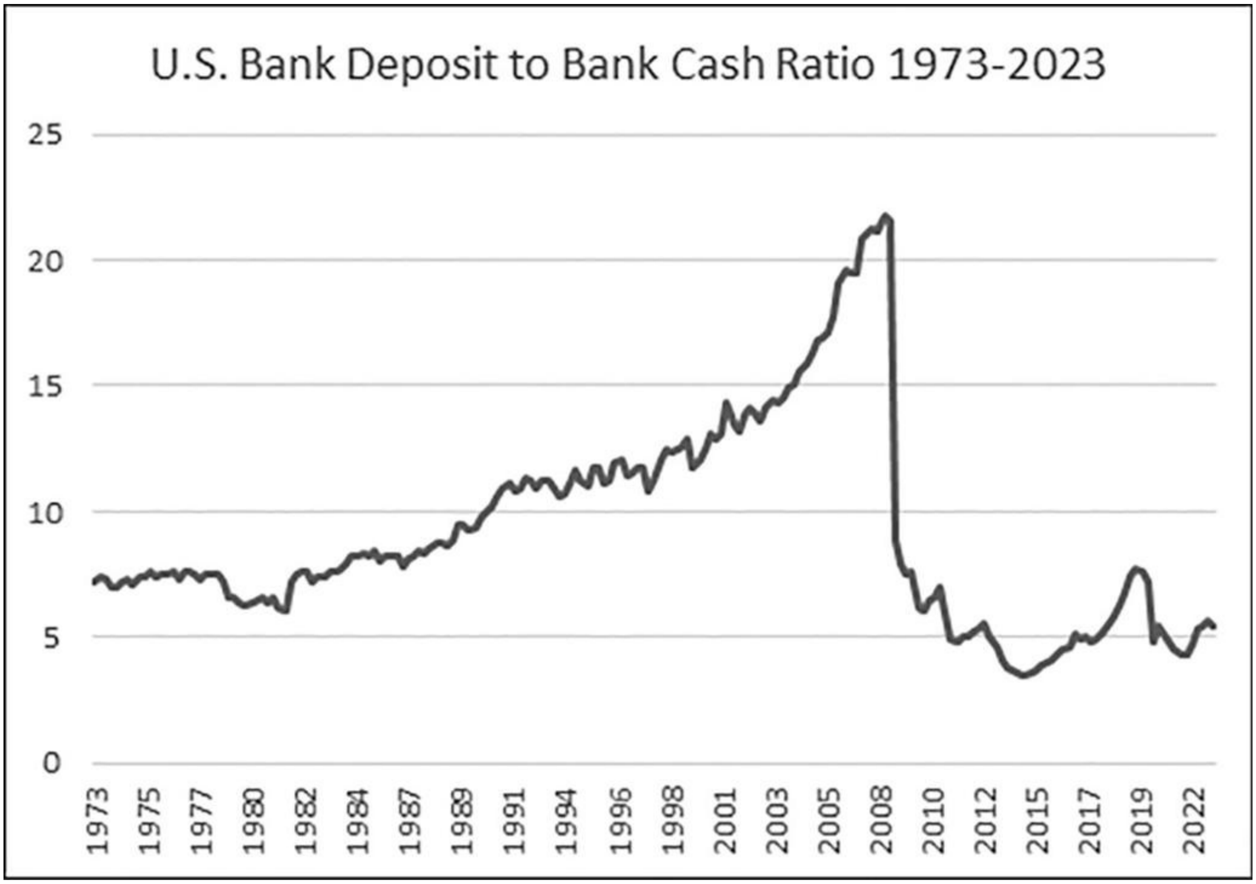

Figure 6-A[104]

As of the end of 2022, banks in the United States had approximately $18 trillion worth of deposits that they owed to customers, and only had a little over $3 trillion worth of liquid bank cash.

That sounds (slightly) less scary when we consider that, at the end of 2022 banks had about $22.6 trillion in total assets (of which $3 trillion was liquid bank cash). Their other assets consist of things like mortgages, government bonds, and business loans. Overall, banks have more assets than they have liabilities, but most of the assets are loans and securities rather than cash on hand. The financial system cannot withstand a significant percentage of depositors pulling out their cash at once. If they were to try, they would be denied.[105] In fact, at the end of 2022, U.S. banks had only around $100 billion in actual physical cash on hand; the rest of their cash was in the form of intangible bank reserves listed as assets for them on the ledger of the central bank. During 2023, there were indeed some bank runs against banks that had mismanaged some of their assets during the Federal Reserve's rapid tightening of monetary policy, resulting in some of the largest bank failures in American history.

Part 4 of this book provides additional examples of fractional reserve lending and deposit creation within the context of a fiat currency banking system rather than a gold-backed banking system. For now, focusing on older gold-backed banking systems, we can ask the question, "Who controls the ledger"?

The answer is that each bank controls its own sub-ledger.[106] When customers deposit funds at a bank, they are trusting that the banks are both ethical and competent, and either that they will fully retain the funds (in the case of full reserve custodian services) or if they do take risks, that they will do so prudently (in the case of fractional reserve banking).

In addition, we could say that the government partially controls the full ledger. There are not that many different banks in a country, and so government officials could easily go to each bank and order them to do something. Maybe they want to freeze or confiscate someone's deposits, for example. The bank would have to comply with this, whether the government is doing it for fair reasons or not. Maybe the government is persecuting someone for their religion, political affiliation, their sexual orientation, or for speaking inconvenient truths, which would be terrible. Or maybe the government is prosecuting someone for being a thief or con artist, and therefore is performing reasonable legal actions to administer justice. A government could also force all banks in its jurisdiction to hand over their gold to a central authority and give them paper IOUs for it, which is inevitably what happened to various countries over time. It's easier for a government to get the gold from a handful of banks than it would be to get it from each individual household.

Overall, it's the combination of the banks and the government that have power over the ledger that most people use as money in any banking system. For a gold-backed banking system, the only part of the ledger that individual users have control of is the precious metal coins that they retain in their own custody, and for that they rely on the properties of nature to maintain the integrity of the ledger. Once they surrender coins over to the banking system, they have begun to rely on a hierarchy of other people to control their money.

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[94] Alan Sangster et al., "The Market for Luca Pacioli's *Summa Arithmetica*."

[95] Ugolini, *Central Banking*, 11.

[96] Markus Denzel, "The European Bill of Exchange."

[97] Jim Bolton and Francesco Guidi-Bruscoli, "'Your Flexible Friend': The Bill of Exchange in Theory and Practice in the Fifteenth Century,"

[98] Larry Neal, *The Rise of Financial Capitalism*, 7–16; John Munro, "Rentes and the European 'Financial Revolution'," 236.

[99] Donald McCloskey and Richard Zacher, "How the Gold Standard Worked."

[100] Eichengreen, *Exorbitant Privilege*, 15–16.

[101] Martin Slater, *The National Debt: A Short History*, 15–44.

[102] Federal Reserve Economic Data, "Deposits, All Commercial Banks"; "Cash Assets, All Commercial Banks"

[103] Michael McLeay et al., "Money Creation in the Modern Economy," 21–25.

[104] Federal Reserve Economic Data, "Deposits, All Commercial Banks"; "Cash Assets, All Commercial Banks."

[105] Jiang et al., "U.S. Bank Fragility."

[106] Michael McLeay et al., "Money Creation in the Modern Economy," 18–20.

CHAPTER 7

FREE BANKING VS CENTRAL BANKING

Over centuries, various banking models have been used. For the purposes of this chapter we can divide national banking systems into two types: free banking and central banking.

The banks described in the prior chapter were examples of free banks. Free banks hold base money (such as gold) and have liabilities to the depositors that represent claims on that money. They also may issue banknotes that represent claims on that money, which serve as bearer assets that are not assigned to any individual but instead give the bearer (holder) of the banknote access to the base money. Individual banknotes will often be passed around as bearer asset currency, and only occasionally used to withdraw the base money from the bank.[107]

Figure 7-A shows an example of a full reserve, gold-backed free banking system.

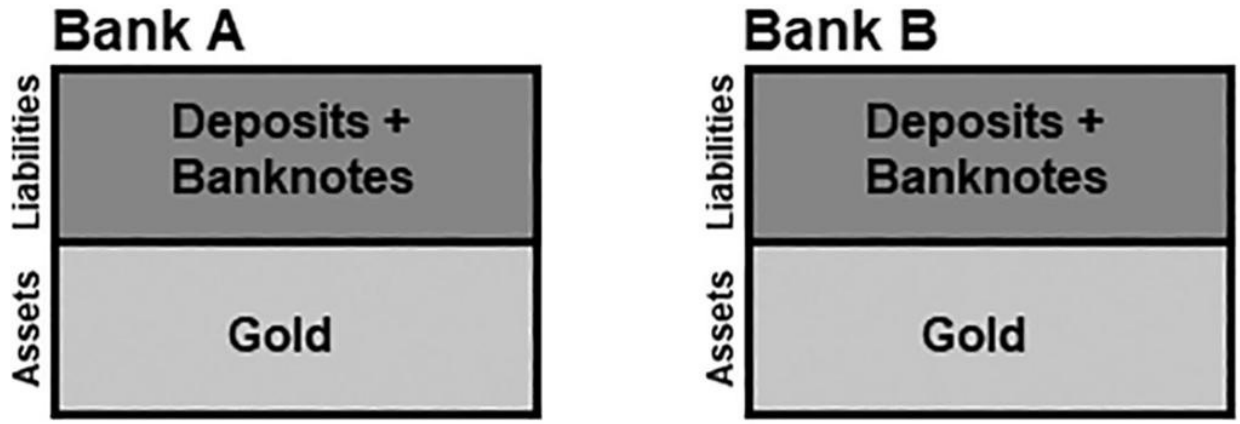


Figure 7-A

In most contexts, however, free banks used a fractional reserve model. They collected gold deposits, held some of that gold in their vault, and lent some of the gold out for interest. Due to generating profit on the deposits via lending, the bank can waive fees or pay interest to depositors. This increases risks for the bank and the depositors, because if too many people want their gold back at once, the bank will have to suspend withdrawals. [108]

Figure 7-B shows an example of a 50% fractional reserve, gold-backed free banking system.

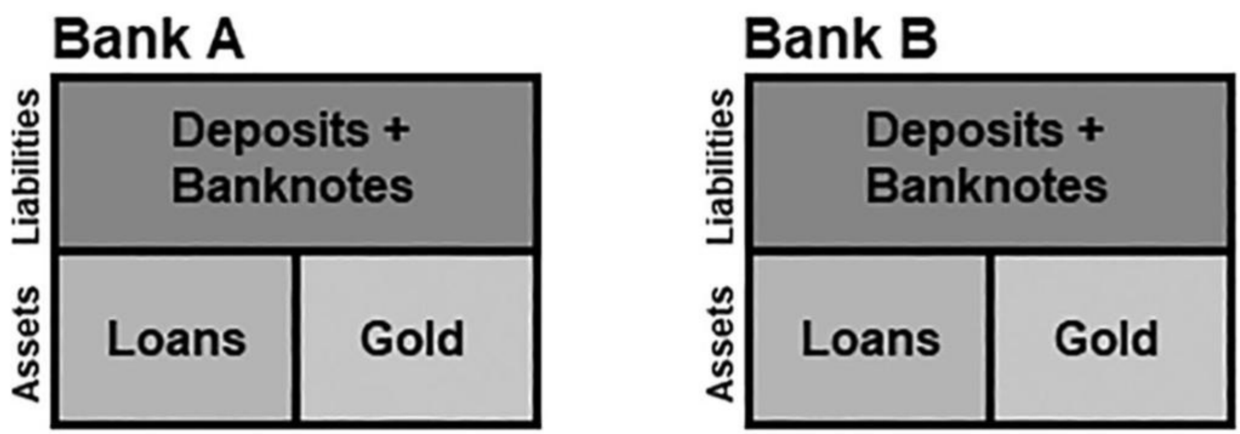


Figure 7-B

The answer to “who controls the ledger?” in this scenario is a combination of nature and individual banks. In a free banking system based on gold or some other natural base money, the amount of base money in the country is determined by the forces of geology and international trade. The supply of gold may be expanded with the discovery of new deposits (such as was the case for the California gold rush). Alternatively, the supply of gold may be expanded or reduced by running trade surpluses or trade deficits respectively. If the people of a country in aggregate continually buy more than they sell to people in foreign nations, then the country will run a structural trade deficit, and gold will continually flow out of the country and into the coffers of its foreign trading partners. If a country is highly productive, and people in it sell more goods and services to foreign nations than they buy, then the country will run a structural trade surplus, and gold will continually flow into the country.

Throughout the 18th and 19th centuries, free banking was prevalent in many countries. It was particularly successful in Canada, Switzerland, and Scotland despite relying on duration mismatching. The turbulent free banking era in the United States from the 1830s to the 1860s was filled with numerous bank failures and is often pointed to as evidence for the failure of free banking as a concept, but this was a small and troubled time in the bigger and more global history of free banking that generally can be described as having a mixed success rate. George Selgin's 1988 book on the theory of free banking provided useful research into 19th-century free banking practices.[109] Selgin went on to provide decades of additional research in the form of books and scholarly articles on the subject to the present day.

In his book on the history of money, Glyn Davies listed examples of different free bank regulations on a state-by-state basis. Massachusetts allowed nearly anyone to create a bank, and with minimal requirements. New York had more stringent requirements, with various capital requirements along with the necessity to keep a reserve of precious metal coins equal to at least 12.5% of circulating banknotes. Louisiana had a tighter requirement of reserving banknotes with at least one-third precious metal coins in reserve for circulating banknotes, along with other capital and liquidity regulations.[110]

In contrast to free banking, central banking standardizes and centralizes the national ledger and the banknotes. In this type of system, a central bank is recognized or established by the government, and each bank uses the central bank's ledger as its base money. Rather than holding their reserves as vaulted gold, they hold their reserves as entries on a central bank's ledger, and the central bank (or its government) holds the gold — assuming for the moment that the system is still gold-backed, as it once was. The central bank replaces individual banks as the issuer of banknotes.[111]

The central bank itself has both assets and liabilities. Their liabilities are primarily the reserves that individual banks store with them, as well as all the banknotes in circulation that are issued by the central bank. The assets can vary depending on the period of history. They might have gold as their primary assets, for example. In the modern fiat era, central banks use government bonds as their primary assets.

Figure 7-C shows an example of a fractional reserve, gold-backed central banking system.

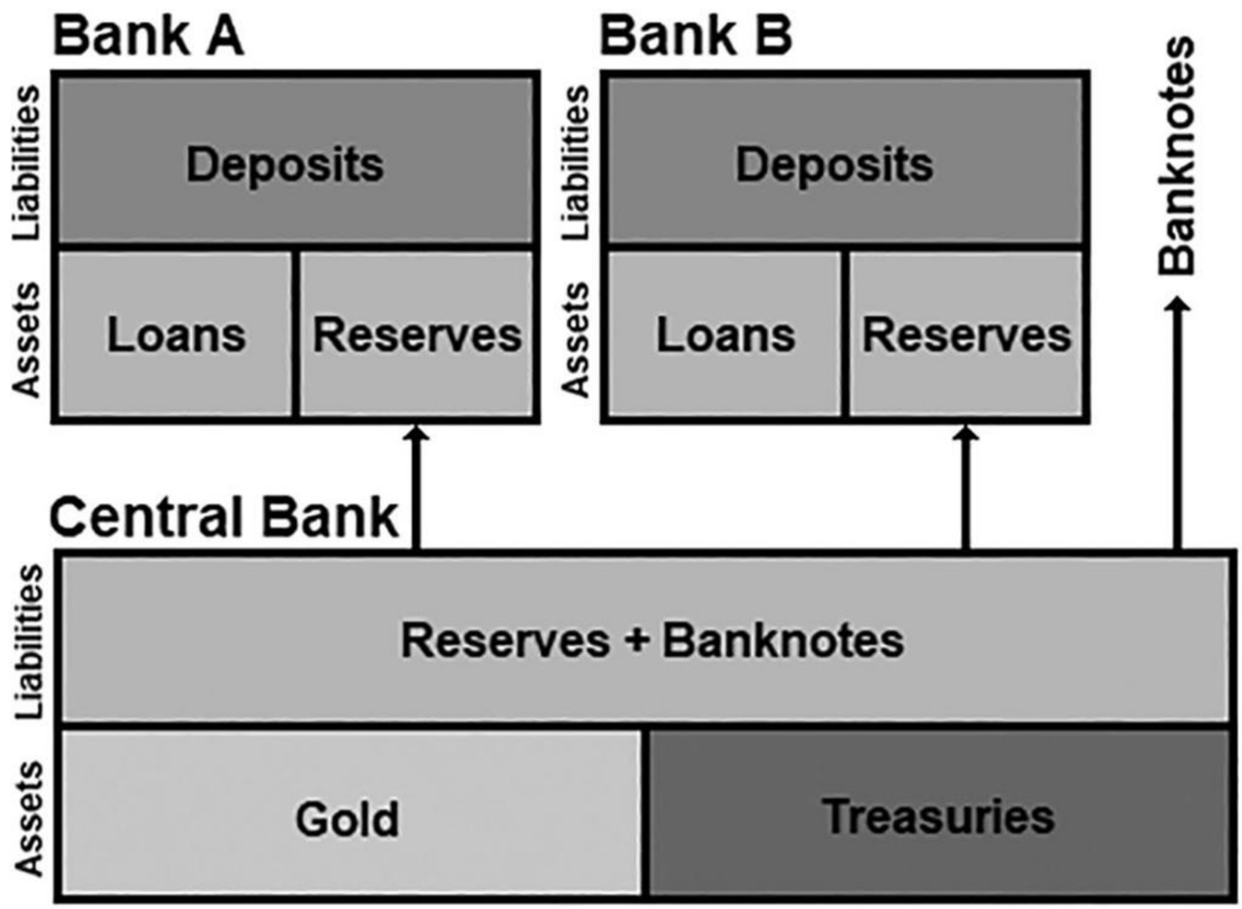


Figure 7-C

In this framework, the central bank mainly determines the amount of base money (the sum of physical currency and bank reserves) in the system. If there is a crisis, the central bank can create more base money, and can serve as a lender of last resort due to this flexibility. Specifically, they have some flexibility regarding how much of their base money is backed by physical gold, if the system is functioning pretty well. In many contexts during the late 19th century and early 20th century, central banks would be mandated to have at least 35% or 40% gold backing, and therefore tried to keep the number above the required threshold most of the time.[112] In simplified terms: if too many people pulled gold out of the system, a central bank could raise interest rates (more specifically "discount rates") to entice some of that gold to be deposited back in — either domestically or from abroad. If a central bank had plenty of gold on hand, they could cut interest rates (discount rates) to stimulate credit growth and economic expansion.

Central banking consists of several layers of abstraction and centralization. Individual depositors in banks are powerless within this type of system. Each bank is also effectively powerless because all its assets consist of IOUs. The central bank holds all the power, and a central bank can be controlled by the government. When we ask our recurring question — "who controls the ledger?" — we can see that the answer to this question changes a bit between free banking and central banking.

In a gold-backed free banking system, the answer is that nature and individual banks control the ledger, with the government in turn having the option to influence or take over banks to varying degrees. The properties of nature continue to provide scarcity for the underlying precious metal, and people can still directly hold precious metal coins, bars, and jewelry. To the extent that they deposit funds into a bank, that bank controls that part of the ledger.

In a gold-backed central banking system, the answer is that nature still provides scarcity for the underlying precious metal, but it's becoming increasingly removed from everyday operation of the system. Individual banks are barely in control anymore, because rather than vaulting gold directly, they store their reserves as entries on the central bank ledger. They can lose funds (including customer deposits) by making bad loans, but they have no agency over the value of their own reserves, since they have a layer of abstraction between themselves and the underlying metal. The central bank now controls the ledger for deposits and their underlying reserves throughout the country. The only control that individuals retain is the portion that they hold themselves in precious metal coins.

A BRISK WALK THROUGH AMERICAN MONETARY HISTORY

Banking systems have trended toward centralization over time. This happened in various European countries, and then the United States and other countries went through a similar process. The rather recent and continuous history of the United States provides a useful walkthrough for how this centralization tends to happen.

The founding of the United States and its monetary system happened in phases. The Revolutionary War began in 1775, and the Declaration of Independence was written in 1776. During the war era, the Continental Congress issued banknotes called Continentals, which eventually hyperinflated.[113] The Constitution went into effect in 1789. The Coinage Act of 1792 made the silver dollar the base unit of account in the United States and established the U.S. Mint to issue standardized legal tender coinage. Within that Coinage Act, a silver dollar was established to be equivalent to 371.25 grain (24.1 grams) silver. A tri-metallic decimal system was structured around it as follows:

- Eagles: 247.5 grain of gold, denominated as $10.00.
- Half eagles: 123.75 grain of gold, denominated as $5.00.
- Quarter eagles: 61.875 grain of gold, denominated as $2.50.
- Dollars: 371.25 grain of silver, denominated as $1.00.
- Half dollars: 185.625 grain of silver, denominated as $0.50.
- Quarter dollars: 92.8125 grain of silver, denominated as $0.25.
- Dimes: 37.125 grain of silver, denominated as $0.10.
- Half dimes: 18.5625 grain of silver, denominated as $0.05.
- Cents: 264 grain of copper, denominated as $0.01.
- Half cents: 132 grain of copper, denominated as $0.005.[114]

The First Bank of the United States was established in 1791, but it was not a true central bank, and was limited in its scope due to the deeply embedded controversy about having a central bank at the time. It had a finite charter of 20 years which expired in 1811. In 1816, the Second Bank of the United States was established, similarly limited in scope, and lasted for another 20 years until 1836.[115]

Various commercial banks existed at this time; they could issue banknotes and used precious metals and other assets as reserves that those banknotes were redeemable for. So, while the government's role was to standardize and produce coinage for the national unit of account, it left the issuance of paper banknotes to individual banks. Any money put into circulation by the government itself was limited by the availability of precious metals; they couldn't just create money out of thin air. Banks could use various types of collateral for their banknotes, but to be credible they had to be able to honor redemptions of banknotes for precious metals on demand.

States regulated the individual banks within their jurisdictions. There is often a lot of corruption in terms of who gets to run a bank, because it's very lucrative to be one of the entities allowed to issue fractionally reserved banknotes. Branching was often limited or disallowed, meaning that a bank could not open several different branches in several different states. This prevented banks from diversifying their deposits and loans properly across geographies, and thus they were quite prone to bank runs and various liquidity and solvency crises. Compared to Canada, Sweden, and Scotland, free banking in the United States was a lot more restricted, and these individual banks in aggregate were not very safe outside of certain jurisdictions.[116]

In the 1860s, under President Abraham Lincoln during the American Civil War, the country began to centralize its banking system. The National Banking Acts of 1863 and 1864 established a set of national banks with stricter regulations, established a national paper currency issued by national banks that were backed up partially by government bonds, and expanded the ability of the federal government to issue war bonds. Each national bank, as part of its setup process, had to buy government bonds and deposit them with the Comptroller of the Currency. Further legislation in 1865 effectively taxed state banknotes out of existence, establishing the national banknotes as the near monopoly on currency issuance.[117]

To fund the American Civil War in the 1860s, the U.S. federal government began issuing "greenbacks" as fiat currency — first in the form of demand notes and then in the form of United States notes. At this point, the U.S. federal government was engaging in seigniorage — it could issue currency and debt for nearly zero cost. This gave them the ability to absorb savings from the population (as long as they could retain some degree of credibility and reputation) and channel those savings toward the war effort. While their valuations relative to gold did fluctuate, the monetary properties of the greenbacks were managed better than the Continentals and avoided hyperinflation. On the other side of the war, the Confederate States of America also issued fiat currency to channel peoples' savings toward the war, and their currency went on to hyperinflate due to their loss in the war.[118]

After the war ended, a multi-decade disagreement between creditors and debtors emerged. Creditors, referring especially to the wealthier financial class centered in the Northeast, wanted to tighten the money supply as much as possible, including retiring the fiat greenbacks and demonetizing silver, so that the dollar would only be pegged to gold. Debtors, referring to farmers and certain other working-class groups and organizing under the "Free Silver" movement, tended to be more in favor of keeping the greenbacks in circulation and maintaining both gold and silver as money, which would allow for a larger supply of dollars.[119] This brought to attention an important issue: dollars were merely an abstraction of value, redeemable for *something* of value which meant that the definition of a dollar could change in a political group's favor by shrinking or expanding its supply. Savers and creditors of dollars will naturally want a stronger dollar; debtors that owe dollars will naturally want a weaker dollar. In this case the hard money side won; the Coinage Act of 1873 and the Gold Standard Act of 1900 demonetized silver and set the country on a gold standard until 1933.

Much analysis on inflation decries the printing of money by governments and central banks, and indeed money-printing is something that occurs frequently in the modern era. But similar attention must be paid to the centralized destruction of money as well. When savers save money in a unit of account that they expect to be stable, and that unit of account is rapidly printed or redefined to be weaker by a central authority (reduced in terms of purchasing power), then it is basically a breach of contract for savers. Conversely, when debtors borrow money in a unit of account that they expect to be stable, and that unit of account is rapidly destroyed or redefined to be stronger by a central authority (increased in terms of purchasing power), than it is likewise a breach of contract for debtors.

With the 1913 Federal Reserve Act a third national bank of the United States was established, and the first true central bank of the country: the Federal Reserve System. The Federal Reserve was constructed as a system of twelve Federal Reserve banks, which are owned by commercial banks but are overseen by a board of federally appointed officials. The Act gave the Federal Reserve authority to oversee the banking system, serve as lender of last resort, and issue Federal Reserve banknotes. The Federal Reserve held gold among its assets and administered the ledger that served as the monetary base for the country, with commercial banks storing their reserves as entries on the Federal Reserve's ledger.[120]

During the Great Depression in 1933, President Roosevelt signed Executive Order 6102, which made it a criminal offense, punishable by up to ten years in prison, for Americans to own gold anywhere in the world other than small amounts for things like wedding rings. People were told to hand over their gold and were given the existing pegged exchange rate of 20.67 dollars per ounce in return. In the next year, the 1934 Gold Reserve Act barred all banks from redeeming dollars for gold and required the Federal Reserve to hand over all its gold to the United States Treasury. Through the combination of these actions, large amounts of gold were handed over by the public to the U.S. federal government in exchange for paper dollars and bank deposits.

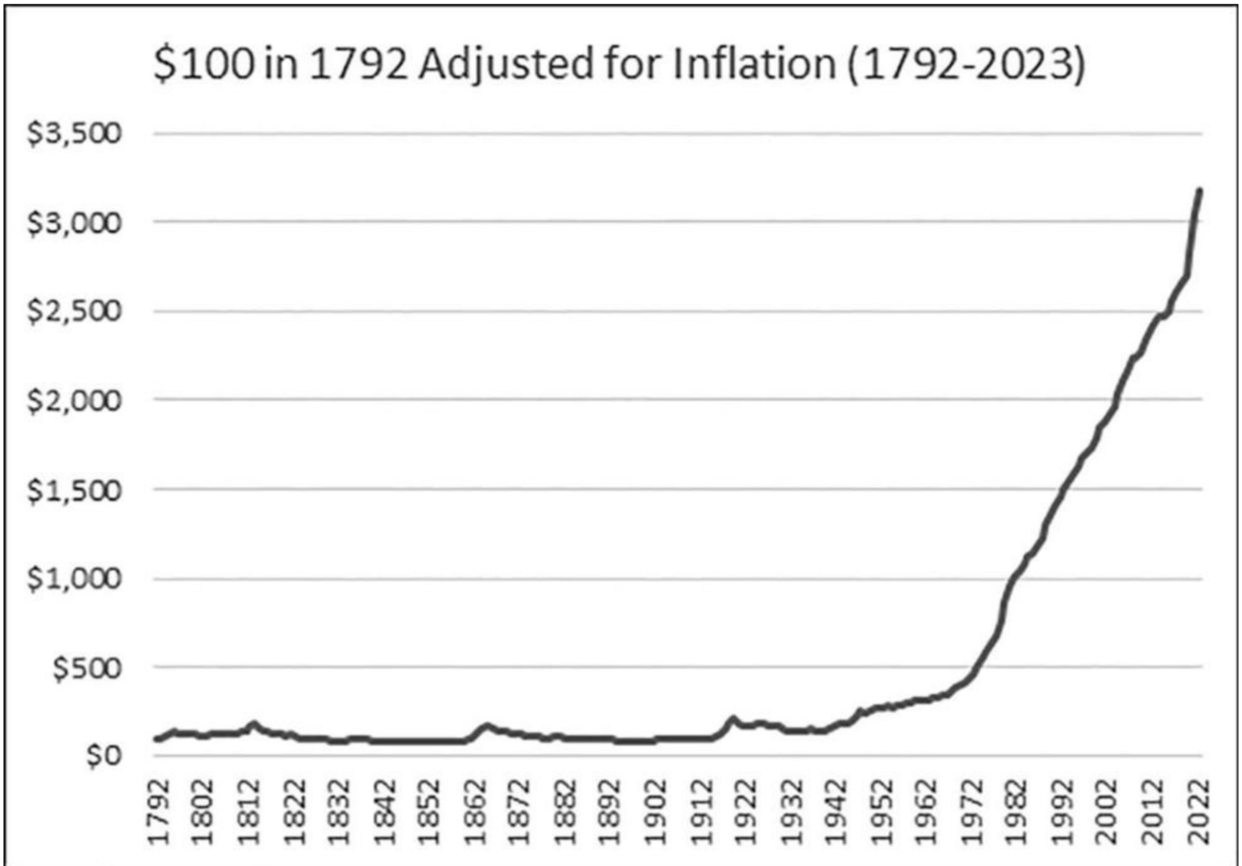
After the 1934 Gold Reserve Act, the federal government then sharply devalued the dollar relative to gold. An ounce of gold went from being worth 20.67 dollars to 35 dollars. This allowed them to expand the monetary base in dollar terms relative to their amount of gold reserves, and thus devalue peoples' dollar-denominated savings — as well as devalue various debts, including the federal debt. The federal government constructed the United States Bullion Depository at Fort Knox and transferred their gold to that location.[121]

Although it was illegal for Americans to own gold for approximately four decades, many of them secretly did, and the ban wasn't very enforceable in practice. It's easy for a government to get all the gold out of banks with the stroke of a pen, but to get all the smaller amounts of gold out of individual households would require a much more expensive and draconian operation. They had to be content with getting a significant percentage of it, mainly from banks and from individuals who willingly turned it over early on to avoid the low chance of getting caught.

From the 1933 until 1971, dollars were still redeemable for gold by foreign central banks at this new devalued rate, but not by American citizens, and not by foreign private entities. In 1971, the United States defaulted on foreign redemption as well, and rendered the dollar redeemable for nothing. After that point, the dollar's fall in value accelerated. By the 1980s and 1990s, an ounce of gold was worth approximately ten times as many dollars ($300 to $400 depending on the year) as it used to be, as dollars were rapidly debased. By the 2010s and 2020s, an ounce of gold was worth well over $1,000 and at times reached over $2,000.

Figure 7-D shows the change in purchasing power of the U.S. dollar over time as

measured by aggregate price inflation, with key moments annotated.


$100 in 1792 Adjusted for Inflation (1792-2023)
$3,500
$3,000
$2,500
$2,000
$1,500
$1,000
$500
$0
1792
1802
1812
1822
1832
1842
1852
1862
1872
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1982
1992
2002
2012
2022

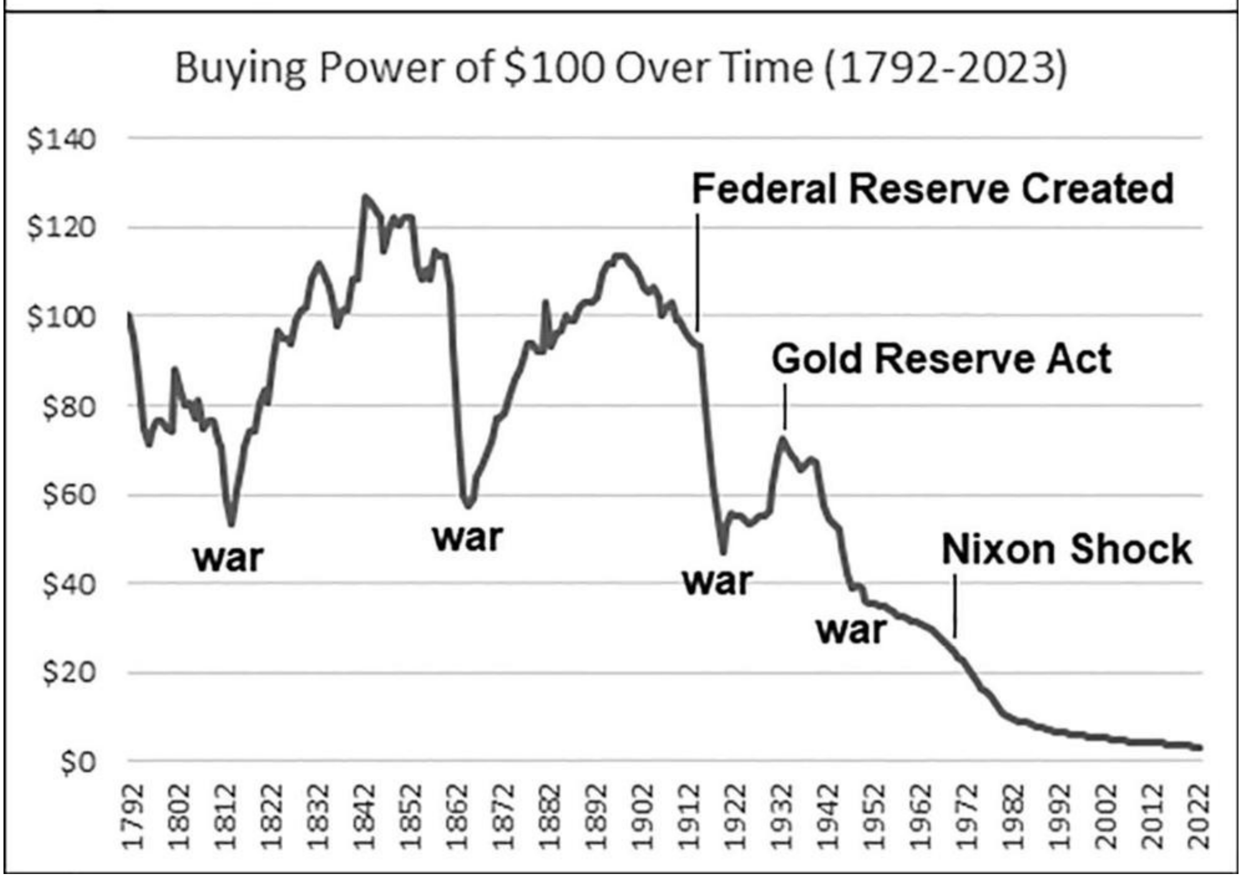
Buying Power of $100 Over Time (1792-2023)
$140
$120
$100
$80
$60
$40
$20
$0
Federal Reserve Created
Gold Reserve Act
war
war
war
war
Nixon Shock
1792
1802
1812
1822
1832
1842
1852
1862
1872
1882
1892
1902
1912
1922
1932
1942
1952
1962
1972
1982
1992
2002
2012
2022

Figure 7-D

As Figure 7-D shows, the War of 1812 and the 1860s Civil War resulted in temporary debasement, but due to the success in those wars, national productivity, and the underlying dollar-to-gold peg, the debasement reversed back to the prior value.[122] Starting in 1913 with the creation of the Federal Reserve, followed up by the World Wars, the 1933 elimination of domestic gold redeemability, and then again with the 1971 elimination of international gold redeemability, the dollar sharply fell out of that historical range. And yet despite all of that, the U.S. dollar was the second-best performing currency in the world during this timeframe; most currencies lost value even more quickly.

During the period where the dollar was stable in value, it was fine for people to hold physical banknotes from high-quality banks for long periods of time since they didn’t have to worry about persistent devaluation. Putting deposits into a bank to collect interest was optional, rather than a necessity. However, in the post-1913 world and especially in the post-1971 world, as dollars began losing value more continuously and rapidly, it became untenable to hold large amounts of banknotes outside of banks due to their continual loss of purchasing power. If a saver had any hope of keeping up with inflation, it became necessary to deposit money in banks and collect interest. Bank deposits underperformed inflation from 1913 to the present, but at least underperformed *less* than holding physical banknotes that paid no interest. Therefore, this structurally inflationary system enhanced the power of banks by making them more necessary for everyone to deposit the bulk of their savings with. It also increased the power of the government to surveil account balances and transactions, collect taxes, and freeze funds on demand, since most of the money was in the banks rather than in the form of physical and private bearer assets. Put simply, an inflationary money necessitates the use of counterparties and leverage to try to keep up with inflation by earning interest, which is not the case with a hard money.

In 1970, Congress passed the Bank Secrecy Act, which made banks file reports to the government whenever their customers do more than $10,000 in transactions within a day. Back then, this dollar amount was worth more than the median annual income, and reporting therefore happened rather infrequently. However, the Bank Secrecy Act was not adjusted for inflation, and so over the course of five decades, the government has automatically reduced the threshold for necessary reporting and has therefore continually expanded their surveillance mandate each year without further legislation. The combination of restricting the number of physical banknotes in circulation, making it undesirable to hold physical banknotes for long periods of time due to inflation without interest, and surveilling bank deposits, has been an effective surveillance and control combination.

Figure 7-E shows a simplified version of what the system looks like now, with gold replaced by Treasuries and mortgage-backed securities as the Federal Reserve's primary assets.

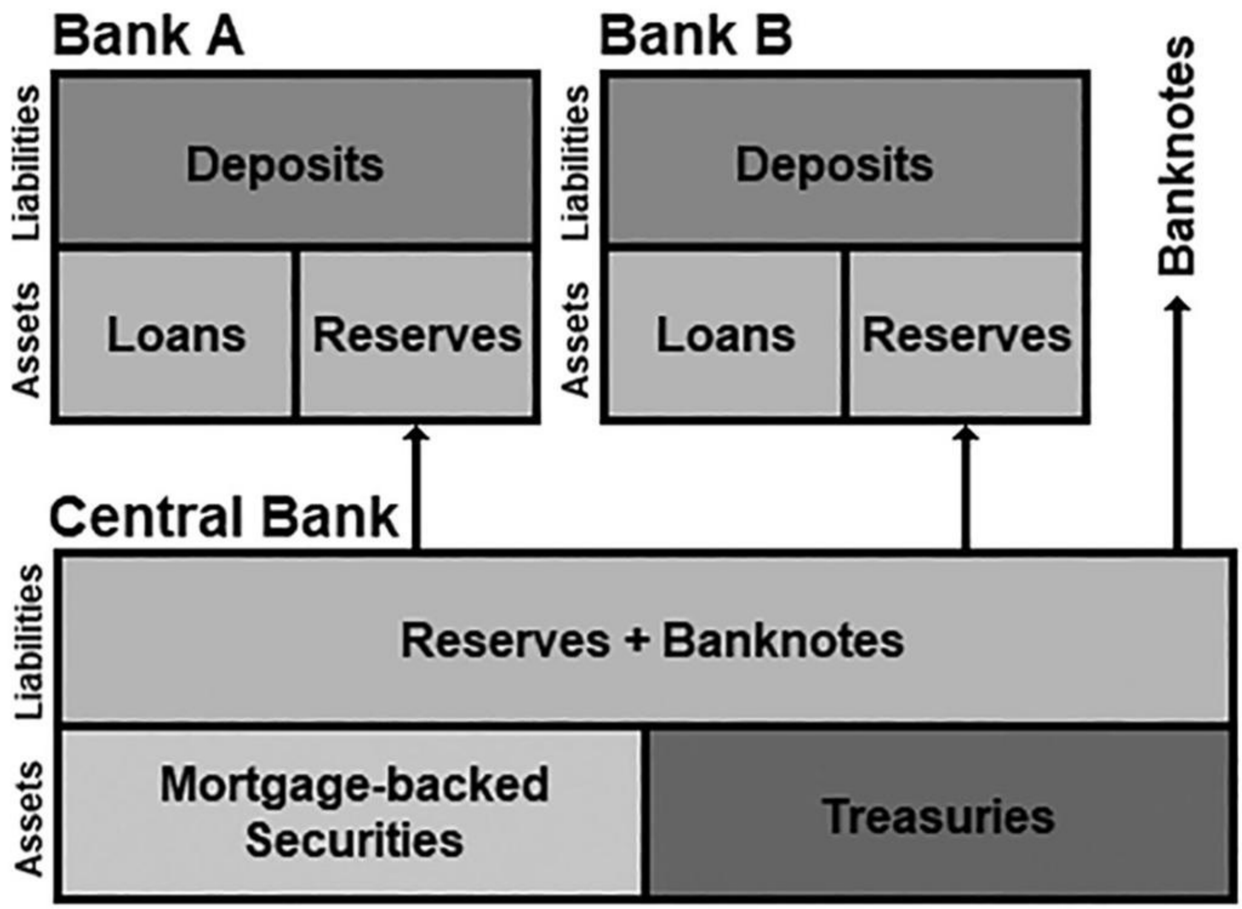

Figure 7-E

The combination of these actions shows why the question of "who controls the ledger" is very important. It also shows how quickly the answer to the question can change.

When people hold precious metals directly, they rely on nature to administer their ledger, since it is mainly the scarcity of the metal available for humans to mine economically that determines to what extent their savings can retain their purchasing power. In addition, people can hand these precious metals to other people, which allows for private, censorship-resistant transactions that don't depend on counterparties. People are, however, vulnerable to physical theft to whatever extent they custody their own coins at home.

When people deposit some of their funds into custodians or free banks that vault some of their gold, they are now relying on both nature and that bank to administer the ledger. The user must trust the scarcity of gold itself and must trust the bank not to mismanage their loan book or to commit fraud. The user also gives up their privacy; their banker knows their wealth and who they deal with; and their government knows their wealth and who they deal with; and both have the power to seize their funds if desired. In exchange, the user gets more convenience including fast, long-distance transaction capabilities. The user can still hold some gold or silver in their own custody, and therefore can decide how to manage the risk/reward of holding their money with themselves and with their bank.

Any time that balances are defined in a unit of account that is pegged to something else, then the authorities who control that peg can determine the fate of both savers and debtors. Changing the rules for that unit to peg it to something scarcer can dramatically harm debtors. Likewise, changing the rules to peg it to something more abundant can dramatically harm savers.

When the government establishes a central bank, and especially if it outlaws gold ownership, it takes monetary power away from the people and gives it almost entirely to banks and government authorities. People at that point have limited ability to custody their own scarce and liquid assets, and instead must rely on the central banking ledger; they must therefore submit to the risks of currency debasement and must give up most of their privacy. Government officials can now more easily take purchasing power away from savers — not just through transparent taxation but also through non-transparent inflation of the money supply — and channel it toward their goals. Governments can also more easily surveil and audit everyone's finances.

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107 Quinn, "Goldsmith Banking."

108 Lawrence White, *The Theory of Monetary Institutions*, 57–73.

109 George Selgin, *The Theory of Free Banking: Money Supply Under Competitive Note Issue*.

[110] Davies, *A History of Money*, 461–68, 482.

[111] Goodhart, *Evolution*, 85–99; Lawrence White, *Free Banking in Britain: Theory, Experience, and Debate, 1800–1845*, 21–63.

[112] David Wheelock, "Monetary Policy in the Great Depression," 14–19.

[113] Farley Grubb, "The Continental Dollar: What Happened to It after 1779?"

[114] U.S. Mint, "Coinage Act of April 2, 1792."

[115] Andrew Hill, "The Second Bank of the United States," 2–5.

[116] Kurt Schuler, "The World History of Free Banking," 14–37.

[117] George Selgin and Lawrence White, "Monetary Reform and the Redemption of National Bank Notes, 1863–1913."

[118] Ben Baack, "America's First Monetary Policy: Inflation and Seigniorage During the Revolutionary War."

[119] Gretchen Ritter, *Goldbugs and Greenbacks: The Antimonopoly Tradition and the Politics of Finance in America, 1865–1896.*

[120] Allen Meltzer, *A History of the Federal Reserve, Volume 1: 1913-1951*, 65–68.

[121] Henry Mark Holzer, "How Americans Lost Their Right To Own Gold And Became Criminals in the Process."

[122] Alioth Finance, "Inflation Calculator," U.S. Official Inflation Data.

CHAPTER 8

THE SPEED OF TRANSACTIONS VS THE SPEED OF SETTLEMENTS

From papyrus-based bills of exchange to double-entry booking and paper banknotes, the main purpose of banking was to enable transactions to move more quickly and frequently than the transportation and verification of physical gold would allow. Banking also allowed for the usage of more extensive credit systems, by allowing a third party (a money changer or a bank) to serve as a trusted intermediary between two non-trusting entities (buyers and sellers, or creditors and debtors).

In other words, banking allowed for transactions (commerce) and settlements (money) to be separated. Transactions for individual goods and services could occur more frequently, existing for a period of time in a state of credit, until they were settled with precious metals in less frequent occurrences and in larger amounts. However, while this process of batching multiple transactions into fewer and larger settlements increased transaction efficiency and reduced the risk of theft, it couldn't overcome a fundamental constraint: the speed of information.

For thousands of years, transactions and settlements had the same maximum speed limit: the speed of foot, horses, and ships. Peoples' ability to do transactions, and the bearer assets they transacted with (mainly gold and silver in advanced regions), had no inherent difference in terms of travel speed, although the transactions themselves were more efficient in practice. All of it was limited by the speed of physical human travel. Even the invention of banking couldn't get around this basic limitation. The paper bills of exchange and banknotes, while easier and safer to transport than gold, still couldn't move faster than foot, horses, and ships. Ledger-based account systems, while convenient, still couldn't send information over long distances any faster than the existing modes of physical travel.

However, with the invention of the telegraph, and then the telephone, the speed of transactions increased to nearly the speed of light. The first working telegraph was invented in the 1830s. Engineers then spent much of the 1840s and 1850s figuring out how to run cables over long distances, including under large bodies of water, during which time they were able to connect the various financial centers of Europe together, including London and Paris. After some failed attempts, the first long-lasting transatlantic telegraph cables were put in place in the 1860s, and the global banking system quickly became more interconnected in the decades that followed.[123] From that point, people could transact across the world by updating each other's bank ledgers over telecommunication systems nearly at the speed of light.[124] Banks and central banks had full control over that process. Meanwhile, gold and silver as bearer assets still moved slowly, and thus had to be increasingly abstracted to keep up.

Prior to the invention and usage of telecommunication systems, gold and silver were already frequently abstracted with paper claims due to divisibility limitations or security concerns or convenience or the desire to earn interest as described in prior chapters, but once telecommunication technology was invented, their slow speed made it even more necessary to abstract them to keep up. All around the world, people and institutions increasingly relied on interconnected bank accounts rather than coinage.[125] And with currency units abstracted from the underlying metal, it turned currency units into an inherently political topic between creditor groups and debtor groups.

In his 1875 book *Money and the Mechanism of Exchange*, which was published less than 25 years after the telegraph connection between the United Kingdom and France, and less than a decade after the completion of the transatlantic telegraph connection, the English economist and logician William Stanley Jevons described in detail the increasing centralization of the global financial system. He discussed the inherent challenges of physical coinage and bullion, including their various imperfections, inefficiencies, and the complexities of authentication, and how increasingly centralized financial centers were becoming more and more efficient at performing abstract transactions so that gold and silver diminished in their day-to-day roles.

In that book, Jevons provided four separate diagrams shown together in Figure 8-A (now in the public domain) to walk the reader step-by-step through an increasingly connected set of hypothetical banks and how this centralization was occurring over time. The first diagram showed how account holders of a single bank could send money to each other using the bank as a settlement layer. The second diagram showed a connection between two such banks, who accept each other's paper payment instruments so that their accountholders can easily send money to each other across banks as well. The third diagram showed the introduction of a central bank, which allowed for more efficient settlement between many banks. The fourth diagram showed a base layer clearing house, either at a national scale or even a global scale centered in a major financial hub like London, to connect all banks.

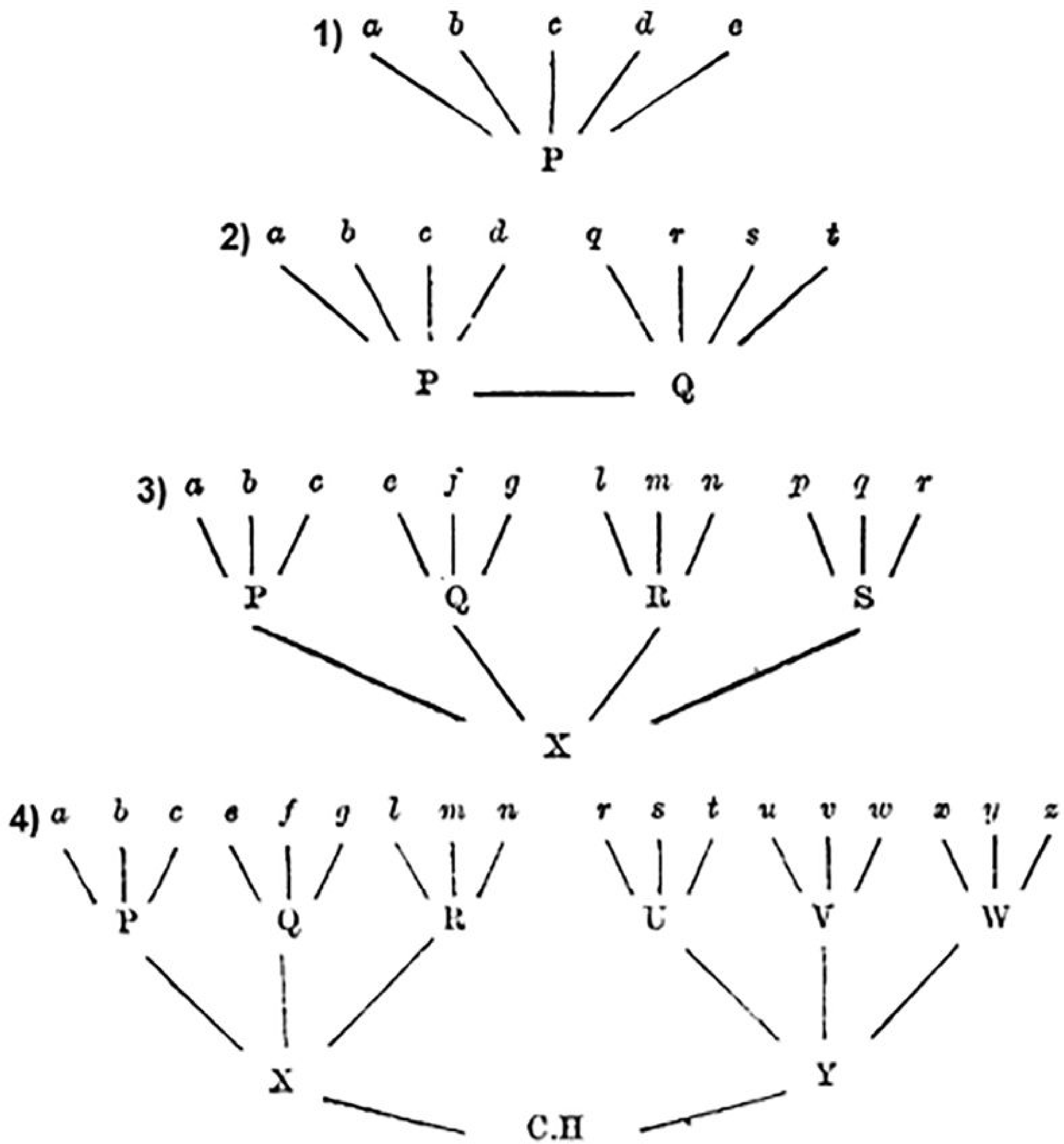

Figure 8-A[126]

Throughout the book, Jevons excitedly described the increasing abstraction and efficiency of global commerce, as claims for payment could cancel out against other claims between banks and therefore render gold settlements rare and almost irrelevant. And toward the end of the book in a section called "The World's Clearing House", he described London's increasing role as the centralized ledger administrator for the world. Banks from across the whole world had offices in London to connect with the financial network effects that existed there.

> England buys every year from America a great quantity of cotton, corn, pork, and many other articles. America at the same time buys from England iron, linen, silk, and other manufactured goods. It would be obviously absurd that a double current of specie should be passing across the Atlantic Ocean in payment for these goods, when the intervention of a few paper acknowledgments of debt will enable the goods passing in one direction to pay for those going in the opposite direction. The American merchant who has shipped cotton to England can draw a bill upon the consignee to an amount not exceeding the value of the cotton. Selling this bill in New York to a party who has imported iron from England to an equivalent amount, it will be transmitted by post to the English creditor, presented for acceptance to the English debtor, and one payment of cash on maturity will close the whole circle of transactions. Money intervenes twice over, indeed, once when the bill is sold in New York, once when it is finally cancelled in England; but it is evident that payment between two parties in one town is substituted for payment across the whole breadth of the Atlantic. Moreover, the payments may be effected by the use of cheques, or the bills when due may themselves be presented through the Clearing House, and balanced off against other bills and cheques. Thus the use of metallic money seems to be rendered almost superfluous, and, so long as there is no great disturbance in the balance of exports and imports, foreign trade is restored to a system of *perfected barter*.
>
> […]
>
> It might seem that in the use of cheques internally, and of bills of exchange in foreign trade, we have reached the climax in the economy of metallic money; but there is yet one further step to make. We found that so long as all the merchants of a town keep their cash with the same banker, they have no need to handle the money at all, but can make payments by transfers in the books of their banker. Let us imagine, then, that merchants all over the world agreed to keep their principal accounts with the bankers of any one great commercial town. All their mutual transactions could then be settled among those bankers. An approximation to such a state of things exists in the tendency to make London the monetary head-quarters of the commercial world, and the general clearing house of international transactions. All that is needed to secure economy of money is centralization of transactions, so that there may be the wider scope for the balancing of claims.[127]

Jevons' book is remarkable in two ways. Firstly, it was excellent at describing the increasing role of technology as it relates to money, from ancient times until its publication in 1875, and how the next few decades would likely come together in even more centralized ways. Secondly, it was prescient at identifying some of the catastrophic problems that such a centralized system could lead to, even though Jevons himself was highly supportive of this centralization for the sake of efficiency and thought that those problems could be managed appropriately.

Specifically, in a series of instances throughout the book, Jevons identified the greater and greater scope of claims for gold relative to the amount of actual gold in the system, due to the ease of dealing with claims rather than the metal itself. He cited numbers from his time showing that a mere four to seven percent of claims were held in reserves by the banking system of the United Kingdom, and that even those reserves were themselves fractional claims for gold.

> It is requisite, too, that our bankers, financiers, and merchants should regulate their operations with a thorough comprehension of the immense system in which they play a part, and the risks of derangement and failure which they encounter by over-severe competition. No one doubts that alarming symptoms have during recent years presented themselves in the London money market. There is a tendency to frequent severe scarcities of loanable capital, causing sudden variations of the rate of interest almost unknown thirty years ago. I will therefore in the next chapter offer a few remarks intended to show that this is an evil naturally resulting from the excessive economy of the precious metals, which the increasing perfection of our banking system allows to be practised, but which may be carried too far and lead to extreme disaster.
>
> […]
>
> The metals took the place of other commodities as currency, and delicate considerations began to enter concerning token and standard coins. From metallic representative money, we passed to paper representative money, and finally discovered that, by the cheque and clearing system, metallic money was almost eliminated from the internal exchanges of the country. Pecuniary transactions now present themselves in the form of a room full of accountants, hastily adding up sums of money. But we must never forget that all the figures in the books of a bank represent gold, and every creditor can demand the payment of the metal. In the ordinary state of trade no one cares to embarrass himself with a quantity of precious metal, which is both safer and more available in the vaults of a bank. But in international trade, gold and silver are still the media by which balances of indebtedness must be paid, and serious consequences may arise from any disproportion between the amount of transactions carried on, and the basis of gold upon which they are settled.
>
> […]
>
> It is quite apparent, therefore, that the tendency is to carry on a greater and greater trade upon an amount of metallic currency which does not grow in anything like the same proportion. The system of banking, too, grows more perfect in the sense of increasing the economy with which money is used. The competition of many great banks, leads them to transact the largest possible business with the smallest reserves which they can venture to retain. Some of these banks pay dividends of from 20 to 25 per cent, which can only be possible by using large deposits in a very fearless manner. Even the reserves consist not so much of actual coins or bank-notes in the vaults, as of money employed at call in the Stock Exchange, or deposited in the Bank of England, which again lends the deposits out to a certain extent.
>
> Now the larger the trade which is carried on, the larger will be the occasional demand for gold to make foreign payments; and if the stock of gold kept in London be growing comparatively smaller and smaller, the greater will be the difficulty in meeting the demand from time to time. Such is, I believe, the whole secret of the growing instability and delicacy of the money market in this country. There is a larger and larger quantity of claims for gold, and comparatively less gold to meet them, so that every now and then there is a natural difficulty in paying claims, and the rate of interest has to be suddenly raised to induce those who have gold to lend it, or to induce those who were demanding it to forego their claims for a time.
>
> […]
>
> Mr. R. H. Inglis Palgrave, in his important "Notes on Banking," published both in the Statistical Journal, for March, 1873 (Vol. xxxvi. p. 106), and as a separate book, has given the results of an inquiry into this subject, and states the amount of coin and Bank of England notes, held by the bankers

> of the United Kingdom, as not exceeding four or five per cent. of their liabilities, or from one twenty-fifth to one twentieth part. Mr. T. B. Moxon, of Stockport and Manchester, has subsequently made an elaborate inquiry into the same point, and finds that the cash reserve does not exceed about seven per cent. of the deposits and notes payable on demand. He remarks that even of this reserve a large proportion is absolutely indispensable for the daily transactions of the bankers' business, and could not be parted with. Thus the whole fabric of our vast commerce is found to depend upon the improbability that the merchants and other customers of the banks will ever want, simultaneously and suddenly, so much as one-twentieth part of the gold money which they have a right to receive on demand at any moment during banking hours.[128]

The more and more efficient the global banking system became at netting and clearing imbalances, the less and less it needed metal as a proportion of transactional volumes and saving volumes during the normal course of operation. And consumers happily went along with it as well, due to the greater ease that it provided them with. And yet this increasing efficiency is precisely what allowed it to become so unbacked and unstable at its foundation. The disinclination of most people to want to withdraw and secure the cumbersome physical metals allowed for the extreme proliferation of gold claims relative to the amount of actual gold.

By the early 20th century, thanks to this extreme degree of monetary abstraction and the associated ease of claim creation for World War I approximately four decades after Jevons' book, the global gold standard collapsed and never recovered. In the decades after that, governments eventually dropped gold and silver backing from their financial systems entirely, and that's how we eventually got to this world of 160 different inflationary fiat currencies — each with a local monopoly in their respective jurisdiction. The difference in speed between transactional commerce and bearer asset commodity money gave governments and banks a huge opportunity for custodial arbitrage. A centralized and globally interconnected banking system with a monopoly on fast long-distance transfers of value became too powerful and convenient for gold to keep up with, even if gold could still make for better private savings. The introduction of credit cards in the 1950s, e-commerce in the 1990s, and smartphone-based payments in the 2010s further cemented the importance of fast telecommunication-based payments.

This is the only time in history where, on a global scale, a weaker money won out in terms of adoption over a harder money.[129] And it occurred because telecommunication systems introduced *speed* as a new variable into the competition. Gold, with its inherently slow speed of transport and authentication, couldn't compete with the pound, the dollar, and other top fiat currencies with their combination of speed and convenience, despite gold being in scarcer supply. The combination of legal tender laws, taxation authority, and greater speed has allowed fiat currencies to outcompete their slower but scarcer precious metal counterparts all over the world in terms of usage. This mismatch or gap in speed has been a foundational reason for the greater and greater levels of financialization that the world has seen over the past century and a half. Monetary ledgers became increasingly detached from any sort of natural constraint or scarce units of settlement, because the only scarce monetary alternatives such as gold were too slow to present a complete alternative.

Barry Eichengreen, in his book *Globalizing Capital*, pointed out that the international central bank gold standard as we know it began in the 1870s.[130] This was right around the time of Jevons' book quoted above. Prior to that, there were frequent uses of bimetallic standards and free banking systems. In the gold standard framework, central banks in Europe held gold, issued currency against that gold (which was fractionally reserved), and used the combination of telecommunication systems and bank ledger divisibility to create a rather fast-moving and convenient set of globally interconnected ledgers. The United States increasingly joined them as well, formally with the Coinage Act of 1873 and the Gold Standard Act of 1900.

The rise of the credit theory of money in its various forms, which I described in Chapter 4, also coincided with these technological developments in the second half of the 19th century. As currency claims or IOUs moved around the world at the speed of telecommunication, within a highly efficient globally connected banking system, many monetary theorists began to wonder, "why do we even need these metals?"

In 1905, Georg Friedrich Knapp published *The State Theory of Money* which described and founded the monetary theory known as Chartalism. This school of thought was a precursor to what is now known as Modern Monetary Theory and argued that money originated with states' attempts to direct economic activity, and that rather than commodities giving money value, the state gives money value due to the imposition of tax IOUs on the public that only the state's money can satisfy.

In his 1914 "Credit Theory of Money" essay Alfred Mitchell-Innes highlighted the writings of Henry Dunning Macleod from the late 1850s to the 1890s as the original formulator of the credit theory, and elaborately made the case that money had nothing to do with metal. I don't view it as coincidental that these theories by Macleod, Knapp, Mitchell-Innes, and others were developed and rose in prominence as telecommunication-based ledgers increasingly became the norm. As Mitchell-Innes wrote:

> The present writer is not the first to enunciate the Credit Theory of money. This distinction belongs to that remarkable economist H. D. Macleod. Many writers have, of course, maintained that certain credit instruments must be included in the term "money", but Macleod, almost the only economist known to me who has scientifically treated of banking and credit, alone saw that money was to be identified with credit, and these articles are but a more consistent and logical development of his teaching. Macleod wrote in advance of his time and the want of accurate historical knowledge prevented his realizing that credit was more ancient than the earliest use of metal coins. His ideas therefore never entirely clarified themselves, and he was unable to formulate the basic theory that a sale and purchase is the exchange of a commodity for a credit and not for a piece of metal or any other property. In that theory lies the essence of the whole science of money.
>
> But even when we have grasped this truth there remain obscurities which in the present state of our knowledge cannot be entirely eliminated.
>
> What is a monetary unit? What is a dollar?
>
> We do not know. All we do know for certain — and I wish to reiterate and emphasize the fact that on this point the evidence which in these articles I have only been able briefly to indicate, is clear and conclusive — all, I say, that we do know is that the dollar is a measure of the value of all commodities, but is not itself a commodity, nor can it be embodied in any commodity. It is intangible, immaterial, abstract. It is a measure in terms of credit and debt.[131]

Some economists such as Saifedean Ammous have argued that from a monetary perspective, World War I never really ended once it began in 1914. In prior wars throughout history, wars had to be funded with savings or taxes or very slow debasement of coinage. Physical coinage held by citizens could usually only be debased by their government gradually rather than diluted instantaneously, because a government couldn't just magically change the properties of the coins that were held by households; it could only debase them over time by taxing purer coins, issuing various decrees to try to pull some of those purer coins in, and spending debased coins back out into the economy (and convincing initial recipients to accept them at the same prior value, despite the lesser precious metal content, which would only work for a time and might not even be noticed at first). However, with the widespread holding of centrally issued banknotes and bank deposits that were redeemable for specific amounts of gold, governments could change the redemptive value with the stroke of a pen or eliminate redemption all together. This gave governments the power to instantaneously devalue a substantial part of their citizens' savings, literally overnight, and funnel that purchasing power toward war or other government expenditures whenever they determine that the situation calls for it.[132]

The pound sterling of the United Kingdom is the world's oldest continuously used currency that is still in use today. In Anglo-Saxon England during the eighth century, the pound sterling was defined as a pound of silver. The definition of a pound back then differed slightly compared to its definition today, and so it was equal to about three-quarters of what we currently define as a pound.[133] Over the next nine centuries, the pound sterling was gradually debased, and lost more than two-thirds of its value by the beginning of the 18th century. That's quite a slow debasement rate, equal to less than 0.15% compounded debasement per year on average over the course of centuries, although it tended to occur in small stepwise bursts from time to time.[134] By the 1800s, Britain had switched to a gold standard and maintained it until the early 20th century. It wasn't until World War I, when the pound sterling was completely decoupled from precious metals, that the pound rapidly devalued and lost almost the entirety of its value within one or two human lifetimes. Today a pound sterling is worth less than two grams of silver.

The 20th century and the beginning of the 21st century have been defined by a greater role of nation states, financed by their flexible ledgers. On one hand, this has allowed for centralized and widespread social safety net implementations, but they tend to be popular enough that they could be financed more transparently in some form or another through taxation. On the other hand, this has allowed for constant warfare and selective bailouts around the world by diluting the savings of others in continuous and non-transparent ways. Corporations can cozy up to governments, and shape legislation that determines where public deficit spending goes, with that spending being opaquely drawn out of peoples' savings through ongoing debasement.[135]

Although above-ground gold increases in supply by approximately 1.5% per year on average,[136] the broad money supplies of most major countries have grown at an annualized rate of between 6% and 12% since 1960, while the long tail of developing country currencies generally grew at double-digit rates or outright hyperinflated at some point within the period.[137] As a result, people around the world have repeatedly seen their savings debased, especially in developing countries, and for most of this time they have not had an alternative. Gold can still be stored as a long-term niche asset for savings and jewelry, but due to its slow speed and lack of widespread acceptance in modern times — along with legal tender laws — gold is not a viable alternative to the global fiat currency system for payments, unless heavily abstracted via trusted counterparties. People often must interact with fiat banknotes and centralized banking system deposits on a regular basis if they wish to make and receive payments in our digital and globally connected world.

Many critics of central banking or government monetary policy frame the departure from the gold standard as a moral failing: “If only the government had maintained the gold standard, things would be better,” summarizes many of their positions. Or to go back further, many will assert, “if only fractional reserve banking had never been used, we’d have a more honest and sustainable financial system.”

However, while I sympathize with those views and I personally would like money to hold its value, I see things differently, and mainly through the lens of technological inevitability based on the gap in speed between transactions and settlements that widened over time. People shifted over to transacting in fast gold claims and didn’t withdraw gold frequently enough to keep the number of claims “honest.” Therefore, the number of claims proliferated far faster than gold, and then gold was abandoned by governments to keep those claims in circulation. And it happened everywhere.

Out of nearly 200 countries in the world as of this writing, none of them use a gold standard. Switzerland was the longest remaining country on a gold standard, having dropped their gold standard in 1999.[138] In most of the world it was gone far earlier during the 20th century. Something that existed in the past but does not exist anywhere in the present likely has a lack of fitness. The gold standard’s weak incentive structure along with the slow speed of gold itself hasn’t allowed the gold standard to exist in any form in the modern era. It became too easy for every country in the world to discard it, and so they did. And to the extent that people want to hold more scarce forms of illiquid savings than currencies, they now turn to real estate or corporate equities more-so than they turn to gold. Gold’s primary role has been reduced to being a non-correlated portfolio asset among many others, and to serve as a form of macroeconomic disaster insurance due to its ability to be physically possessed by the holder with a high ratio of value to size and weight.

If we were to run this period of human development back a hundred times, I think almost every time we would end up in a similar place in terms of money, due to the path dependence of technological development itself. Once telecommunication systems were invented, bank-controlled ledgers dominated, and this gave nearly unassailable monetary power to the banks and central bankers that ran those ledgers. In order to move money quickly, people and banks came to rely on their country's central bank as the underlying ledger, and in an international context, various countries also came to rely on the central bank ledger of the world reserve currency issuer, which was the United Kingdom at the start of the telecommunication age and then shifted over to the United States in the 20th century.

Political decisions affect things locally and temporarily, while technological changes affect things globally and permanently. Every single government, whether authoritarian or democratic, has moved toward a fiat currency system, and has been debasing their unit of account at an accelerated rate. Due to the slow speed of transporting and authenticating gold, full reserve banks inevitably turned into fractional reserve banks to tap into the arbitrage that this speed gap between gold and bank deposits provided. By making use of the fact that people rarely withdrew their gold, they built inherently unstable systems that work "most of the time" but occasionally required bailouts when they did not. From there, fractional reserve banks inevitably became centralized by their governments and globally interconnected with telecommunication systems, and then the underlying metals were dropped from the backing by governmental decree when the governments no longer wished to be constrained by them. Each time, in every jurisdiction, users of the currency went along with the transition and accepted it over the course of decades. Even when fiat currencies fail in a country, people in that country tend to turn to a newly issued fiat currency or use another country's fiat currency — such as dollars — rather than falling back to gold as a medium of exchange.

Nature's ledger (gold) has robust parameters for supply and debasement but doesn't move and get verified fast enough in the telecommunication age. Mankind's ledger (the dollar) moves and gets verified fast enough but doesn't have robust parameters for supply and debasement. The only way to fix this speed gap in the long run would be to develop a way for a widely accepted, scarce, monetary bearer asset itself to also be able to settle over long distances at the speed of light.

[123] William Phalen, *How the Telegraph Changed the World*: 94–99, 120–21.

[124] Catherine Schenk, "Designing Global Payments, Telegraph to Tether."

[125] Meir Kohn, "Money, Trade, and Payments in Preindustrial Europe," 9–12, 14–17.

[126] W. Stanley Jevons, *Money and the Mechanism of Exchange, 251-262*.

[127] W. Stanley Jevons, *Money and the Mechanism of Exchange, 300-301,* 304-305.

[128] W. Stanley Jevons, *Money and the Mechanism of Exchange, 308-312*, 321.

[129] Saifedean Ammous, *The Fiat Standard: The Debt Slavery Alternative to Human Civilization*, 48.

[130] Eichengreen, *Globalizing Capital*, 38.

[131] Mitchell-Innes, "Credit Theory," 159.

[132] Ammous, *The Bitcoin Standard*, 44–46.

[133] Albert Edgar Feavearyear, *The Pound Sterling: A History of English Money*, 2–5. Will Kenton, "What is a Quid? With History of the British Pound Sterling" *Investopedia*.

[134] Carmen Reinhart and Kenneth Rogoff, *This Time Is Different: Eight Centuries of Financial Folly*, 176–78.

[135] See for instance: George Selgin, *The Menace of Fiscal QE*; Mohamed El-Erian, *The Only Game in Town: Central Banks, Instability, and Recovering from Another Collapse*; and Sarah Binder and Mark Spindel, *The Myth of Fed Independence: How Congress Governs the Federal Reserve*, chs. 1, 2, 7, 8.

[136] Cipolaro and Stevens, "Bitcoin's Network Effect," 6.

[137] Ammous, *Bitcoin Standard*, 63–66.

[138] Jean-Pierre Roth, "Mr Roth Discusses Demonitisation of Gold in Switzerland," Speech at 22nd Annual FT World Gold Conference, June 14, 1999.

PART THREE

THE RISE AND FALL OF GLOBAL MONETARY ORDERS

"By a continuing process of inflation, governments can confiscate, secretly and unobserved, an important part of the wealth of their citizens. By this method they not only confiscate, but they confiscate arbitrarily*; and, while the process impoverishes many, it actually enriches some."*[139]

-John Maynard Keynes

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[139] John Maynard Keynes, *Essays in Persuasion*, 77.

CHAPTER 9

PRINTING MONEY FOR WAR

World War I started much like any other regional conflict, but quickly expanded into a global war at a scale never previously seen, resulting in tens of millions of deaths and unimaginable suffering.

In 1914, the Archduke of Austria, Franz Ferdinand, was assassinated by a Bosnian Serb named Gavrilo Princip, because Princip was associated with a group that wanted to free Bosnia from Austria-Hungary's control. Austria-Hungary subsequently declared war on Serbia, and Russia determined it was in its interest to come to Serbia's defense — in large part due to Russia's desire to strengthen its influence in the region. As these events unfolded, Germany had a pre-existing military alliance with Austria-Hungary, and France had a pre-existing military alliance with Russia, so Germany and France quickly got involved as well. The United Kingdom did not want to see Germany defeat France and gain power across continental Europe, and so under considerable political pressure, the United Kingdom chose to join the war on the side of France and Russia even though the Eastern European conflict on its surface had nothing to do with their own citizens or island nation.

In the years leading up to the war, the United Kingdom was the dominant global power, and the issuer of the world reserve currency. The United States represented a rising power — technically the world's biggest economy by then — but the United States was far across the ocean and maintained a rather isolationist policy toward the rest of the world at the time. Germany represented a more direct rising power competitor, with rapidly strengthening industrial prowess on the same continent as the United Kingdom, at a time when the United Kingdom's global dominance was past its prime. There was considerable trade between the United Kingdom and Germany, and many people at the time thought that war between them was unthinkable. The prior several decades had seen considerable peace across Europe, during which time countless trade connections and business relationships had been built.[140]

The problem for any country is that war is expensive, unless that country is successful and greedy enough to become an empire, conquer their enemies, take their gold, and turn them into vessel states that pay recurring tribute. It's especially hard to sell to the public the idea that the government needs to raise domestic taxes to go fight a war between different foreign nations in foreign lands for some sort of vague national strategic advantage.

So, the United Kingdom issued war bonds in 1914 to raise capital from the public to go fight the war, and these war bonds paid interest rates that were higher than the prevailing government bonds at the time. These war bonds were widely reported as being massively oversubscribed. Newspapers described capital pouring in by the patriotic public to support the government in its war efforts and to earn good returns at the same time.

The problem, however, was that the story wasn't true. In 2017, over a century later, researchers at the Bank of England found in their archives that it had all been a cover-up. *Bank Underground* is a blog written by staff at the Bank of England, and they published a 2017 piece called "Your country needs funds: the extraordinary story of Britain's early efforts to finance the First World War" that described the truth. Their piece began with a summary:

> Financing World War I required the UK government to borrow the equivalent of a full year's GDP. But its first effort to raise capital in the bond market was a spectacular failure. The 1914 War Loan raised less than a third of its £350m target and attracted only a very narrow set of investors. This failure and its subsequent cover-up has only recently come to light following research analysing the Bank's ledgers. It reveals the shortfall was secretly plugged by the Bank, with funds registered individually under the names of the Chief Cashier and his deputy to hide their true origin. Keynes, one of a handful of officials in the know at the time, described the concealment as "a masterly manipulation."[141]

In other words, when the government went to the public to raise capital, money merely trickled in rather than poured in, despite the higher interest rates that were offered. A narrow set of wealthy investors centered around London allocated some capital, but it wasn’t nearly enough, and the government found itself lacking the required funds for war. As the article describes, allowing the public to know the truth would have been disastrous for the government’s finances and the public perception of the war:

> Disclosure of the failed fund raising would have been “disastrous” in the words of John Osborne, a part-time secretary to Governor Montagu Norman, in a history of the war years written in 1926. Copies of this account were only given to the Bank’s top three officials and it was decades before the full version emerged. Revealing the truth would doubtless have led to the collapse of all outstanding War Loan prices, endangering any future capital raising. Apart from the need to plug the funding shortfall, any failure would have been a propaganda coup for Germany.

So, the Bank of England secretly paid for the rest of the war bonds, and lied to the public that the government’s issuance of war bonds was a massive success. Specifically, the Bank of England loaned currency deposits (created out of thin air) to two members of its senior staff, who then went and bought large amounts of the bonds. The government was then able to spend significant money into the economy that they had not actually withdrawn from the economy through either taxes or war bonds. Therefore, the money supply was greatly expanded by manipulating the public ledger.

Barry Eichengreen in his book *Globalizing Capital*, described it as follows:

> To mobilize resources for the war, the authorities imposed new taxes and issued government bonds. When the resources so mobilized proved inadequate, they suspended the statutes requiring them to back currency with gold or foreign exchange. They issued fiat money (unbacked paper) to pay soldiers and purchase war materiel at home.[142]

In the subsequent years, inflation ravaged the country, and greatly devalued the purchasing power of the government’s debt, including the war bonds. Both the broad money supply and the consumer price index more than doubled over a five-year period, which inflated away much of the debt that was used to create that new money in the first place. The actual public buyers of the war bonds, and anyone holding British currency or bonds in general, ended up being the ones who lost considerable purchasing power.

Figure 9-A shows the degradation of the pound with the war, and how it never recovered.

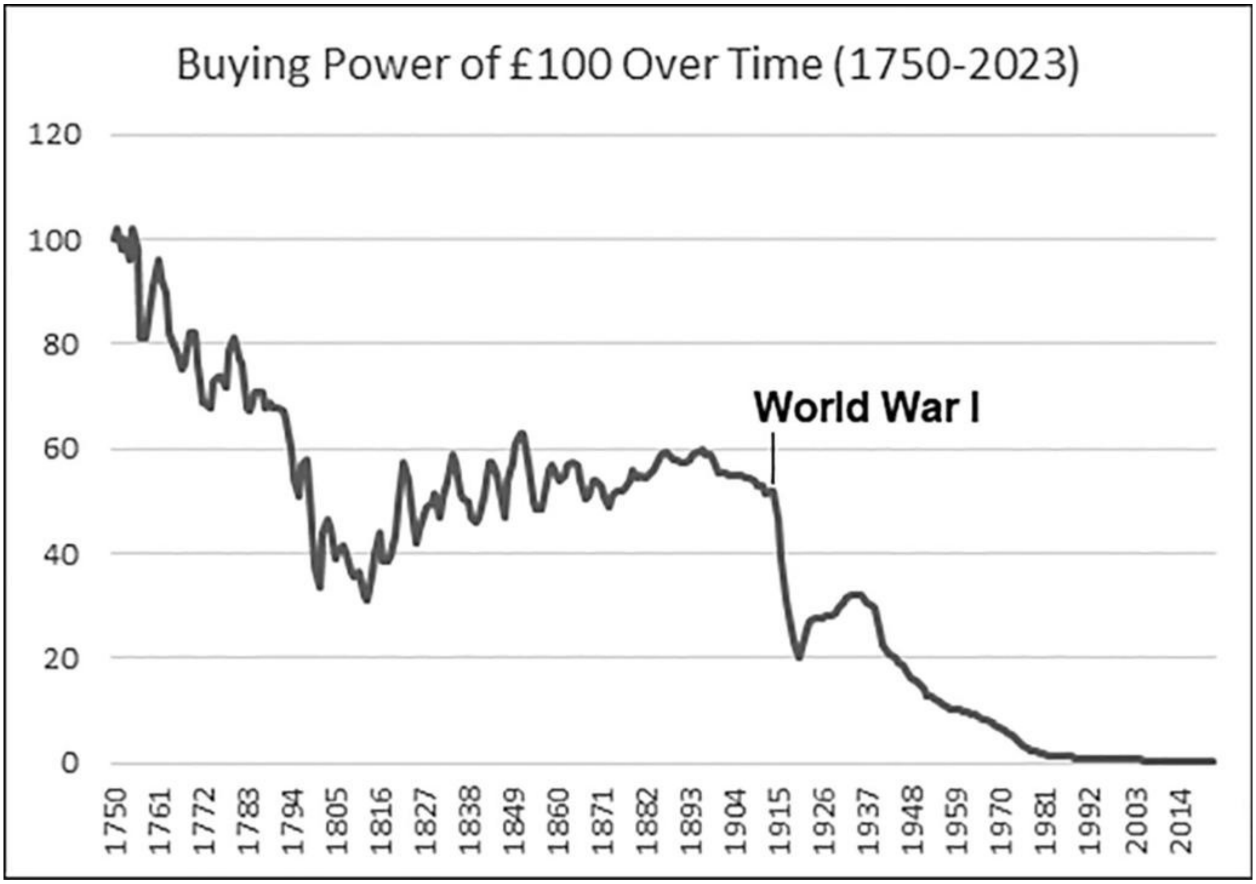

Figure 9-A[143]

The deficits and debts were monetized in the 1910s. Rather than withdraw gold-redeemable currency from the population in a transparent way using taxation and borrowing to spend on the war, the government and central bank instead worked together to secretly print massive amounts of new currency and used that currency to spend on goods and services for the war. The vast divide between the number of claims for gold and actual gold in the financial system that Jevons described in his 1875 book *Money and the Mechanism of Exchange* was exploited by centralized authorities in the most complete way possible. This was the first real test of such a centralized system, and it immediately failed the test. As a result, the savings of the average British household were devalued by over half within a handful of years, and the redeemability of the currency for gold was defaulted on. The government and central bank manipulated their centralized national monetary ledger so that the public paid for the war through their savings, even if they didn't buy the war bonds voluntarily, and even if they didn't have a transparent war tax involuntarily placed on them. The resulting devaluation of savings was therefore both involuntary and opaque.

From there, the government began controlling nearly every aspect of life. They forced businesses to stop producing things for the domestic economy, and to shift to producing things for the war effort instead. They froze rents to try to contain price inflation that their own expansion of the currency caused in the first place. As that same 2017 *Bank Underground* article goes on to describe:

> Faced with the possibility of catastrophic defeat, Britain threw overboard its centuries-long embrace of free market principles in several areas. It demonstrated a previously unseen willingness to interfere in private ownership of industry and property. It demanded that industries produce required goods, imposed rent freezes on private property, rationed imports and ultimately confiscated its own citizens' foreign securities (Archive: 8A240/1).... But even this wasn't enough. In January 1915, the Treasury prohibited the issue of any new private securities without clearance, and UK investors were banned from buying most new securities (Morgan (1952)).

The *Financial Times*, which in 1914 had helped spread the false news that the war bonds were oversubscribed, issued a correction in 2017 in response to the newly discovered archives of what really happened. Their correction was titled "A correction 103 years late: How the BoE covered up failed war bond sale" and began with a summary that got straight to the point:

> Clarification: On 23 November 1914, a piece published in the Financial Times claimed the UK government's War Loan was "oversubscribed", with applications "pouring in". The item described this as an "amazing result" that "proves how strong is the financial position of the British nation". We are now happy to make clear that none of the above was true.[144]

Of course, the United Kingdom wasn't the only country that printed money for the war. Every combatant country did, on both sides. When the United States later entered the war in 1917, they did so with printed money as well. The losing sides of the war mostly saw their currencies hyperinflate away, while the winning sides of the war merely had "very high" inflation rather than outright hyperinflation.

What made it particularly notable that the United Kingdom engaged in this monetary expansion, however, was that they were the world reserve currency at the time. Many countries around the world held part of their sovereign reserves in the United Kingdom's government bonds, partly voluntarily for the benefit of efficiency, and partly by coercion under a system of colonialism. Not only did the United Kingdom devalue their own citizens' savings for the war effort, but they also devalued the purchasing power of many developing countries that were not otherwise involved in the war at all. Global value, from all around the world, was drained by centralized decree from savers and channeled toward war in continental Europe.

The speed and ease with which this occurred was only possible due to the abstraction of gold as money. If people and nations were primarily holding physical gold or silver as money, it would be much harder to pry that money from them and channel it toward the war. The debasement of physical coinage has always been a theme historically, but the physical aspect of it provides an inherent limit in terms of how fast the debasement can occur. But because people and nations were merely holding paper claims and bank deposit claims for gold, promises could be quietly severed overnight with the stroke of a pen, while the consequences could be dealt with later and spread over time.

The ability and willingness of governments to print money for war or other crises spread like a virus. Thanks to centralization and abstraction of money, governments were no longer constrained by the amount of gold in their vaults; they could tap into the savings of their entire citizenry. If one government could drain their citizens' wealth quickly and non-transparently for war, then it increased their odds of winning — unless their opponent nations did the same. The ability of the issuer of the world reserve currency to drain value from countries all around the world was even more powerful. Countries willing to sacrifice the long-term to win in the short-term had an advantage.

This is why I argue that the global failure of the gold standard was inevitable due to a technological mismatch, and why it eventually failed practically everywhere all at once, rather than just in some places. The easier it is to manipulate a ledger, the more likely it is that it will be manipulated. A centralized gold-backed paper currency and banking system is easy to manipulate, since currency can be printed first and the consequences such as the inevitable inflation and breaking of the gold peg can be dealt with later.

John Maynard Keynes, who had described the Bank of England's secret financing of the war bonds in 1914 as a "masterful manipulation," went on to write about the dangers of currency debasement shortly after the war:

> Lenin is said to have declared that the best way to destroy the capitalist system was to debauch the currency. By a continuing process of inflation, governments can confiscate, secretly and unobserved, an important part of the wealth of their citizens. By this method they not only confiscate, but they confiscate arbitrarily; and, while the process impoverishes many, it actually enriches some. The sight of this arbitrary rearrangement of riches strikes not only at security but at confidence in the equity of the existing distribution of wealth.
>
> Those to whom the system brings windfalls, beyond their deserts and even beyond their expectations or desires, become "profiteers," who are the object of the hatred of the bourgeoisie, whom the inflationism has impoverished, not less than of the proletariat. As the inflation proceeds and the real value of the

> currency fluctuates wildly from month to month, all permanent relations between debtors and creditors, which form the ultimate foundation of capitalism, become so utterly disordered as to be almost meaningless; and the process of wealth-getting degenerates into a gamble and a lottery.
>
> Lenin was certainly right. There is no subtler, no surer means of overturning the existing basis of society than to debauch the currency. The process engages all the hidden forces of economic law on the side of destruction, and does it in a manner which not one man in a million is able to diagnose.[145]

Throughout the war, countries around the world showed that their governments and central banks now had nearly complete control of the ledgers that people around the world used for savings and payments. Savings could be rapidly devalued in a non-transparent way and channeled toward what the government considers worthwhile to spend money on. Countries including the United Kingdom went on to re-establish gold pegs several years after the war but broke them again in the 1930s. They then began permanently shifting away from any gold redeemability of their currencies whatsoever, toward a practice of constant money supply dilution. Direct usage of gold by the public to try to bypass this practice was too slow and inconvenient, and in some countries was criminalized.

Keynes, in his essay that is partially quoted here, wrote in extraordinary clarity about the dangers of using a ledger that other people control, even though he himself was a proponent of doing exactly that. Involuntary taxes are one thing — at least people can see what they are and respond accordingly if needed. The involuntary devaluation of savings in an arbitrary and opaque way is another thing entirely, and this new capability represented a tremendous power shift from those who *use* the ledger to those who *control* the ledger.

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140 Niall Ferguson, *The Pity of War*, ch. 2.

141 Michael Anson et al., “Your Country Needs Funds.”

142 Eichengreen, *Globalizing Capital*, 43.

143 Alioth Finance, “Inflation Calculator.”

144 Patrick McClean, “A Corrections 103 Years Late: How the BoE Covered Up Failed War Bond Sale,” *Financial Times* Aug 8, 2017.

145 Keynes, *Essays in Persuasion*, 77–78.

CHAPTER 10

THE BRETTON WOODS SYSTEM

After World War I, several countries including Germany and Russia experienced outright hyperinflation. Some countries that came out of the war in better shape such as the United Kingdom, on the other hand, merely experienced very high inflation, and attempted to re-peg their currencies to gold.

The British leadership, being the issuer of the world reserve currency at the time, took great pride in the historic soundness of their money that they had recently debased quite severely. They attempted to re-peg their currency to gold in 1925 at the pre-war rate, even though there was much more currency in the system relative to gold at that point compared to pre-war levels. Even sound money advocates at the time, such as Ludwig von Mises, criticized this attempt as being nonsensical. The inflationary damage was already done; the currency needed to be re-pegged at a realistic lower rate.[146]

The 1920s decade after the first World War saw persistently higher unemployment in the United Kingdom than they had in the years and decades prior to the war. This was due to many factors, including a brief post-war depression period, but creating an artificially strong currency due to a currency-to-gold peg at a nonsensical level contributed to it. Due to severe inflation in the money supply and prices, wages had gone up significantly in the United Kingdom in terms of pound sterling compared to the decade prior, and yet they were still attempting to peg the pound to gold at the pre-war exchange rate. In other words, the average worker would supposedly earn much more gold per hour worked than they did prior to the war. This artificially made wages far higher than they really were on an actual economic basis, which rendered the United Kingdom uncompetitive in the global marketplace.[147] It wasn't that a strong currency was a problem, but rather, it was that an *artificially* strong currency was a problem. Furthermore, it would be hard for the Bank of England to maintain enough gold reserves to honor redemptions with a peg at the pre-war rate, since their gold reserves did not grow in line with how much the money supply had grown.

This artificial top-down enforcement of monetary value by the United Kingdom and several countries contributed to excessive capital flows and bubbles globally throughout the decade, which ultimately contributed to the 1929 credit and speculation bubble in the United States. This was followed by the subsequent crash and the 1930s Great Depression. Then, during the 1930s, many governments gave up on their gold standards, and either eliminated the possibility for currency redemption for gold altogether or re-priced their gold pegs at much weaker currency rates.

During the 1920s in the United States, debt built up to a very large degree relative to the money supply. Total debt in the system was $173 billion in 1929, while the monetary base was a little over $6 billion — and the monetary base itself was only partially backed by gold.[148] As a result, there was roughly a 28-to-1 ratio in the amount of dollars promised to be paid to people in the future relative to the amount of dollars that existed, and even higher in terms of gold, which dollars were redeemable for. This was unsustainable, and when the economy eventually ran out of steam from such a leveraged state, it was fated toward catastrophe.

During the early 1930s, fractional reserve banks failed across the United States, and therefore the broad money supply shrank severely. Many depositors were wiped out, many creditors were wiped out, and people lost their jobs. The Dust Bowl (caused by a combination of natural drought and improper farming techniques, partially fueled by farmer financing strategies at the time) further exacerbated the real poverty that people experienced during the 1930s. As banks failed and many peoples' deposits were outright defaulted on, more and more depositors stood in line at banks to withdraw their cash, preferring to hold it under their mattress rather than keeping it in a bank.[149] This further exacerbated the insolvency and illiquidity of the banking system, which was inherently unstable due to how many claims there were for base dollars compared to actual base dollars. The centralized ledger of the United States and its financial system was spiraling downward toward complete failure.[150]

In 1933, the United States federal government proclaimed a bank holiday, where banks were shut down for many days, and subsequently re-opened gradually with better capitalization to encourage people to put their deposits back in. In a paper published in 2009 for the Federal Reserve Bank of New York called “Why Did FDR’s Bank Holiday Succeed?,” William Silber described that, “The President used the emergency currency provisions of the Act to encourage the Federal Reserve to create de facto 100 percent deposit insurance in the reopened banks.”[151]

This de facto deposit insurance was only possible due to the government and central bank’s ability to create more base dollars out of thin air, but their ability to create base dollars didn’t extend to creating more gold which those base dollars were redeemable for. Therefore, as dollars were printed and banks were recapitalized, dollars would become increasingly unbacked by actual gold. The central bank’s gold vaults would be depleted if this was allowed to continue.

This was in large part due to the inherent gap in speed between banking ledgers and gold. That speed gap became arbitraged over time such that there were far, *far* more IOUs for gold-backed dollars moving around the economy than there was actual gold — until a pin came along and popped that fragile bubble. If gold could inherently move and be authenticated faster, then there would be less of a reason to use IOUs for it. The various IOUs that did exist would be tested (redeemed) more often, which would prevent such a huge imbalance in supply from building up over time. But alas, gold doesn’t move as fast as telecommunication-enhanced ledgers do, and so the mismatch remained unaddressed for long stretches of time until it became outrageously imbalanced.

Soon after the bank holiday in 1933, the United States federal government put forth an executive order saying that all citizens must turn in their gold for payment in dollars at the prevailing redemption rate. It became illegal to own meaningful amounts of gold, punishable by up to a decade in prison. It was even illegal for Americans to own gold overseas. In other words, the U.S. federal government’s centrally controlled, leveraged ledger was in such dire conditions that they had to outlaw the ownership of a benign yellow metal under the threat of imprisonment and violence. They also shifted ownership of gold reserves from the Federal Reserve to the U.S. Treasury.

Once they collected a significant amount of gold, the U.S. federal government passed the 1934 Gold Reserve Act. This redefined the dollar from about 1/20th of an ounce of gold to 1/35th an ounce of gold. In other words, they devalued the dollar significantly relative to gold after they got much of the gold in their possession. This amounted to a default toward the public; the dollars that the public had been holding, which had been promised for a long time to be redeemable for gold on an exchange rate of $20.67 for an ounce of gold, were now officially set at $35 per ounce of gold and were no longer redeemable to them even at that rate.[152] Currency devaluation favors debtors over creditors, and there was no bigger debtor than the U.S. federal government.

With this huge uptick in gold collection by the government, and the devaluation of the dollar relative to gold, the government effectively increased the amount of gold backing that it had for its currency. Although they had ended the convertibility of gold toward the public, the U.S. government still maintained redemption of the dollar for gold by foreign creditors, to maintain international credibility of this newly refreshed centralized ledger system. From 1933 until 1971, the United States operated on a marginal gold standard, where the currency was still technically pegged to gold (at a lower rate), but with no way for American citizens to enforce that peg.

Throughout the 1930s decade, during a period of global economic stagnation, political populism grew around the world. Many remnants of World War I, which had not been fully dealt with, bubbled back up to the surface. Currencies had failed, savings had disappeared, the working class had revolted against the wealthy class to varying degrees across nations, and people in previously defeated nations had turned toward political extremism. Large portions of the public wanted “strong men” to lead them and tell them who was causing their problems, even if it meant a reduction in individual liberty and laying false blame on minority groups. These issues, along with many other factors that are far too many to list here, eventually led to World War II.

During World War II, governments around the world once again printed vast sums of new money to drain their citizens’ savings and finance their war efforts, which led to major currency devaluations and persistent price inflation. And governments once again enacted price and wage controls to try to curtail the inflation that they themselves caused with their money-printing. They also enacted various policies to direct private sector production toward the war effort.[153] Multiple currencies outright hyperinflated, while the currencies of the winning nations devalued by half or more.

As the war began to wind down in 1944, with the Allied Forces moving toward a clear victory, representatives of 44 countries met in Bretton Woods, New Hampshire, to discuss how the post-war monetary system should be constructed.

TWO COMPETING VISIONS

A global monetary order is, at its core, a description of how trade will be settled between countries who don't necessarily trust each other's public ledger. To the extent that technology allows them to, governments can enforce the usage of their own centralized ledger systems on people in their country, but they can't really force other countries to accept the validity of those systems.

Historically, precious metals tended to be internationally accepted money, being used as nature's ledger that no country could substantially manipulate. However, in the era of globally interconnected bank ledgers, a powerful empire such as the United Kingdom in the 19th century or the United States in the 20th century can determine the global monetary order for a period of time and put their ledger system at or near the heart of it.

During the 1944 Bretton Woods conference, there were two primary visions for how the global monetary system should be built. The first was from John Maynard Keynes of the United Kingdom, and the second was from Harry Dexter White of the United States.

John Maynard Keynes proposed a neutral settlement system, with a supranational currency unit of account called a "bancor" at the center. A bancor would essentially represent a proportional basket of major global currencies, and while gold could be redeemed for bancors, bancors would not be redeemable for gold. In his book, *The Battle of Bretton Woods*, Benn Steil described the bancor as the following:

> Each item a member country exported would add bancors to its ICB account, and each item it imported would subtract bancors. Limits would be imposed on the amount of bancor a country could accumulate by selling more abroad than it bought, and on the amount of bancor debt it could rack up by buying more than it sold. This was to stop countries building up excessive surpluses or deficits. Each country's limits would be proportional to its share of world trade. This method of establishing bancor quotas was, not incidentally, convivial to British interests, as Britain had little gold but needed to conduct lots of

> trade.
>
> Once initial limits had been breached, deficit countries would be allowed to depreciate, and surplus countries to appreciate their currencies. This would make deficit country goods cheaper, and surplus country goods more expensive, with the aim of stimulating a rebalancing of trade. Further bancor debit or credit position breaches would trigger mandatory action. For chronic debtors, this would include obligatory currency depreciation, rising interest payments to the ICB Reserve Fund, forced gold sales, and capital export restrictions. For chronic creditors, it would include currency appreciation and payment of a minimum of 5 percent interest on excess credits, rising to 10 percent on larger excess credits, to the ICB's Reserve Fund.[154]

The advantage of Keynes' proposal was that it would in many ways replicate the gold standard from a global settlement perspective: Like gold, the bancor was a neutral settlement asset, but operated at higher speed and with some supply flexibility. Trade imbalances between countries would inevitably correct themselves over time. The disadvantage of Keynes' proposal was that it was a centralized and tightly managed system built around a depreciating asset that required a lot of seamless coordination between many countries to work properly, and therefore would be geopolitically fragile.

Harry Dexter White, on the other hand, proposed that all participating governments should peg their currencies to the United States dollar, and that the dollar would remain pegged to gold at a fixed exchange rate, and redeemable for gold to foreign central banks. Foreign central banks should therefore hold dollars (mainly in the form of U.S. Treasury bonds), since they were supposedly as good as gold and earned some interest. Along with this proposal, White helped to engineer the International Monetary Fund and the World Bank, which would serve as the enticements, guardrails, and enforcers of this system.

At the time of this proposal, the United States had a tremendous amount of geopolitical leverage to get what it wanted. Unlike the rest of the world, the United States' homeland was nearly untouched by the ravages of the war. Many other countries had experienced massive devastation to their industrial production capabilities, including those on the winning side who merely achieved a Pyrrhic victory. In addition, the United States had the world's largest economy that represented over 40% of global GDP on its own, the world's best geography (two massive oceans, two friendly borders, the world's most extensive inland river system, and plenty of oil deposits), along with vast amounts of gold. Aside from owning large amounts of its own gold, many allied countries had sent their gold to the United States for custodial safekeeping as well, in case they were overrun by their enemies during the war. Acceptance of the Bretton Woods system was also part of the Marshall Plan, meaning that if war-torn countries wanted financial assistance from the United States to rebuild after the war, they needed to accept the vision of the United States for how the global order should be structured in terms of money and trade.[155]

Ultimately, White's proposal won out, and when it was finalized after the war in 1946, it represented a switchover from the United Kingdom to the United States being the issuer of the world reserve currency.[156] Unfortunately, however, the system's design was flawed from the start, and these flaws quickly manifested themselves once the system went into full operation after 1958, when exchange controls on current account transactions were eliminated.[157]

EURODOLLARS AND THE BRETTON WOODS DEFAULT

In a free banking system, where individual banks rather than the government issue gold-backed currency, the amount of currency in the system is at least somewhat constrained by the amount of gold in the system. This is because individual banks only have so much gold reserves and need to maintain adequate backing to meet customer redemptions. Banks that fail to do this will eventually experience a bank run and be put out of business. Therefore, while the amount of currency in the system can fluctuate relative to gold, it quickly encounters problems and contracts whenever the disconnect becomes too wide, since there is no central entity that can instantly create more gold and bail out the system. Individual free banks can, if allowed by regulators, manage their risk by branching and by using careful lending policies, but they are always subject to tests on their liquidity and solvency due to the prospect for bank runs.[158]

However, if most of the gold is centralized in the hands of the central bank or sovereign government, and is no longer redeemable to most participants for gold, then the amount of currency in the system is not at all constrained by the amount of gold in the system. The narrower the path is regarding the redemption of currency for gold, the less constrained the currency creation system will be by gold. As will be discussed in Part 4 of this book, most new currency is created from either 1) monetized government deficit spending, or 2) an increase in fractional reserve bank lending. If fractionally reserved commercial banks hold cash reserves at their central bank, and issue loans as a money multiplier on top of that monetary base, then gold held by the central bank or the government isn't really a constraint on how much currency is created over time. And to the extent that banks do experience liquidity issues from time to time, the central bank can create more base money, buy some of the bank's assets, and therefore keep the system growing.

From 1920 to 1950, the United States' official gold reserves grew from under 4,000 metric tons to over 20,000 metric tons. However, from 1950 to 1970 during the Bretton Woods system, the gold reserves quickly decreased from over 20,000 metric tons to just over 9,000 metric tons, due to redemptions by foreign central banks.[159] And yet, also from 1950 to 1970, the amount of base dollars in the United States doubled, and the amount of broad dollars in the United States more than tripled. As this occurred from 1950 to 1970, dollars became exponentially less "backed" by reasonable amounts of gold.[160]

This problem occurred because the U.S. domestic banking system, as well as the foreign dollar-denominated banking system (often referred to as the "Eurodollar" system) continued to grow, since the fractional reserve lending practices were completely disconnected from the amount of gold in the system. The Federal Reserve kept increasing the monetary base despite the Treasury not having enough gold to support it, and commercial banks kept multiplying those reserves into larger and larger amounts of dollar deposits. As a result, foreign central banks owned larger and larger amounts of dollars, and some of them redeemed those ever-increasing amounts of dollars for scarce gold. As American gold reserves rapidly drew down, some of those foreign creditors began to realize that the dollar wouldn't be able to maintain its gold peg for much longer, and therefore they started redeeming even more of their dollars for gold, accelerating the downfall of the system.

The Eurodollar system refers to U.S. dollar deposits that exist outside of the United States, and thus exist outside of direct control by the U.S. central bank. Despite the name, Eurodollars refer to dollars in any non-U.S. jurisdictions, rather than just dollars in Europe, although Europe was the starting point for the system. Beginning with the Marshall Plan in the late 1940s, considerable amounts of dollars began flowing into Europe. The Soviets also had dollars that they earned from trade, and due to the competitive nature between them and the United States, they often held their dollars in European banks rather than American banks, due to the risk of seizure.[161]

Through the 1950s and 1960s, the Eurodollar system kept growing. We can visualize this as a fractional reserve system built on a fractional reserve system.

The Federal Reserve, in its role as the country's central bank, serves as the "bank of banks" in the United States. Domestic U.S. commercial banks hold their cash reserves as ledger entries at the Federal Reserve, while the various retail and corporate depositors hold their cash deposits as fractionally reserved ledger entries at a commercial bank. So, there are two tiers of money, referring to base money and broad money. From there, a foreign bank can collect dollar deposits, keep them on deposit with a U.S. bank, and offer fractionally reserved bank deposits to various foreign entities. This is a third tier of fractionally reserved IOUs for dollars.

From the perspective of the foreign depositor, they hold a chain of fractionally reserved liabilities that leads all the way back to the Federal Reserve. The foreign depositor's dollar assets are liabilities of the foreign commercial bank that they are depositing at. The foreign commercial bank holds their cash assets (which represent a fraction of their customer deposits) at a U.S.-based commercial bank, and those dollar assets represent liabilities for that U.S.-based commercial bank. The U.S.-based commercial bank holds its cash assets (which represent a fraction of their customer deposits) at the Federal Reserve, and those dollar assets represent liabilities for the Federal Reserve. The Federal Reserve, meanwhile, can see the total number of deposits at all domestic US banks, but has limited transparency into what is happening with the third tier — all of those foreign dollar claims.[162]

Those fraction-of-a-fraction deposits represented redeemable claims for gold by foreign central banks. And yet this process of money creation was completely unconstrained by the amount of American gold reserves held in Fort Knox. As even a small percentage of these numerous dollars were redeemed for gold, it quickly began to drain those gold reserves.

As the amount of domestic and foreign dollars grew and the United States' gold reserves shrank, the U.S. federal government could buy time due to its military and geopolitical power. If some countries redeemed too much gold, the U.S. federal government could quietly pressure them and suggest that they shouldn't keep it up. "Do you want us to remove our military bases from your country, and leave you militarily exposed to the Soviets? No? Then maybe stop redeeming so much gold and challenging our monetary system..."

However, math is math, and some of the more assertive leaders of nations realized the inevitable downfall of this system and kept redeeming dollars for gold anyway. By the late 1960s, the system was already broken, and in 1971, President Nixon officially ended the redeemability of dollars for gold to foreign central banks to stop the downward spiral in U.S. gold reserves. At the time, he blamed speculators and said that the closed period of redemption would be temporary, but as the reader surely knows, it became permanent.[163] The Bretton Woods system was poorly designed from the start and destined to inevitable default, and it only took about a quarter-century to do so from its conception in 1944, and barely over a decade from its launch and full operation in 1958–59.[164]

At that point in 1971, the world entered the modern fiat currency regime, meaning the world reserve currency and other currencies are not redeemable for anything.

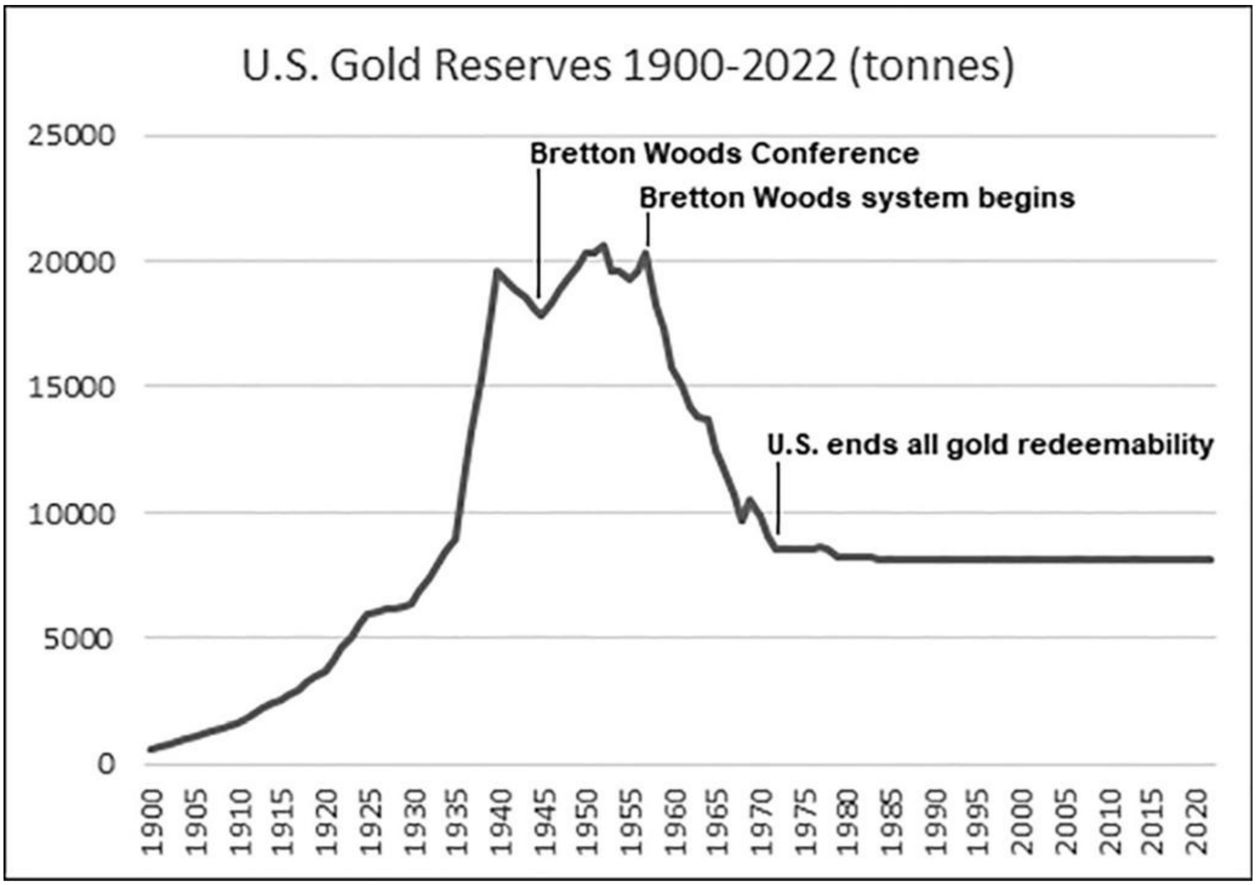

Figure 10-A[165]

[146] Ludwig von Mises, *Human Action: A Treatise on Economics*, Scholar's Edition, 565 and 778.
[147] Barry Eichengreen, "The British Economy Between the Wars," 328–39.

[148] Robert Bangs, “Public and Private Debt in the United States, 1929–40,” 21; Federal Reserve Economic Data, “St. Louis Adjusted Monetary Base.”

[149] James Boughton and Elmus Wicker, “The Behavior of the Currency-Deposit Ratio During the Great Depression,”

[150] Milton Friedman and Anna Schwartz, *A Monetary History of the United States, 1867–1960*. See also Scott Sumner, *The Money Illusion: Market Monetarism, the Great Recession, and the Future of Monetary Policy*, ch. 7.

[151] William Silber, “Why did FDR’s Bank Holiday Succeed?,” 19.

[152] George Selgin, “The Rise and Fall of the Gold Standard in the United States,” 24–30.

[153] Robert Higgs, “Wartime Prosperity? A Reassessment of the U.S. Economy in the 1940s,” 44–53.

[154] Benn Steil, *The Battle for Bretton Woods: John Maynard Keynes, Harry Dexter White, and the Making of a New World Order*, 143–44.

[155] Perry Mehrling, *Money and Empire*, 154–170; Michael Bordo, “The Bretton Woods International Monetary System: A Historical Overview,” 28–38.

[156] Barry Eichengreen and Marc Flandreau, “The Rise and Fall of the Dollar,” *European Review of Economic History* 13.

[157] Robert Hetzel, “Launch of the Bretton Woods System.”

[158] Selgin, *Theory of Free Banking*, 23–41; White¸*Monetary Institutions*, ch. 2.

[159] Timothy Green, “Central Bank Gold Reserves,” 17–18.

[160] Meltzer, *A History of the Federal Reserve, Volume 2, Book 2: 1970–1986*, 686–88; Michael Bordo and Robert McCauley, “Triffin: Dilemma or Myth?” 5.

[161] Paul Einzig, *The Euro-dollar System: Practice and Theory of International Interest Rates*; Robert Aliber, “Eurodollars: An Economic Analysis,” 77–85.

[162] Nik Bhatia, *Layered Money*: *From Gold and Dollars to Bitcoin and Central Bank Digital Currency*, 60–79.

[163] Jeffrey Garten, *Three Days at Camp David: How a Secret Meeting in 1971 Transformed the Global Economy*, 19–45.

[164] Robert Hetzel, *The Federal Reserve: A New History*, 355–56.

[165] Green, “Central Bank Gold Reserve,” 17–19; World Gold Council, “Central Bank Holdings.”

CHAPTER 11

THE RISE OF THE PETRODOLLAR

After the default of the Bretton Woods system in 1971, the world found itself in a situation that it had never been in before: The money that practically everybody used globally was completely unbacked by anything scarce. There had been periods in the past where fiat currencies were attempted and eventually hyperinflated, but only on national and regional scales. This post-Bretton Woods system was the first time that a purely fiat currency was attempted worldwide.

A sovereign government can be rather effective at forcing the usage of its currency domestically. By making taxes payable only in their currency, by adding capital gains taxes to commodity monies, by enforcing legal tender laws that require all merchants to accept that currency as payment, and through various bank regulations that attempt to slow down the supply growth of their currency, they can often maintain a sufficient degree of demand for the currency relative to the available supply. However, a government has little or no way to force other countries to accept their currency. Their currency is nothing more than pieces of paper, or a bank ledger, which are not backed by anything and for which the rules can be unilaterally changed. Fiat currency offers no utility to any end user, nor is it redeemable for anything else that offers utility.

The United States and other countries experienced major inflation in the 1970s. The supply of dollars, pounds, francs, and other currencies continued to expand, and were not backed by or redeemable for anything. Meanwhile, U.S.

conventional oil production peaked in 1970 after a century of nearly continuous growth, and domestic production began to roll over for many years, which made the country more reliant on oil imports. In 1973, Saudi Arabia and other oil-producing nations in the Middle East embargoed oil for nations that supported Israel in the Yom Kippur War, including the United States. This caused an oil supply shock and associated oil price shock during a time of sharply rising demand.

However, the United States was unique in terms of how large and powerful it was, both militarily and economically. If there was any country who could force or entice other countries to accept their unbacked currency as real payment, it would be them. Andrea Wong's 2016 long-form article for *Bloomberg*, "The Untold Story Behind Saudi Arabia's 41-Year U.S. Debt Secret" described in detail how the United States convinced Saudi Arabia and other nations in the region to accept dollars for payment and to hold dollars in the form of U.S. Treasury securities as long-term savings.

In 1974, President Nixon's new U.S. Treasury Secretary William Simon flew to Europe and the Middle East for a diplomacy trip. Out of all people, why would the United States send its Treasury secretary for such a mission? The answer was that it was mainly a trip regarding financial diplomacy, centered around U.S. Treasury securities. From Wong's article:

> Officially, Simon's two-week trip was billed as a tour of economic diplomacy across Europe and the Middle East, full of the customary meet-and-greets and evening banquets. But the real mission, kept in strict confidence within President Richard Nixon's inner circle, would take place during a four-day layover in the coastal city of Jeddah, Saudi Arabia.
>
> The goal: neutralize crude oil as an economic weapon and find a way to persuade a hostile kingdom to finance America's widening deficit with its newfound petrodollar wealth. And according to Parsky, Nixon made clear there was simply no coming back empty-handed. Failure would not only jeopardize America's financial health but could also give the Soviet Union an opening to make further inroads into the Arab world.[166]

The deal that Simon reached on behalf of the Nixon Administration with Saudi leadership was as follows. The United States would buy a lot of oil from Saudi Arabia and sell a lot of military equipment and aid to them in return. The United States would, by extension, also use its unrivaled naval power to ensure that the Strait of Hormuz (a narrow portion of the Persian Gulf between Saudi Arabia and their adversary Iran) would remain open for global oil trade, since that is how the U.S. would get its oil as well. Saudi Arabia would take their dollar trade surpluses, which were referred to as "petrodollars," and invest them primarily into U.S. Treasury securities to finance U.S. federal deficit spending. In addition, Saudi Arabia would only sell their oil to other countries in dollars, which would reinforce global demand for dollars and reinforce the dollar's status as the world's international medium of exchange and store of value.

A final condition on the deal was that Saudi Arabia wanted to keep the deal secret. Treasuries were to be sold to Saudi Arabia mostly off the record, outside of the normal auction process. Wong continued:

> It took several discreet follow-up meetings to iron out all the details, Parsky said. But at the end of months of negotiations, there remained one small, yet crucial, catch: King Faisal bin Abdulaziz Al Saud demanded the country's Treasury purchases stay "strictly secret," according to a diplomatic cable obtained by Bloomberg from the National Archives database.

For her article, Wong used the Freedom of Information Act to obtain previously non-public information on the arrangement. Prior to this article, the financial relationship between Saudi Arabia and the United States was a "known secret," and this reporting by mainstream media gave it additional transparency and weight. Due to the United States' support of Israel, the United States was viewed very negatively by many Muslim-majority countries in the 1970s, and so Saudi Arabia wanted to keep the relationship a secret. Saudi Arabia's leadership worried about the negative optics of associating closely with the United States. However, they also wanted to strengthen their economic and military security against their nearby rival Iran, which is why the petrodollar deal was compelling to them.

The summary of this period of history was that the United States had enough military and economic prowess to convince Saudi Arabia and other nations to keep using its centralized and unbacked fiat currency ledger. The global oil market is enormous, and by convincing many producers to price it in dollars, sell it in dollars, and to hold their petrodollar surpluses in U.S. Treasuries, the United States basically backed the dollar by oil. The dollar was not redeemable or pegged to any specific amount of oil, but this new system made it so that any oil-importing country should want to hold dollars (often in the form of U.S. Treasuries) as reserves, to ensure that they could buy oil when needed. This kept global demand for dollars going strong, and therefore kept the overall dollar network effect going strong. Starting in 1974 and continuing to the present, the world has mostly operated on this petrodollar standard.[167] I refer to this system as the Eurodollar/Petrodollar system because it's a combination of natural network effects from being the world's largest economy in an era where transactions occur far faster than settlements, and from intentional design choices by that dominant country to encourage producers of scarce resources to use that ledger and reinforce those network effects.

And for the United States' role, they had to maintain somewhat credible institutions and a high degree of division of powers between their central bank and their government so that the dollar would be viewed as a credible currency on a global scale. In 1978 and 1979, after a decade of runaway inflation, the United States financial reputation was bad enough that they issued some of their government debt in Swiss francs and West German marks to build up foreign exchange reserves — almost like a developing country generally must do.[168] Starting in 1979 and continuing into the 1980s, the new chairman of the Federal Reserve Paul Volcker raised interest rates to nearly 20% and put the United States into a recession to stabilize the dollar. Both Jimmy Carter and his successor Ronald Reagan supported him in this hawkish action.

At the time, countries in Latin America in aggregate had rather high dollar-denominated debt. By hardening the dollar with very high inflation-adjusted interest rates, the chairman of the U.S. Federal Reserve Paul Volcker crushed many of their businesses and government finances, and thus reduced their purchasing power for oil consumption. The United States was able to continue receiving oil from Saudi Arabia at low prices, while Latin American oil consumption stagnated due to the value of their currencies being crushed. During the 1980s as shown in Figure 11-A, the world temporarily stopped increasing its oil consumption, mainly because developed countries continued to increase oil consumption while many developing countries (especially in Latin America) had to reduce theirs.[169]

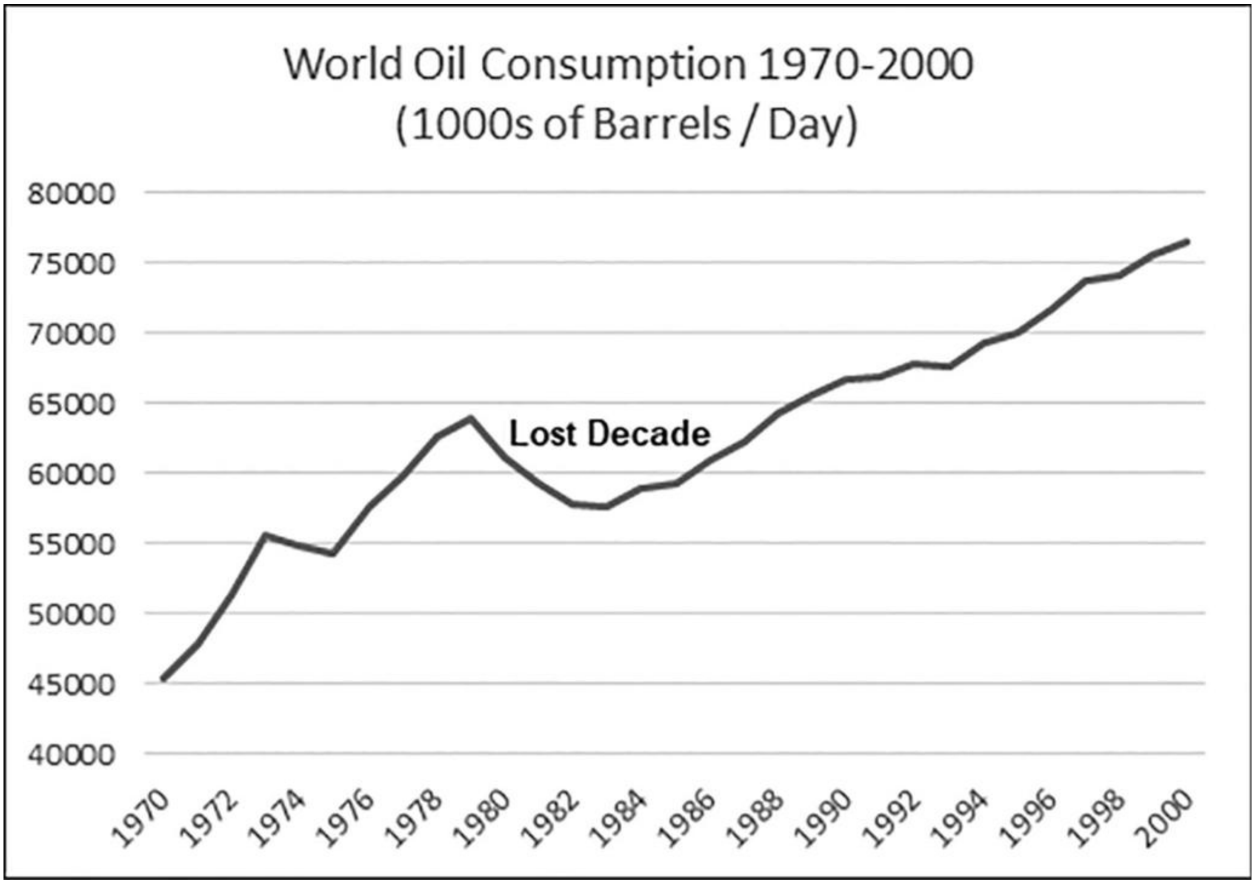

Figure 11-A[170]

In 1999, Saddam Hussein of Iraq (which at the time had the second-largest oil reserves) began selling oil in the newly created euro. Russia, Venezuela, and Iran were also dabbling in non-dollar oil sales around the same time. After the multilateral invasion of Afghanistan in 2001 in the aftermath of the 9/11 terrorist attacks, the United States performed a unilateral invasion of Iraq in 2003, with very little support from the global community other than the United Kingdom.

To this day, there has never been a satisfactory explanation for why the United States invaded Iraq. The public reason at the time was focused on Iraq's weapons of mass destruction, which were never found and were never there. There is no shortage of dictators in the world, including some that do have weapons of mass destruction such as North Korea. Why did the United States invade Iraq in particular? Among the 19 terrorists that were directly involved in the 9/11 terrorist attacks, 15 of them were Saudi Arabian and none of them were Iraqi. The masterminds of the attack, meanwhile, were in Afghanistan near the border of Pakistan.

Shortly after the United States' invasion of Iraq, Iraq went back to selling oil in dollars. The idea that the United States invaded them due to their sale of oil for euros is often labeled a conspiracy theory; it probably wasn't the only reason, but the United States does have a very aggressive track record with countries that sell significant amounts of oil outside of the dollar-based system, with this being the most high-profile example. Ron Paul, who was a sitting U.S. congressman at the time, gave a 2006 speech to Congress on this topic and therefore put it on the public record. The following is a key excerpt from Paul's speech:

> It is now common knowledge that the immediate reaction of the administration after 9/11 revolved around how they could connect Saddam Hussein to the attacks to justify an invasion and overthrow of his government. Even with no evidence of any connection to 9/11 or evidence of weapons of mass destruction, public and congressional support was generated through distortions and flat-out misrepresentations of the facts to justify overthrowing Saddam Hussein.
>
> There was no public talk of removing Saddam Hussein because of his attack on the integrity of the dollar as a reserve currency by selling his oil in euros, yet many believe this was the reason for our obsession with Iraq. I doubt it was the only reason, but it may well have played a significant role in our motivation to wage war. Within a very short period after the military victory in Iraq, all Iraqi oil sales were carried out in dollars. The euro was immediately abandoned.
>
> In 2001, Venezuela's ambassador to Russia spoke of Venezuela's switching to the euro for all their oil sales. Within a year, there was a coup attempt against Chavez, reportedly with assistance from our CIA. After these attempts to nudge the euro toward replacing the dollar as the world's reserve currency were met with resistance, the sharp fall of the dollar against the euro was reversed. These events may well have played a significant role in maintaining dollar dominance.
>
> It has become clear the U.S. administration was sympathetic to those who plotted the overthrow of Chavez and was embarrassed by its failure. The fact that Chavez was democratically elected had little influence on which side we supported. Now a new attempt is being made against the petrodollar system. Iran, another member of the 'Axis of Evil,' has announced her plans to initiate an oil bourse in March of this year. Guess what? The oil sales will be priced in euros, not dollars.
>
> Most Americans forgot how our policies have systematically and needlessly antagonized the Iranians over the years. In 1953, the CIA helped overthrow a democratically elected Mohammed Mossadegh and installed the authoritarian Shah, who was friendly to the U.S. The Iranians were still fuming over this when the hostages were seized in 1979. Our alliance with Saddam Hussein in his invasion of Iran in the early 1980s did not help matters and obviously did not do much for our relationship with Saddam Hussein. The administration's announcement in 2001 that Iran was part of the Axis of Evil did not improve the diplomatic relationship between our two countries. Recent threats over nuclear power, while ignoring the fact that they are surrounded by countries with nuclear weapons, does not seem to register with those who continue to provoke Iran. With what most Muslims perceive as our war against Islam and this recent history, there is little wonder why Iran might choose to harm America by undermining the dollar. Iran, like Iraq, has zero capability to attack us, but that did not stop us from turning Saddam Hussein into a modern-day Hitler ready to take over the world. Now Iran, especially since she has made plans for pricing oil in euros, has been on the receiving end of a propaganda war not unlike that waged against Iraq before our invasion.

> It is not likely that maintaining dollar supremacy was the only motivating factor for the war against Iraq nor for agitating against Iran. Though the real reasons for going to war are complex, we now know the reasons given before the war started, like the presence of weapons of mass destruction and Saddam's connection to 9/11, were false.[171]

In a world of competing sovereign ledgers, each of which are unbacked and centralized, we can once again return to this book's thematic question, "Who controls the ledger?" The answer, geopolitically, is that in the telecommunication age, whichever country has the most economic and military prowess is likely to have the primary control over the world's ledger, unless or until there is a better solution, or until no single nation is large enough to force its will onto the rest of the world. The mightiest country's ledger serves as the independent third-party unit of account for international transactions. South Korea and Saudi Arabia, for example, don't have to trust each other's ledgers if they want to trade with each other, but they do both need to trust the United States. Among fiat currencies, the world reserve currency is the most salable for international trade by far.

As of this writing, there are approximately 160 fiat currencies in the world, and most of them are not very salable or desired outside of their own monopoly jurisdictions. Money is supposed to avoid the need for barter, but when there are 160 different government-issued monies, it ironically ends up replicating a barter system — at least when it comes to global trade. Therefore, a primary settlement asset and unit of account is important so that nations who don't trust each other's arbitrary fiat currencies can still trade with each other. Prior to 1944, this settlement asset and unit of account was gold. During the Bretton Woods era from 1944 to 1971, gold was still used, while U.S. dollars (being redeemable for gold and representing the full faith and credit of the world's largest economic and military power) were used as well. From the mid-1970s to the present day, the U.S. dollar has represented the primary unit of account and payment rail for international trade, with U.S. dollar deposits and U.S. Treasury securities also representing the primary savings asset for foreign reserve holdings.

The United States maintains its fiat ledger, and other sovereign nations attach themselves to the United States' ledger by holding a considerable amount of dollars, either in the form of U.S. bank deposits or U.S. Treasury securities. If their currencies weaken too much, the central banks of those countries can sell some of their dollars and buy back some of their currency, thereby tightening and strengthening it. On the other hand, if a country runs considerable trade surpluses and their currency strengthens, they can print more of their currency, expand their ledger, and buy more dollar assets to weaken the individual unit value of their currency and increase their dollar reserves. To a lesser extent, countries also hold units of other major countries' currencies for a bit of diversification, and many countries also still hold considerable amounts of gold.

Putting this together, the world basically operates on a two-tier financial system. Most people on the bottom tier are stuck paying and saving in whatever their local currency is, and out of 160 currencies, most are not very good. Especially in developing countries, individual people often find it very hard to save money, as their currencies are constantly devalued and occasionally hyperinflated. On the second tier, meanwhile, the export companies, import companies, wealthy class, and central banks of these countries use dollars and other major currencies to interact with global markets. The leaders of these countries, who frequently devalue the savings of their people, often maintain dollar-denominated or franc-denominated or euro-denominated accounts for themselves in offshore banks and tax havens rather than subject themselves to the ongoing currency weakness that their own people routinely experience.

A HISTORY OF MONETARY TRANSITIONS

This chapter finishes with a set of simplified diagrams to summarize the monetary transitions that have occurred since the dawn of the telecommunication age, as described over these past three chapters.

From the 1870s until World War I, the international gold standard looked like Figure 11-B. Each major country that participated in the system pegged its own currency to a fixed amount of gold and held a fluctuating amount of gold in reserve, for which it was redeemable to its citizens and foreign creditors.

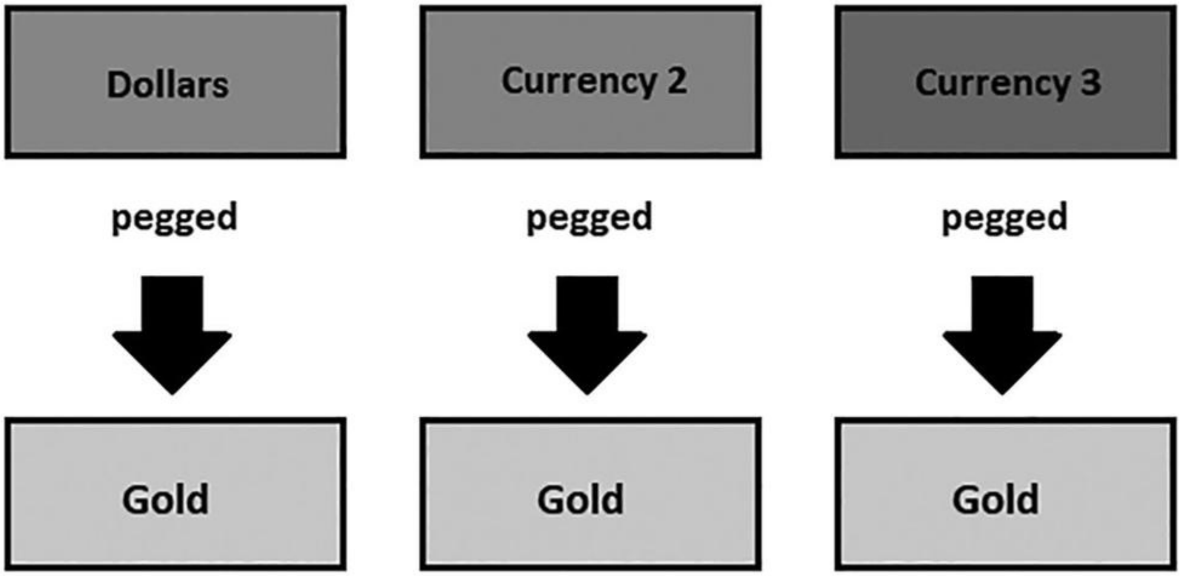

Figure 11-B

The Bretton Woods system from the 1940s until 1971, shown in Figure 11-C, involved the dollar being backed by gold, but only redeemable to foreign creditors in limited amounts. Foreign currencies pegged themselves to the dollar and held dollars/Treasuries and gold in reserve.

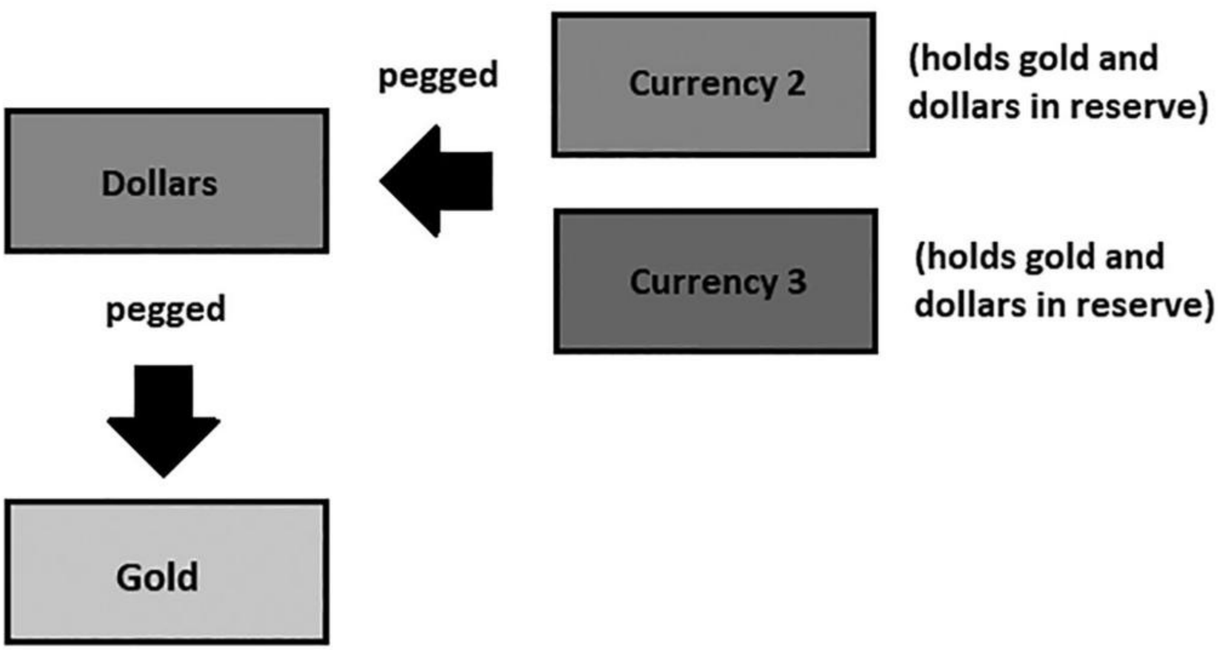

Figure 11-C

The Petrodollar system from the 1970s to the present, shown in Figure 11-D, made it so that practically only dollars could buy oil imports around the world, and so countries globally hold a combination of dollars, gold, and other major currencies as reserves, with an emphasis on dollars. As their network effect became entrenched over time after years of the Bretton Woods system and the Petrodollar system being in place, dollars became the primary global unit of account for international trade and finance more broadly. Under this system of floating exchange rates, if countries want to strengthen their currencies, they can sell some reserves and buy back their own currency. If countries want to weaken their currencies, they can print more of their currency and buy more reserve assets.

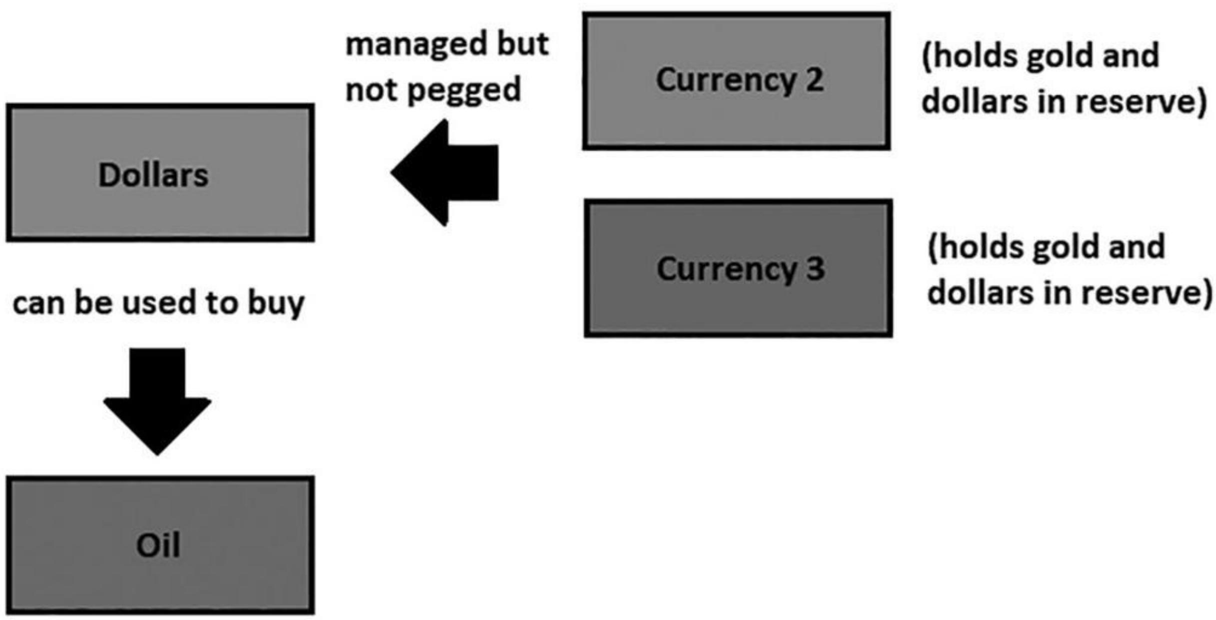

Figure 11-D

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166 Andrea Wong, "The Untold Story Behind Saudi Arabia's 41-Year U.S. Debt Secret," *Bloomberg*, May 30, 2016.

167 Alex Gladstein, *Check Your Financial Privilege*, 38–42.

168 Paul Lewis, "U.S. Reported Set To Borrow Marks Worth $1.25 Billion," *The New York Times*, November 28, 1978.

169 David Spiro, *The Hidden Hand of American Hegemony Petrodollar Recycling and International Markets*.

170 YCharts, "World Oil Consumption (I:WOCNY)."

171 Ron Paul, "The End of Dollar Hegemony." Speech before House of Representatives, February 15, 2006.

CHAPTER 12

PUSHING CHAOS TO THE PERIPHERY

For several centuries and up through the first half of the 20th century, large portions of the world existed under European colonialism. Spain, France, the United Kingdom, and other European powers claimed vast stretches of land on foreign continents. Throughout the second half of the 20th century, many of those regions regained independence from these European powers, but vestiges of that colonialism remain today.

In many ways, the Bretton Woods monetary system and subsequently the Eurodollar/Petrodollar monetary system represent forms of monetary neocolonialism, with the United States in charge. Wealthy nations near the center of the system optimize their ledgers for their needs, especially in terms of suppressing inflation and volatility. However, destroying volatility usually carries a cost and it tends instead to be pushed somewhere else, or only temporarily suppressed until it comes out all at once. In this case, wealthy nations tend to push their inflation and volatility toward developing nations who sit at the periphery of the system, and those developing nations can do little other than take it. Developing nations are expected to attach themselves to the ledgers of the advanced nations, with no recourse for when those ledgers fluctuate in ways that harm them.

The U.S. Federal Reserve has three official mandates, even though they refer to it as the “dual mandate.”[172] The first is to maximize long-term U.S. employment.

The second is to maintain stable prices, which they currently define to be 2% increases in average prices per year. The third is to maintain moderate long-term interest rates. A fourth informal mandate is to maintain U.S. financial stability because that is an important requirement to support the first three official mandates.

The reader should notice that despite being the issuer of the world reserve currency, none of the Federal Reserve's mandates say anything about foreign countries. As the issuer of the world reserve currency, U.S. monetary policy decisions affect almost everyone in the world, but the Federal Reserve only officially cares about foreign impacts if those impacts can bounce back and affect the United States' economy.

One of the key things that broadly separates developed countries (which are the minority in terms of population) from developing countries (which are the majority), is that developed countries mostly have their debts denominated in their own currency, while developing countries have a significant portion of their debts, both at the government level and the corporate level, denominated in major foreign currencies like dollars and euros. For example, Japan as a developed country has the vast majority of its government and corporate liabilities denominated in Japanese yen, which they are able to print more of as needed, while Brazil as a developing country has a significant portion of its government and corporate liabilities denominated in U.S. dollars, which they have no ability to print more of and which fluctuate severely against their own currency and cash flows.

This is because companies and governments in developing countries have substantial need for debt financing, but foreign investors mostly do not trust the domestic ledgers of developing countries. A French lender, for example, usually does not want to lend money to a Brazilian company in Brazilian currency, because the Brazilian central bank could print a ton more of that currency. Instead, the French lender to a Brazilian company would rather lend money in U.S. dollars or in euros, which have a stronger track record. And if they do lend in Brazilian currency, it would be at a much higher interest rate in order to compensate them for taking on so much developing country currency risk. Only advanced economies, with entrenched network effects and a long history of semi-credible monetary management, have been able to issue most of their debt in their own currency and have it be trusted by foreign counterparties.

The problem, therefore, is that many developing country governments and corporations have their assets and revenue streams denominated primarily in their local currency but have a large portion of their liabilities denominated in U.S. dollars. If the U.S. dollar strengthens significantly relative to their local currency, then their liabilities grow in purchasing power relative to their assets and income streams. This causes economic pain, substantial volatility, or outright sovereign defaults in some cases. It also contributes to a vicious cycle, because having foreign currency debt adds risk and volatility to developing country currencies, and that risk and volatility in their currencies is why they generally have to issue debt in foreign currencies. Very few countries in the Petrodollar era have successfully made the transition from a developing country that relies on foreign currency debt to a developed country that is able to exclusively issue debt in its own currency.

Figure 12-A shows the U.S. dollar's purchasing power relative to a basket of major foreign currencies. As the reader can see, sometimes it goes up 50-100% in value in a short period of time. The fluctuations against developing market currencies are even more severe. This hardening of the dollar puts a ton of pressure on developing countries when it happens.

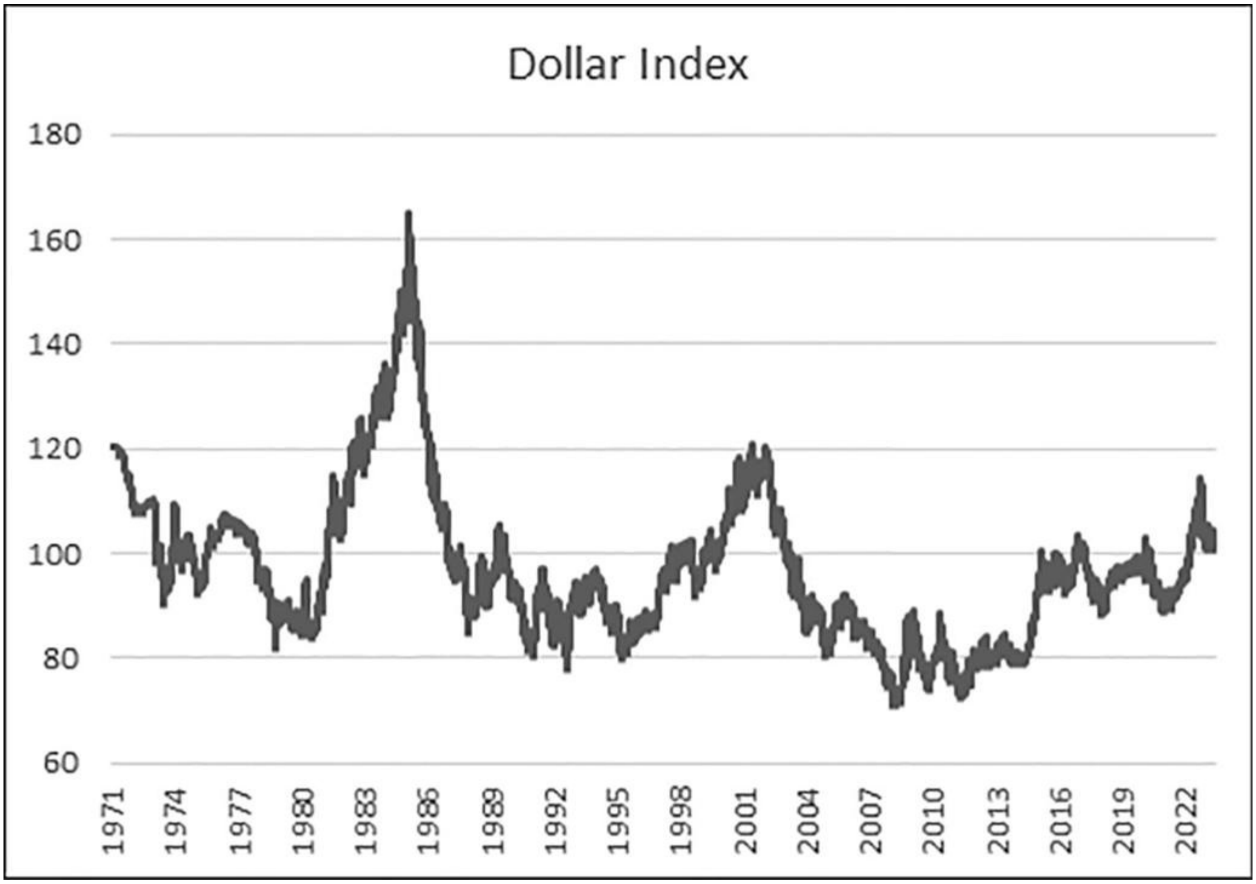

Figure 12-A[173]

The first spike in dollar strength in the mid-1980s heavily contributed to the Latin American debt crisis, which led to defaults, currency crises, and decade-long economic depressions for several Latin American countries. The second dollar spike in the late 1990s and early 2000s heavily contributed to the Asian Financial Crisis and Russian default, which led to significant economic pain for much of Asia overall. The third dollar spike in the late 2010s and early 2020s squeezed many countries around the world, and especially countries like Türkiye, Argentina, Lebanon, and several African nations. As U.S. policymakers try to tighten or loosen monetary policy to smooth out the U.S. economy, they push volatility and economic pain toward developing countries.

In contrast, whenever the dollar weakens significantly, it hurts creditor nations that have large dollar surpluses and low dollar debts, such as Saudi Arabia or China. If countries store their sovereign reserves primarily in U.S. Treasuries, and those Treasuries underperform inflation, then they are basically paying tribute to the U.S. by financing its deficit spending at negative inflation-adjusted interest rates.

Altogether, a spike in the dollar relative to other currencies is bad for debtor nations, and a decline in the dollar relative to other currencies (or relative to real goods and services) is bad for creditor nations. The U.S. Federal Reserve and U.S. Treasury Department can purposely strengthen or weaken the U.S. dollar whenever they feel that it serves their goals. If they are experiencing price inflation, they can raise interest rates, reduce the amount of base money in the system, and cause a sharp tightening of financial conditions and a strengthening of the dollar. If they are experiencing disinflation and economic stagnation, they can cut interest rates, expand the amount of base money in the system, perform fiscal stimulus, and cause a sharp loosening of financial conditions and a weakening of the dollar. If they see that many countries have a lot of dollar-denominated debt, they can purposely tighten financial conditions and strengthen the dollar to cause a lot of economic pain. A developing country with too much dollar-denominated debt will generally experience economic contraction, reduced resource usage, and potentially default. This can reduce resource inflation in the United States, and the United States could then swoop in to help save them with dollar loans, subject to the United States' own conditions and influence — up to and including deals to put U.S. military bases in their country for geopolitical purposes.

In many cases, the governments of developing nations bring pain to their own people. They mismanage their economies, restrain social and economic freedoms, fail to build strong institutions to decentralize power, and thereby contribute to social and economic stagnation. However, their job of managing their financial systems is made much harder by the fact that a significant portion of their liabilities are denominated in a unit that a foreign power (the United States) can strengthen or weaken whenever it serves their interests to do so. Managing a two-currency system like developing country leaders must do is inherently harder than managing a one-currency system like wealthy country leaders must do.

THE IMF AND WORLD BANK

When developing countries run into currency crises and defaults, the International Monetary Fund swoops in with offers of dollar financing. The IMF was created along with the World Bank in 1944 as part of the Bretton Woods system of U.S. monetary dominance, and while it is ostensibly a supranational entity, it is under significant influence by the United States. Both the IMF and

World Bank are physically headquartered in Washington D.C. and in many ways, they have served as guardrails for the Bretton Woods system and the Eurodollar/Petrodollar system since their inception. The United States holds unilateral veto power over major decisions for both institutions.[174] The World Bank is traditionally run by an American and the IMF is run by a European, but both are firmly controlled by the United States and its close allies. The IMF helps countries deal with balance of payments problems, while the World Bank provides funding for infrastructure development. Joining the IMF is a requirement for a country to join the World Bank, and joining the IMF requires a country to pay money into it.

To receive IMF loans, a developing country must agree to all sorts of terms, which often include deliberate currency debasement to suppress domestic wages and make their exports more competitive. Wealthy, advanced nations that control the IMF get to dictate terms to those receiving the loans. Alex Gladstein, Chief Strategy Officer of the Human Rights Foundation, wrote a critical book about the IMF and World Bank in 2023 called *Hidden Repression: How the IMF and World Bank Sell Exploitation as Development*.[175] In the well-researched book, he summarized some of Cheryl Payer's work that described the primary reforms that the IMF requires when they hand out loans:

1. Currency devaluation.
2. Abolition or reduction of foreign exchange and import controls.
3. Shrinking of domestic bank credit.
4. Higher interest rates.
5. Increased taxes.
6. An end to consumer subsidies on food and energy.
7. Wage ceilings.
8. Restrictions on government spending, especially in healthcare and education.
9. Favorable legal conditions and incentives for multinational corporations.
10. Selling off state enterprises and claims on natural resources at fire sale prices.

The reader should notice that the United States and other wealthy nations often skip these steps when they have their own crises. Rather than trim spending on healthcare and education during a period of economic contraction, they expand it. Rather than raise taxes during periods of economic contraction, they tend to cut them as a form of stimulus. They often maintain protectionist trade policies for themselves, even as they tell developing countries to open their countries for foreign trade. While wealthy nations rarely turn toward financial austerity themselves, they expect developing nations to turn toward financial austerity whenever they face economic contraction, to play along with the global financial system as it is currently structured.

The combination of telling developing countries to shrink access to domestic bank credit while enticing multinational corporations to enter their market with various tax incentives, is particularly toxic. Shrinking domestic bank credit makes it harder for smaller, local businesses to survive and grow. Meanwhile, tax incentives and partnerships with multinational corporations gives those multinational corporations big opportunities to come into the market at a moment of weakness to take market share from those local businesses. This happens repeatedly in cycles.

Many developing countries around the world have received well over a dozen IMF loans since the institution was created. Old debts get restructured and refinanced and rolled over into new ever-expanding debts. In many cases, countries have paid back their loan value many times over due to high levels of interest, and still owe more money than they originally borrowed.

Furthermore, large portions of the original loans get quickly funneled back into U.S. and European companies, while sticking the developing country with the bill. For example, the World Bank may lend money to developing countries to build a railroad and a port, who then hire U.S. and European and Japanese infrastructure firms and pay them to design and build much of the work, using this money that they borrowed. The money flows as a loan from the developed countries, briefly to the developing countries, and then back to the developed countries' corporations — while the developing countries get stuck with the debt, owed to developed countries. The railroad and the port are then used primarily to transport and export natural resources from the developing country to the developed countries that financed this, from which the local developing country population received little value but was saddled with the debt for the project. When the debt comes close to defaulting, the loan is generally restructured, and the local currency (and thus the savings and wages of their people) is sharply devalued.

What makes this worse is the fact that many of these developing countries have corrupt, authoritarian rulers. The IMF and World Bank frequently make deals with these authoritarians who control their own country's local fiat ledger, and those authoritarians generally siphon off a significant chunk of money for themselves and their cronies to live in luxury while storing their wealth in offshore bank accounts and real estate. Most people in these countries have no say in the process, generally see little benefit from the deals, and yet get stuck with debt and austerity and currency devaluation that they never signed up for in the first place. Even if the authoritarian leader is eventually removed from power, the IMF still generally expects the country to repay the loans, even if they had no input into receiving those loans in the first place.

In his 2011 book *Debt: The First 5000 Years*, David Graeber described what occurred when France made Madagascar an outright colony from 1895 to 1958, and it is just one of many such examples:

> In 1895, for example, France invaded Madagascar, disbanded the government of then-Queen Ranavalona III, and declared the country a French colony. One of the first thing General Gallieni did after "pacification," as they liked to call it then, was to impose heavy taxes on the Malagasy population, in part so they could reimburse the costs of having been invaded, but also, since French colonies were supposed to be fiscally self-supporting, to defray the costs of building the railroads, highways, bridges, plantations, and so forth that the French regime wished to build. Malagasy taxpayers were never asked whether they wanted these railroads, highways, bridges, and plantations, or allowed much input into where and how they were built. To the contrary: over the next half century, the French army and police slaughtered quite a number of Malagasy who objected too strongly to the arrangement (a hundred thousand, by some reports, during one revolt in 1947). It's not as if Madagascar has ever done any comparable damage to France. Despite this, from the beginning, the Malagasy people were told they owed France money, and to this day, the Malagasy people are still held to owe France money, and the rest of the world accepts the justice of this arrangement.[176]

Outside of Madagascar, to this day France partially controls the currencies of several countries in central and western Africa, which were also former French colonies. Rather than maintain their own currencies, these countries use the "CFA franc" which used to be pegged to the French currency and is now pegged to the euro. As part of this arrangement, these countries must hold at least half of their foreign exchange reserves in France's custody, and France has considerable influence over their monetary policy, including reducing the currency peg at times. France charges fees for this service, including for printing the banknotes and for exchanging the CFA franc into and out of euros (since despite being pegged to the euro, the CFA franc is not accepted outside of these African countries, including in Europe). More darkly, most of these countries are deeply impoverished and have authoritarian rulers that are implicitly supported by France. Up-and-coming political challengers that have opposed this CFA franc system have tended to have short lifespans due to murders and coups, with France then supporting the pro-CFA franc leaders that gained power through violent means.[177]

Similarly, in his previously mentioned book on the subject, Gladstein described in detail, with numerous citations, how the IMF and World Bank often reshape the economies of countries that they finance toward an export-driven economic model. Rather than develop into natural, diversified economies, various countries are structured in a top-down manner to serve wealthy nations with specific exports, such as shrimp from Bangladesh, copper from Zambia, and cotton from Togo. As Gladstein describes:

> World Bank loans traditionally are project- or sector-specific, and have focused on facilitating the raw export of commodities (for example: financing the roads, tunnels, dams, and ports needed to get minerals out of the ground and into international markets) and on transforming traditional consumption agriculture into industrial agriculture or aquaculture so that countries could export more food and goods to the West.[178]

A subtle result is that many developing countries are structured by these creditor organizations to produce and export cash-rich crops to wealthy developed countries that provide little or no caloric value (e.g., tea, coffee, cotton, and so forth), or to produce luxury foodstuffs that are too expensive for most of the local population to form as the basis of their diet (e.g., shrimp and cocoa). Meanwhile, these impoverished developing countries import basic grains, beans, oils, and other foodstuffs that form the foundation of their diet from the United States and other countries, rather than growing enough of these items themselves. Developing market economies are therefore optimized to maximize exports to get external currency, rather than be optimized to be as self-sufficient and balanced as possible. This means that when one of these developing countries runs into a balance of payments crisis, its own ability to feed its people becomes seriously imperiled, since it relies on dollar-denominated imports of those basic products despite having plenty of agricultural capacity to produce them domestically. When the U.S. dollar strengthens sharply, it often causes several developing countries to experience balance of payments crises at once, and to turn to the IMF for support for the dozenth time.[179]

In other words, the modern financial structure results in neocolonialist value extraction in a similar (albeit less direct) way to how outright colonialism did. The method involves financial coercion instead of violent warfare. A research paper published in 2021 called “Plunder in the Post-Colonial Era: Quantifying

Drain from the Global South Through Unequal Exchange, 1960–2018" concluded that rather than the wealthy global North giving aid to the impoverished global South for development, there has been a massive ongoing extraction of value from the global South to the global North. The abstract of the study was as follows:

> This paper quantifies drain from the global South through unequal exchange since 1960. According to our primary method, which relies on exchange-rate differentials, we find that in the most recent year of data the global North ('advanced economies') appropriated from the South commodities worth $2.2 trillion in Northern prices — enough to end extreme poverty 15 times over. Over the whole period, drain from the South totaled $62 trillion (constant 2011 dollars), or $152 trillion when accounting for lost growth. Appropriation through unequal exchange represents up to 7% of Northern GDP and 9% of Southern GDP. We also test several alternative methods, for comparison: we quantify unequal exchange in terms of wage differentials instead of exchange-rate differentials, and report drain in global average prices as well as Northern prices. Regardless of the method, we find that the intensity of exploitation and the scale of unequal exchange increased significantly during the structural adjustment period of the 1980s and 1990s. This study affirms that drain from the South remains a significant feature of the world economy in the post-colonial era; rich countries continue to rely on imperial forms of appropriation to sustain their high levels of income and consumption.[180]

All 12 of the heads of the IMF since the institution's inception through to the present day have been European, and five of them have been French specifically, even though France only represents around 3% of global GDP. And yet the IMF disproportionally determines which countries receive emergency financing on a global scale, and under what terms.

The current global financial system with 160 different fiat currencies, each with a local monopoly over its jurisdiction, and each of which being tied to the highly salable U.S. fiat currency through dollar-denominated debts and dollar-denominated reserve holdings, tends to benefit those at the top of the socioeconomic ladder at the expense of those at the bottom. It helps keep people in developing countries in a state of constant development, dependency, and ever-rising debt, while structuring their economies around serving the wealthy developed countries rather than optimizing for self-sufficiency and well-roundedness. Currencies are regularly devalued (either due to mismanagement by their leaders or at the behest of the IMF) which keeps workers' wages and savings low in terms of global purchasing power. This process enriches corrupt developing country rulers who get to control their country's ledgers and siphon off value for themselves by devaluing the savings of the people. It enriches developed market corporations who get paid to do the work, and leaves the bill at the public level with the impoverished people of those nations who had little say in the process. It then helps keep those corrupt rulers in power by giving them bailouts and restructurings — up to a dozen times or more — to repeatedly push the problems into the future whenever they have a crisis in the present. Those crises are often caused by them having too much dollar-denominated debt in the first place, and the typical solution is to help them take on even more dollar-denominated debt and remain on that endless treadmill.

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172 Board of Governors of the Federal Reserve System, "Monetary Policy: What Are Its Goals? How Does It Work?"

173 YCharts, "ICE US Dollar Index."

174 Jakob Vestergaard and Robert Wade, "Trapped in History," 2.

175 Alex Gladstein, *Hidden Repression*, 25–26.

176 Graeber, *Debt*, 5–6.

177 Fanny Pigeaud and Ndongo Samba Sylla, *Africa's Last Colonial Currency: The CFA Franc Story*.

178 Gladstein, *Hidden Repression*, 18.

179 Daron Acemoglu and James Robinson, *Why Nations Fail: The Origins of Power, Prosperity, and Poverty*, ch. 9 and ch. 13.

180 Jason Hickel et al., "Plunder in the Post-Colonial Era."

CHAPTER 13

HEAVY IS THE HEAD THAT WEARS THE CROWN

The “Sword of Damocles” is a 4th century B.C. parable, popularized by Cicero, about a courtier named Damocles and his ruler, Dionysius II of Syracuse. In the story, Damocles tells Dionysius how fortunate Dionysius must feel to be the ruler, since he has all the power and is surrounded by wealth. Dionysius, annoyed at the flattery, offers to let Damocles sit on a throne and experience being surrounded by servitude and opulence for a day. Damocles happily accepts and gets treated to a day of luxury, with servants catering to his every whim.

However, the catch is that while Damocles sits on the mock throne, a sword hangs by a single thread with the point facing down over his head. The sword over Damocles represents the fact that Dionysius, who ruled with an iron fist to achieve and maintain his power and wealth, and therefore made many enemies along the way, is constantly worried about assassination or other threats. To paraphrase Shakespeare, “heavy is the head that wears the crown.” This is what Dionysius wanted to show Damocles. Being the ruler comes with perks, but also comes with great costs compared to those of a simpler life. Once Damocles noticed the sword hanging over him, he felt constantly in danger, could no longer enjoy the luxury of his situation, and begged to end the ordeal.[181]

As the prior chapter discussed, the current global financial system pushes volatility toward developing nations. The United States sits at the core of the system as the issuer of the world reserve currency that most other currency ledgers in various ways attach themselves to. However, while the United States has indeed benefited tremendously from this arrangement, it comes with a great cost.

The cost of the 1944–1971 Bretton Woods system was that it drained the U.S. of its gold reserves over time, until it led to default on the promise of gold redeemability. It was poorly designed from the start, with a finite amount of gold but an endlessly reproducible number of dollars that were redeemable to foreign creditors for gold, and therefore it inevitably broke down over time.

The cost of the Eurodollar/Petrodollar system, from 1974 to the present, is that by having so many entities around the world hold dollar-denominated assets for lack of a better alternative, it artificially increases the purchasing power of the U.S. dollar. The extra monetary premium reduces the United States' export competitiveness and gradually hollows outs the United States' industrial base. To supply the world with the dollars it needs, the United States runs a persistent trade deficit. The very power granted to the reserve currency issuer is also what, over the course of decades, begins to poison it and render it unfit to maintain its status.

To understand how the current Eurodollar/Petrodollar system harms the United States' export competitiveness, we can define four macroeconomic terms: a trade balance, a current account balance, a capital account balance, and a net international investment position.

Trade Balance: A country's trade balance measures the value of goods and services it exports minus the value of goods and services that it imports. A country that exports more than it imports (i.e., produces more than it consumes) has a trade surplus. A country that imports more than it exports (i.e., consumes more than it produces) has a trade deficit.

Current Account Balance: The current account balance is a broader measure that includes the trade balance, plus investment income between nations, plus cash transfers. A country with a current account surplus has more value flowing into it. A country with a current account deficit has more value flowing out of it.

Capital Account Balance: The capital account balance is the opposite side of a current account balance. It represents the change in ownership of assets. A country with a current account deficit ends up with a capital account surplus of the same amount, which means foreigners are owning more and more of the country's capital assets. A country that runs a current account surplus ends up with a capital account deficit of the same amount, which means that they are owning more and more foreign assets.

Net International Investment Position (NIIP): Private citizens and government organizations of a country may own capital assets of other countries, like real estate, shares of corporations, bonds, and so forth. A country's net international investment position represents the accumulation of current account and capital account imbalances. It quantifies the total amount of foreign assets that a country's citizens and government own minus the total amount of domestic assets that foreign citizens and governments own.

Countries that produce more than they consume over a long period of time generate trade surpluses and current account surpluses. This results in a positive net international investment position. In other words, they end up owning a lot of foreign assets including other countries' gold, other countries' real estate, other countries' bonds, and other countries' business equity, plus any income streams that these assets may provide.

Conversely, countries that produce less than they consume over a long period of time generate trade deficits and current account deficits. This results in a negative net international position. This means that people and institutions in foreign countries end up owning more of these countries' gold, real estate, bonds, and business equity, and thus people within the country lose the value of the income streams that these assets may provide.

CORRECTING A BALANCE OF PAYMENTS PROBLEM

When a country runs a large and persistent trade deficit due to a mismatch in consumption and production, it means that value is flowing out of the country. The country is, in essence, living above its means. At the same time, to pay for this imbalance in consumption, various domestic entities (including individuals, companies, and/or the government), are giving up ownership in valuable capital assets to the foreign entities (including individuals, companies, or governments) that they are becoming indebted to.

A simple way to envision this at first is with a very basic gold-backed monetary system example without credit. We start with two countries, Japan and Brazil, a century ago. Brazil exports a lot of commodities, while Japan lacks sufficient domestic commodities but exports a lot of precision industrial goods. They start with a clean slate; no Japanese investors own any Brazilian assets, and no Brazilian investors own any Japanese assets. In this hypothetical example, they establish a trade connection, and Japan happens to export more goods and services to Brazil than Brazil exports to Japan, and all transactions are paid for with gold coins or bars. So, Japan runs a trade surplus with Brazil. If Brazil is paying for the goods and services with gold, it means that gold is flowing out of Brazil and into Japan, in exchange for more goods and services flowing into Brazil from Japan. Brazil is accumulating goods and services that depreciate in their value over time, while Japan is accumulating Brazil's gold, which lasts forever and represents savings. There could, however, be a time in the future where Japan begins importing more than it exports. For example, if commodities become globally undersupplied and expensive at some point in the future, then Japan as a resource-limited country could end up paying a lot more money for its commodity imports, and therefore could benefit from having a lot of gold savings from its prior productive period of running trade surpluses. Brazil, as a nation that exports commodities, might therefore be able to get a lot of that gold back during a period of high commodity prices.

We can then expand this into a more realistic and modern example, with credit and capital ownership. If Japan and Brazil are doing a lot of trading, it could be with a variety of different monies, such as their own fiat currencies, or U.S. dollars, or debt and equity arrangements. For example, maybe Brazil pays for its Japanese imports with Brazilian currency (which are liabilities of Brazil's central bank), and those Japanese producers take the Brazilian currency and immediately buy Brazilian assets with it, such as Brazilian stocks or real estate, or Brazilian government bonds. Instead of losing its gold to Japan in this scenario, Brazil is instead losing some of its ownership of domestic real estate and companies. Japan is acquiring a larger and larger stake in Brazilian real estate and companies, either as an equity holder or as a credit lender. Brazilian entities in aggregate are overconsuming and are paying for current consumption out of their future expected income streams. Japanese entities in aggregate are allowing Brazilian entities to overconsume, and in the process are acquiring a larger and larger share of the future income streams of various Brazilian companies and real estate. Alternatively, Japanese producers could take the Brazilian currency that they earn, sell it for gold or U.S. dollars, and accumulate those instead; their contracts are likely denominated in U.S. dollars anyway. If they do this, it will weaken Brazil's currency, and thus weaken the ability of

Brazilians to buy imports.

Temporary trade deficits are fine, and inevitable. To continue with our example, perhaps in the early years of this trade relationship, Brazil imports many technical products from Japan to build railways and shipping ports, as well as advanced mining and farming equipment, and therefore runs a temporary trade deficit. Brazil gives some of its gold and capital stock to Japan in the process. However, Brazil uses these imports very productively, and with new railways and shipping ports and equipment, it can double its annual commodity imports to the world and start running a trade surplus. It can then accumulate foreign assets over time, such as gold or stakes in foreign capital assets with their associated income streams. This would be an example of productive specialization and trade: Japanese companies have considerable expertise in industrial production and infrastructure but have limited commodity resources, while Brazil has vast commodity deposits and production capabilities that could be enhanced by importing those Japanese goods and services and putting them to good use to unlock some of that value. Brazilian leadership might also use this opportunity to invest in education, so that their own citizens can move up the value ladder and start creating more complex products and services in addition to their commodity exports.

Long-term trade deficits, on the other hand, are usually a problem. If Brazilian entities in the early years of this trade relationship with Japan are just racking up debt, giving away their equity, becoming renters rather than owners, shipping away their gold, and not using the imports to build their own production capabilities, then they are becoming impoverished due to some combination of overconsumption and underproduction. They may also have some of the value siphoned off by corrupt rulers, or by bad terms with multinational corporations in what are basically neocolonialist trade relationships. In this case, well-connected insiders at the top are likely to make a lot of income and put it into offshore bank accounts and other foreign assets, while the population suffers.

After a while, a trade imbalance such as this tends to resolve itself. It could be that the country that is running a persistent deficit (Brazil in this example) realizes the problem, takes corrective action, and begins a series of policy reforms to become more productive. Alternatively, it could be a less pleasant outcome: The country that runs the persistent deficit becomes increasingly impoverished and unable to keep consuming foreign goods and services at the rate that it used to. It loses its gold, it loses a lot of its own domestic equity stakes, its currency weakens, and/or it becomes greatly indebted. They buy fewer imports from foreign countries out of necessity since they lack savings and have bad credit ratings. After that, being rather impoverished now, they are more willing to work for lower wages and their production could therefore start to become more globally competitive. It's a painful cycle, but as long as they don't fall into complete sociopolitical disarray, this reduction in import power and uptick in export competitiveness creates a new opportunity to establish a period of overproduction and underconsumption, which can bring wealth back into the country.

In many cases, a country's current account balance gets expressed through its currency. The fiat currency of a country represents the ability to buy that country's goods, services, and assets. Therefore, a highly productive country's fiat currency tends to strengthen over time relative to the fiat currencies of unproductive countries, since value is continuously flowing into that country's economy and ledger system. Their wages tend to rise, and the quality of life tends to increase. Their ability to import things from other countries therefore increases as well.

Significant imbalances can arise, however, if a country makes its fiat currency artificially strong or weak. Mercantilism, for example, is an economic policy that seeks to maximize exports and minimize imports. Mercantilist political leaders of an export-driven country might, for example, continuously debase their currency to keep real wages in their country low, rather than let the currency rise naturally. This keeps their people from spending much on imports, keeps their labor pay rates globally competitive (i.e., very low), and allows the country to persistently bring in more value than it otherwise would. However, that value tends to consolidate near the top of the socioeconomic ladder and into government hands. Mercantilist countries tend to build large industrial centers and accumulate a lot of foreign reserves, while their laborers see their savings and purchasing power continually drained away from them.

On the other side of mercantilism, is what happens to a country whose fiat currency is used as a world reserve currency. The United States has engineered the global monetary system in such a way that there is vast demand for dollars from places around the world. In addition to dollars representing the ability to buy American goods, services, and assets, dollars can be used to buy almost anything globally, including commodities from around the world. During the mid-/late 20th century and early 21st century, the dollar has been the fiat currency of the most powerful country, both economically and militarily. Japanese entities don't want to hold a lot of Brazilian currency. Brazilian entities don't want to hold a lot of Japanese currency either. But both Brazilian and Japanese entities want to hold a lot of dollars. Some of this is natural demand, and some of this is because they want to be in good relations with the United States and holding plenty of U.S. Treasuries as reserves is a step in the right direction for that. Meanwhile, many countries like Saudi Arabia only price their oil in dollars, no matter who they are selling it to, due to historical arrangements with the United States and its military protection. Many nations want to hold some dollar-denominated assets to ensure that they can sell them to buy oil and other international goods if needed.

This sounds great for Americans at first. Our currency is unusually strong since it is more widely held globally than other fiat currencies and therefore has an extra monetary premium. Entities from countries all around the world hold dollars and dollar-denominated assets like Treasuries and equities. However, this extra currency strength greatly increases American import power and reduces American export competitiveness. It becomes expensive to pay American workers compared to workers in other countries, including both developed and developing countries. A structural trade deficit develops, and never seems to be resolved, decade after decade. Over time, more manufacturing facilities leave the United States and head to places like Germany, Japan, Taiwan, China, and Mexico. Workers in the United States generally cease to build expertise in manufacturing compared to their counterparts in more industrially competitive countries.

In the late 19th century and well into the 20th century, the United States was the up-and-coming industrial powerhouse with a structural trade surplus. The United Kingdom issued the world reserve currency, and ran a structural trade deficit. In the second half of the 20th century, the United States took over as the issuer of the world reserve currency and began experiencing a structural trade deficit, while Saudi Arabia, Germany, Japan, Taiwan, Singapore, Switzerland, China, and other countries arose as the countries with major trade surpluses.[182]

The Eurodollar/Petrodollar system extends the reach of the United States in many ways, including its ability to maintain hundreds of foreign military bases, but it hollows out the domestic industrial base. For most countries, the value of their currency reflects their current account balance over time, but the United

States can maintain a current account deficit for decades upon decades and just keep hollowing itself out due to that extra layer of global demand for its currency.

In this sense, the United States doesn't have the natural response functions that other countries have when trade deficits persist for too long. Instead, the problem is allowed to get worse than normal, for longer than normal. The United States is like a boxer that doesn't feel pain; he's still accumulating damage but doesn't feel it, and thus by the time he *does* feel it, he'll have accumulated a lot more damage than he realized. "Damage" in this context is a deeply negative net international investment position and a hollowed-out domestic industrial base — along with a very angry working class.[183] These types of multi-decade, excessive trade deficits were part of what Keynes was trying to avoid with his proposed bancor-based system, but because that complicated system was avoided in favor of the Bretton Woods system and later the Eurodollar/Petrodollar system, we built up these major trade imbalances.

Starting in the 1970s and 1980s as shown in Figure 13-A, the United States began running a structural trade deficit.

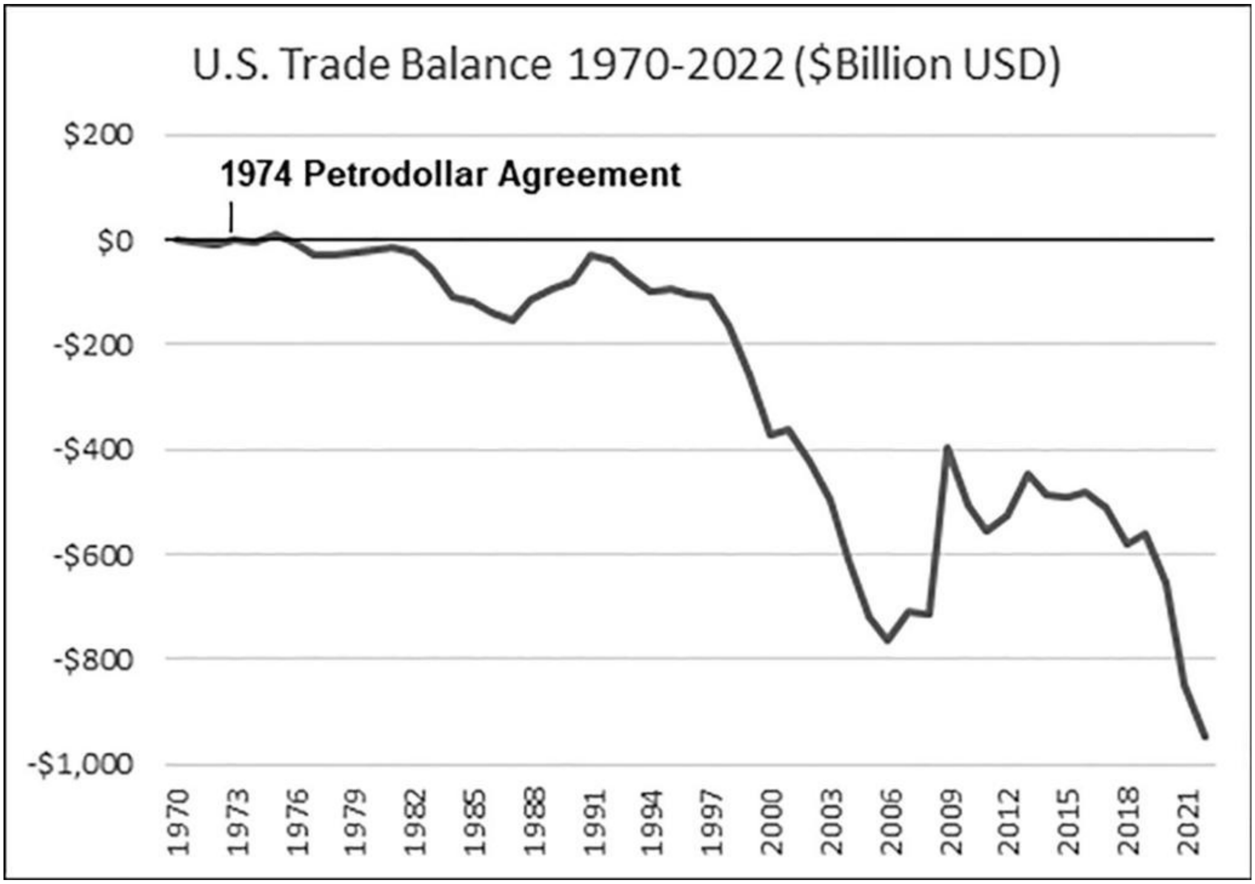

Figure 13-A[184]

Starting in the mid-1980s as shown in Figure 13-B, the United States dipped into a negative net international investment position, which meant that foreigners owned more American assets (stocks, bonds, and real estate) than Americans owned of foreign assets for the first time. By the 2010s, the American net international investment position became deeply negative.

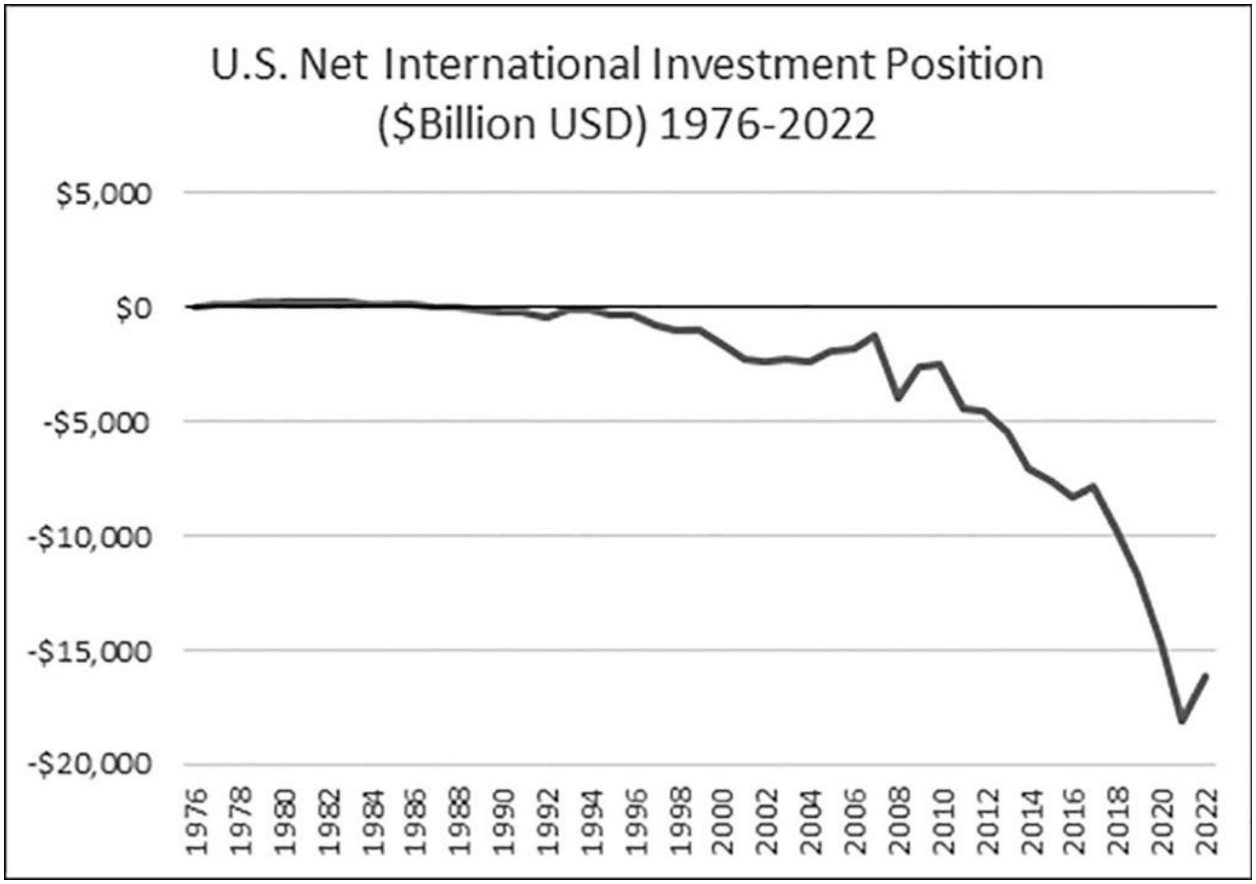

Figure 13-B[185]

By the beginning of the 2000s decade, U.S. industrial production had practically peaked, and has trended mostly sideways ever since. As shown on Figure 13-C, on a per capita basis, U.S. industrial production has been trending down during this sideways period, after eight decades of trending upwards.

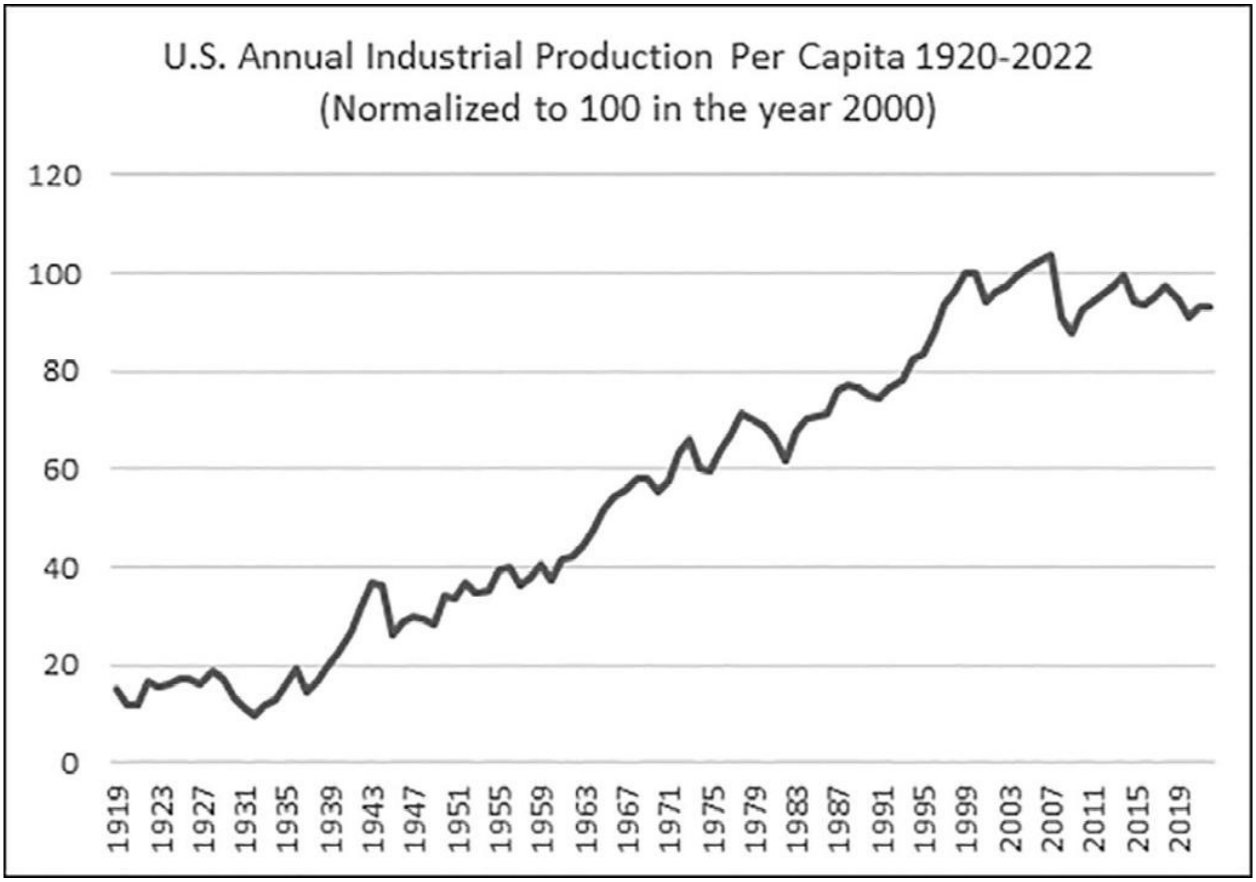

Figure 13-C[186]

Macroeconomic analyst Luke Gromen has made the argument that the Eurodollar/Petrodollar system most likely played a significant role in the United States' victory in the Cold War. Getting several oil-exporting nations to exclusively use dollars for their oil exports helped to box in the Soviet Union economically and geographically throughout the 1980s. The Soviets had to exchange real value for their oil production and other commodity procurements, while the United States could print money for it and defer the costs. However, Gromen argues that by the 1990s after the fall of the Soviet Union, the United States should have attempted to re-arrange this system to clear trade imbalances more regularly, rather than try to keep the system in place as they have.[187] Since the 1990s, the Eurodollar/Petrodollar system has been more of a curse than a blessing, since it allows mercantilist nations to run increasingly large trade surpluses with the United States and hollow out its industrial competitiveness, which by extension leads to a reduction in military competitiveness in the very long run.

The people who benefit from this system are twofold. The first group of beneficiaries consists of American financiers and the establishment class more broadly. Americans who work in finance, government, defense, technology, healthcare, and other monopoly or high-margin non-industrial businesses benefit greatly from this system, because they get all the benefits of increased consumption and global dominion without the drawbacks of less export competitiveness. The second group of beneficiaries consists of foreign exporters and industrialists and their leaders. Chinese manufacturers, for example, have been able to build massive wealth from this imbalance.

The people who are harmed by this system are also twofold. The first group consists of American workers. Working-class Americans who make physical products have been harmed by this system in aggregate, because the wages to hire Americans are high in global terms and their exports are expensive in global terms, even compared to exporters in other developed countries. As a result, a lot of this manufacturing capacity initially flowed to Germany and Japan and then flowed toward China and other developing nations.[188] The second group consists of consumers in developing mercantilist nations, or nations that otherwise fail to have their currencies accrue value. People around the world, especially in developing countries, hold money in their local currencies that get frequently devalued over time. This is either because current account surpluses are converted into sovereign reserves held by the country's central planners, or because the country fails to accrue a current account surplus and faces constant currency dilution.

It's not so much that a strong or weak currency is inherently good or bad per se, but rather that an *artificially* strong or weak currency relative to a country's trade balance is bad. If a country has a persistent trade surplus but constantly weakens its otherwise-appreciating currency by accumulating central bank reserves (mercantilism), then value is siphoned away from workers and toward the leaders. Similarly, if a country has a persistent trade deficit but has an extra monetary premium built onto its otherwise-depreciating currency due to its imperial prowess, then its workers are not very competitive in terms of global labor rates and will likely stagnate, while their political leaders, multinational corporations, and wealthy elite will thrive.

The past fifty years can be described as a period of dominion for United States' elites, which came at the expense of liberty and domestic economic vibrancy for the majority. "United States, the Empire" grew while "United States, the Country" stagnated, and this was largely a bipartisan phenomenon. As a result, we have hundreds of foreign military bases while our domestic infrastructure is aging. We can win practically any naval battle, while we fall behind the rest of the developed world in terms of education. We actively engage with China in a great power competition, while relying heavily on importing Chinese-made goods to finance our consumption.

Much like the Roman Empire eventually found itself with borders so big that it couldn't protect them all, the United States currently finds itself stretched so thin and trying to maintain a financial system and geopolitical structure that it no longer truly benefits from. The boxer hasn't felt pain for a while; he took a lot of punches and is just now starting to feel the damage he took throughout this time. Those near the top have benefited for decades, while those at the bottom have not, and the industrial base and net international investment position of the country have been hollowed out because of it.

The U.S. political establishment could pivot and start to proactively fix this. We could pull back gracefully from the rest of the world, reduce military spending, improve our monetary system, invest domestically, and emphasize "United States, the Country" rather than "United States, the Empire." Other nations would have to step up in terms of their own defense spending, and the world would be more multipolar in general, with separate spheres of influence. In terms of this topic, anthropologist and business executive Natalie Smolenski has described the importance of having a positive political project to focus on. In other words, the mission wouldn't be about stagnating and pulling back (which is hard for the citizenry to rally around and feel good about), but rather the mission would be about re-prioritizing our efforts domestically and building something new and fresh here at home.[189]

Unfortunately, most empires, once they reach their apex, don't pull back gracefully and positively. They expend resources to try to fight and keep every inch of what they have, while factions inside the empire battle each other, and while external forces chip away at the borders.[190] Large organizations in general, including both governments and corporations, rarely disrupt themselves. Institutional inertia exists, meaning once things are set on a path, they tend to remain on that path even when it no longer makes sense, until they are heavily disrupted. Empires usually end up pivoting late from a position of weakness, rather than pivoting early from a position of strength.

Many Americans assume that part of maintaining quality of life in the country means that we should do whatever we can to maintain the status quo situation of the dollar as the world reserve currency. However, I view it differently. The status quo of the dollar's hegemony has directly contributed to the domestic hollowing-out that we've experienced for decades — especially after the Cold War ended. The system that has been in place since the 1970s is antiquated monetary technology and is inherently unsustainable due to the accrued imbalances that it creates. Losing dollar hegemony at this point would harm special interests in the United States, would reduce the country's imperial reach, and would require a shift of priorities, but ultimately it would lead toward a more natural and balanced global economy and provide the opportunity for U.S. domestic revitalization. The risk comes when we fail to recognize that and thus fail to make proactive changes from a position of strength. And so far, that's the path we've chosen.

THE FAILED WAR ON TERROR

After the 9/11 terrorist attacks on the United States, the United States responded with war. The military efforts initially focused on Afghanistan where the attack's organizer Osama Bin Laden and his allies were hiding, but then expanded into Iraq as well — even though Iraq was not involved in the terrorist attacks and doesn't even share a border with Afghanistan. Most Americans couldn't locate either country on a map, conceptually mixed them together, and went along with the messaging of the government and the corporate media at the time about the "War on Terror." At the peak level of support in 2003, Gallup polls showed that 76% of Americans supported going to war against Iraq.[191] For an American to express disapproval regarding the war against Iraq was considered very unpatriotic to many people at the time.

Wars that are financed with debt denominated in fiat currency units that the central bank can print, are not transparently priced. If the war against Iraq came with a 10% special war income tax for all Americans, the level of public support would have surely been lower. If we had to pay for it transparently in real time, then maybe we would think twice and look more deeply into the matter before blindly committing to it. On the other hand, if the costs of war seem trivial or unclear to us, if we barely know the difference between Afghanistan and Iraq, and can't locate either on the map, and the political leaders and media are saying it's a good and patriotic idea and that it's necessary for national security, then why not go to war?

The Watson Institute for International & Public Affairs at Brown University initiated a Costs of War project in 2010 with dozens of scholars that analyzed the full costs of the total War on Terror (Afghanistan, Iraq, and related efforts), which at that point was still ongoing. They continue to update the project to this day, since the costs continue to pile up even now that the war is over. As of fiscal year 2022, they estimated the total cost of the war so far to be approximately $5.8 trillion. This includes over $2.1 trillion in direct war funding, another $2.1 trillion for the expansion of the baseline military expenditures and the creation of the Department of Homeland Security, nearly half a trillion for cumulative veteran's benefits, and $1.1 trillion in interest on the debt used to pay for it. Going forward, they expect another $2.2 trillion in estimated veterans' care over the next three decades that has been committed to, and they calculate that the cumulative debt interest on this is likely to be another $5+ trillion during that period.[192] Meanwhile, hundreds of thousands of foreign civilians are estimated to have been killed in combat zones, and millions of people have been displaced.

When 76% of Americans supported the Iraq war, did they do so with the understanding that it would have a $5.8 trillion cumulative price tag on the public by 2022, and perhaps a $13+ trillion price tag by 2050? The answer of course is no, because the issuance of fiat currency debt, and the currency dilution associated with the monetization of that debt, rendered it almost entirely opaque. People pay for the war over time in ways they can't detect. It can also be thought of as having been paid through opportunity costs; what if the government had instead spent this tremendous amount of value on domestic infrastructure, math and science education, foreign aid to strengthen global alliances, or by giving every American a big tax cut and letting them keep more of their own money?

Decades later, as I write this, the United States faces large fiscal deficits in part due to all of this accumulated interest that we owe on the debt, partly from the failed war. Some politicians are in favor of raising taxes, which along with inflation is a way of paying for the war in hindsight by the next generation, which didn't initiate the war in the first place.

In a 2017 testimony before the Senate Armed Services Committee, Linda J. Bilmes of Harvard University described the opaque financing of the war as follows:

> The wartime budgetary process for the post-9/11 wars from 2001 to 2017 is the largest single deviation from standard budgetary practice in U.S. history.

> In every previous extended US conflict — including the War of 1812, the Spanish-American War, Civil War, World War I, World War II, Korea and Vietnam — we increased taxes and cut non-war spending. We raised taxes on the wealthy.
>
> President Truman raised the top marginal tax rate to 92% during Korea. He believed it was morally right to "pay-as-you-go" — a term he coined and repeated in more than 200 speeches. President Johnson was more reluctant, but in 1967 he imposed a Vietnam War surcharge that raised top tax rates to 77%.
>
> By contrast, in 2001 and 2003, Congress cut taxes — the "Bush tax cuts" as we went to war in Afghanistan and Iraq. Since then, we have paid for these wars by piling up debt on the national credit card. No previous U.S. war was financed entirely through debt. I refer to these wars as the "Credit Card Wars."
>
> In addition, we have budgeted for these wars differently. In every previous major war, the war budget was integrated into the regular defense budget after the initial period. This meant that Congress and the Pentagon had to make trade-offs within the defense budget.
>
> By contrast, the post-9/11 wars have been funded mostly by supplemental appropriations. The post-9/11 wars have been funded through emergency and Overseas Contingency Operations (OCO) bills, which are exempt from spending caps and do not require offsetting cuts anywhere elsewhere in the budget. Over 90% of direct war spending for the current wars has been paid through supplemental money compared to 35% for Korea and 32% for Vietnam.
>
> This process is less transparent, less accountable, and has rendered the cost of the wars far less visible.[193]

Over two decades since the War on Terror began, it's clear by almost every objective analysis that this was a failed war, and failed wars are what put empires at risk. While those involved in the terrorist attacks needed to be sought and held accountable, and future attempts at terrorist attacks needed to be mitigated to reasonable degrees, the spread of the war into Iraq was an expensive distraction and the United States did not gain trillions of dollars of value by engaging in it.

Much like World War I, most of this military engagement didn't need to happen, and mainly happened anyway due to the availability of money printers and opaque financing by a small number of people in seats of imperial power, so that the costs could be abstracted away from the public. The public pays for it over time by currency debasement, or through higher taxes that are imposed decades later to rein in deficit-driven inflation caused by these prior decisions that led to so much debt and cumulative interest expenses. The biggest beneficiaries of the war were the U.S. corporations that make products for the military.

HOW CHINA SUBVERTED THE CURRENT SYSTEM

During the 1970s, 1980s, 1990s, and 2000s decades, trade partners that ran large trade surpluses with the United States generally reinvested those dollars back into U.S. assets — especially U.S. Treasuries. This made the U.S. federal government increasingly indebted to foreign nations, but also allowed it to run significant fiscal deficits while keeping its currency strong.

Saudi Arabia and other OPEC countries would sell a lot of oil to the United States and store those dollar trade surpluses in U.S. Treasuries. Germany and Japan would sell a lot of cars to the United States and store those dollar trade surpluses in U.S. Treasuries. China, Taiwan, and Singapore would sell a lot of electronics to the United States and store those dollar trade surpluses in U.S. Treasuries. Over time, many of these foreign creditors began diversifying into owning U.S. stocks, U.S. real estate, and U.S. private equity. They increasingly owned stakes in U.S. capital assets; Americans were selling away larger and larger parts of their future income streams, through debt and equity, to fuel their ongoing consumption of Chinese-made, depreciating assets.

After the 2008 global financial crisis, interest rates on U.S. Treasuries became very low for a decade, frequently below the rate of price inflation. It was not very desirable to hold them anymore. Any country that holds dollars or Treasuries as its reserve assets at a time when interest rates are below the rate of inflation, is basically paying financial tribute to the United States and devaluing their own savings. Starting in 2013, China did something that other trade partners hadn't done before within the context of the Eurodollar/Petrodollar system: They declared that it was no longer in their best interest to keep accumulating U.S. Treasuries, and instead they launched the Belt and Road Initiative. For this initiative, they began taking their dollar trade surpluses and investing them into approximately 150 countries throughout the world, with an emphasis on infrastructure and commodity production. They made dollar-denominated loans for countries all around the world to build infrastructure, especially trade-based infrastructure (roads, railways, ports, refineries, and commodity deposits). China would get financial returns from these investments or would get rights to their use and production. In other words, China in the 21st century began doing the same sort of neocolonialist financial arrangements that American and European countries did throughout the 20th century.[194]

While I am no fan of China's human rights record or authoritarian form of government, it was clear why they wanted to do this. Britain and France treated China terribly in the 19th century during the Opium Wars, when they literally went to war with China to force opium into the country and to force China to sign unequal trade agreements. This initiated what China refers to as the "century of humiliation" where they were weakened considerably by European powers, and then later invaded by Japan and subjected to myriad war crimes. Then, throughout the latter half of the 20th century, the United States and European countries engaged in monetary neocolonialism throughout the developed world. With a handful of notable exceptions (mostly in Asia), emerging markets rarely ever actually "emerge" within this system. Instead, they tend to remain shackled in foreign currency debt, running on an economic treadmill to send exports to the United States and Europe without accruing durable capital themselves. Chinese leaders see themselves as trying to break out of this system to re-establish their country as a fully sovereign global power that doesn't rely on the U.S. dollar. The same is generally true for India, Brazil, and other large developing countries.

Meanwhile, the United States finds itself with a hollowed-out industrial base and is using its unrivaled navy to protect the global shipping lanes for what is increasingly (and ironically) Chinese-dominated trade. China has larger electricity production than the United States, more skyscrapers, a larger industrial base, more commodity consumption, more manufacturing output, and is the biggest trading partner with most countries in the world now, having replaced the United States in that regard. The United States, meanwhile, continues to run large trade deficits and dig deeper and deeper into a negative net international investment position. As a result, tensions are growing between the United States and China, since the United States isn't benefiting from being the world reserve currency issuer in the way that it used to but still isn't willing to take steps to change that. Increasingly, the United States is having to finance its own fiscal deficits, as much of the world slows down or ceases their accumulation of U.S. Treasuries.

MOVING TOWARD A MULTIPOLAR WORLD

Much like how the Bretton Woods system eventually became untenable by drawing down U.S. gold reserves, the Eurodollar/Petrodollar system is becoming untenable by hollowing out the U.S. industrial base and U.S. net international investment position. Heavy is the head that wears the crown.

When the Bretton Woods system was created, the United States had over 40% of global GDP, by far the largest industrial base, the best geography/agriculture situation, the dominant navy, the largest gold reserves, and a positive net international investment position. Over time, U.S. GDP dropped to 20-25% of global GDP on a nominal basis — or as low as 15% on a purchasing power basis — and with a deeply negative net international investment position after continuously running trade deficits for decades. Meanwhile, we lost the role as the world's largest trading partner. The main things we have left are the best geography and agriculture capacity, a robust startup ecosystem, and a dominant navy. Those aren't necessarily enough when trying to remain in a seat of global power.

However, it's not as though the Eurozone or China can replace the United States as the issuer of a dominant world reserve currency. Neither of those currency blocs have 40% of global GDP, like the United States once had. The Eurozone has a monetary union without a fiscal union, insufficient energy security, and top-heavy demographics. China also has top-heavy demographics, weaker geography in terms of coasts and rivers and safe borders, weaker rule of law, and shallower capital markets, which renders it inherently unfit to play the role that the United States was able to play in the mid-20th century. As a result, the world's economy is naturally a lot more spread out now, rather than heavily concentrated in just one country. The United States, China, India, Japan, Brazil, Russia, and several European countries all have considerable economic power regionally, with certain strengths and weaknesses.

Many people think that the world must have a world reserve currency. They think that much like how the world reserve currency went from the U.K. pound sterling to the U.S. dollar, it will go next to the Chinese yuan. Other analysts think that because the Chinese yuan isn't good enough, there is no alternative other than for it to stay with the U.S. dollar for the foreseeable future.[195] However, I consider both of those scenarios to be a misreading of history. The 19th and 20th centuries were anomalies. The world is instead shifting toward a multipolar, neutral reserve currency system, rather than a system where one country issues far-and-away the most dominant world reserve currency. No country, whether the United States or China or anyone else, is big enough to issue a fiat currency that the whole world can use and would want to use. The only thing that can be big enough is a form of supranational money; one that has natural scarcity and is not issued by a government.

From the mid-19th century until the 1960s, global holdings of gold by central banks (sovereign gold reserves) structurally increased from next to nothing to approximately 38,000 tons. From there, central bank holdings of gold all around the world began to gradually shrink down to under 30,000 tons while central bank holdings of U.S. dollars grew continuously. However, ever since the 2008 global financial crisis, foreign central banks began consistently accumulating gold again, and are now back over 35,000 tons. Starting in the mid-2010s decade, foreign central banks stopped accumulating dollar-denominated reserves in aggregate. Around the margins, countries are increasing their yuan holdings, but from a small base. Rather than primarily accumulating dollars, the central banks of developing countries are diversifying into several currencies, and they are accumulating gold.

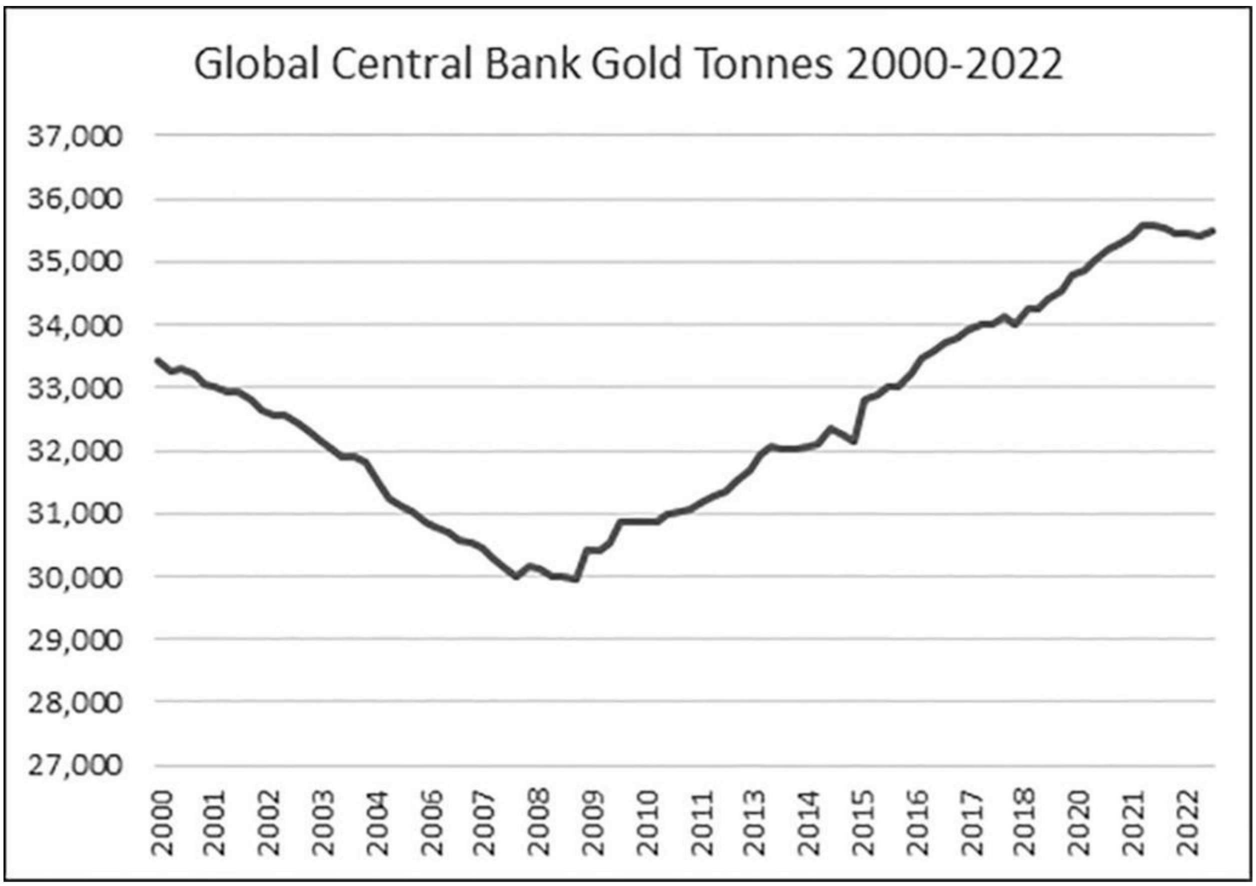

Figure 13-D[196]

This diversification becomes increasingly relevant in a world of conflict and war. The United States can sanction any country as long as that country primarily uses dollar-denominated payment rails or accumulates its reserves in dollar-denominated assets. Russia, partially anticipating this, focused for the past decade on accumulating gold reserves and reducing its dollar reserves. When

Russia invaded Ukraine in 2022, U.S. and European authorities froze Russian reserves (which by that point were mostly in euros; Russia didn't seem to anticipate that even their euro assets would be frozen). Russia then accelerated its goals to sell its oil, gas, and other commodities to China in Chinese yuan. Several other countries have been diversifying their payment and savings methods in a similar way.

Why would Saudi Arabia continue to indefinitely price its oil only in U.S. dollars, and aggressively accumulate U.S. Treasuries, when its largest trading partner now is China? And what if the United States one day decides to freeze Saudi Arabia's reserves? Why would China, as the world's largest exporter of manufactured goods, hold its reserves primarily in U.S. dollars? And why would India do this?

If a country holds most of its reserves in another country's fiat currency, then they are not fully sovereign since their savings can be frozen by that country. Physical banknotes can't be frozen, but holding large amounts of banknotes is mostly untenable since unlike securities, banknotes don't earn interest to offset some of the inflation. So, reserves are normally held as deposits or securities that pay interest, and thus are freezable by the controllers of that nation's ledger. Powerful countries all around the world are seeking to gradually diversify their reserves, use gold as reserves, and/or build alternative payment rails that don't rely on U.S. dollars or go through New York financial institutions. This allows them, as sovereign nations, to save on their terms and pay on their terms, in a global economic environment.

It remains to be seen what the next global financial system will look like, but it's clear that much like the 1860s, the 1940s, and the 1970s, the system is going through a period of structural change in the 2020s.

In recent years, a handful of major currencies such as the Chinese yuan have been able to buy oil and gas and other commodities as well. The dollar remains by far the most-commonly used currency for trade, but its share is slightly drifting lower. Countries have been gradually diversifying their reserve practices and payment systems. Figure 13-E shows a simplified example of a multipolar reserve currency system in the same format as the diagrams from Chapter 11.

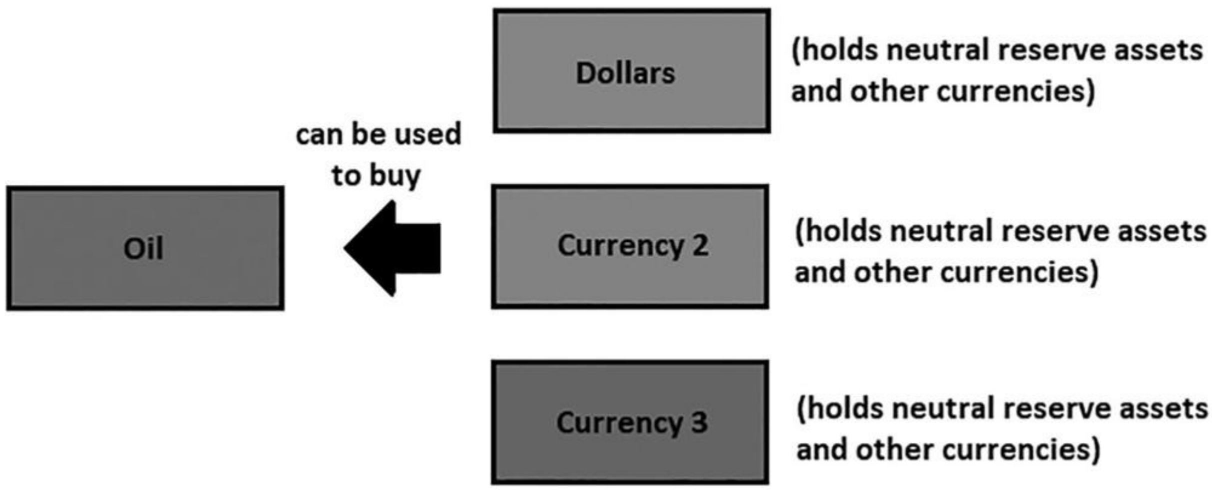

Figure 13-E

If international agreements create supranational currencies that participants hold in reserves (like the bancor concept to varying degrees), or if assets like gold or bitcoin are held in reserve and used as settlement assets to buy international goods, then the system would resemble Figure 13-F.

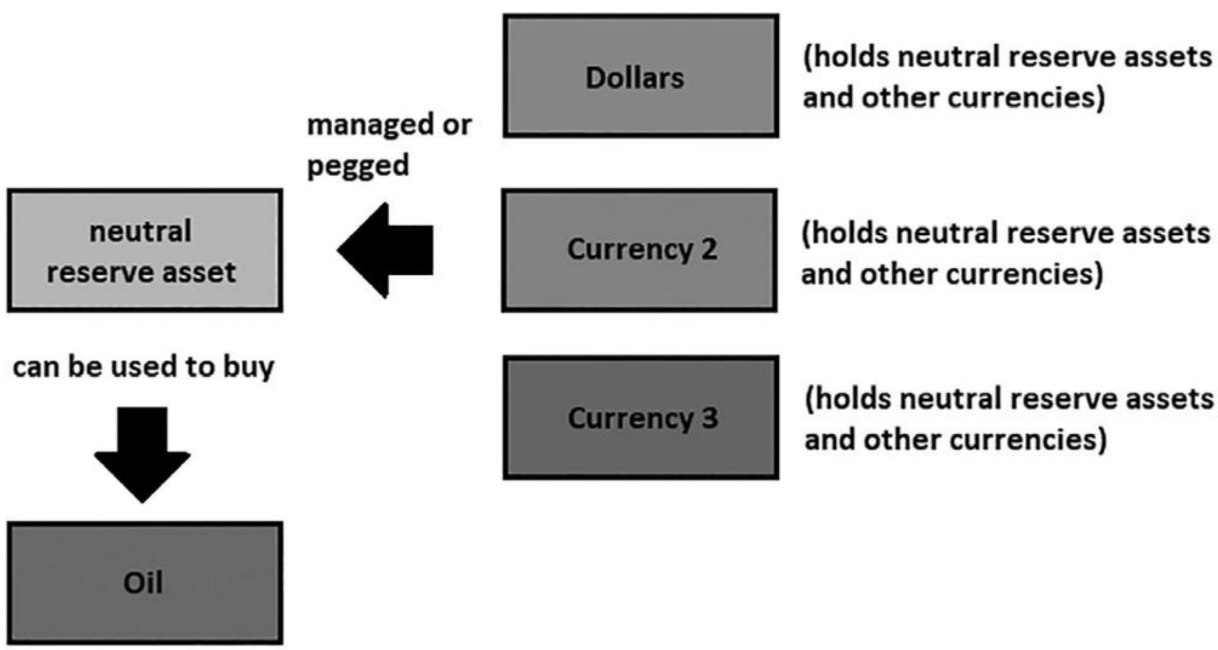

Figure 13-F

[181] Kris Hirst, “What Did Cicero Mean by the Sword of Damocles?”

[182] Brian Reinbold and Yi Wen, “Understanding the Roots of the U.S. Trade Deficit.”

[183] Yakov Feygin and Dominik Leusder, “The Class Politics of the Dollar System.”

[184] World Bank, “Net Trade in Goods and Services (BoP, current US$) – United States.”

[185] Federal Reserve Economic Data, “U.S. Net International Investment Position.”

[186] Federal Reserve Economic Data, “Industrial Production: Total Index.”

[187] Nathaniel Whittemore, “ENCORE: Luke Gromen.”

[188] Feygin and Leusder, “Class Politics.”

[189] Natalie Smolenski, “It is Time to Re-Found the American Republic,” *Bitcoin Magazine*: The Orange Party issue, November 2022.

[190] See for instance Paul Kennedy’s classic analysis, *The Rise and Fall of the Great Powers 1500–2000: Economic Change and Military Control from 1500–2000*.

[191] Frank Newport, “Seventy-Two Percent of Americans Support War Against Iraq,” Gallup News Service.

[192] Neta Crawford, “The U.S. Budgetary Costs of the Post-9/11 Wars.”

[193] Linda Bilmes, “The Credit Card Wars: Post-9/11 War Funding Policy in Historical Perspective.”

[194] John Joshua, *The Belt and Road Initiative and the Global Economy: Volume II – The Changing International Financial System and Implications*, ch. 2.

[195] Sandy Ward “‘Be Careful’ in Stock Markets, Ex-Treasury Sec Summers Warns,” *Morningstar*, April 27, 2023.

[196] World Gold Council, “Central Bank Holdings.”

PART FOUR

THE ENTROPY OF FIAT LEDGERS

"No structure, even an artificial one, enjoys the process of entropy. It is the ultimate fate of everything, and everything resists it."[197]
-Philip K. Dick

[197] Philip Dick, *Galactic Pot-Healer*, 101.

CHAPTER 14

THE MODERN FINANCIAL SYSTEM

This part of the book explores the nuts and bolts of the modern financial system. This includes how the system works, how money is created and destroyed, and how its design benefits and hurts certain types of users.

The following chapters together show that the financial system in its current form is designed in such a way that 1) the money supply continually inflates, 2) purchasing power is gradually siphoned away from savers and toward arbitrageurs who sit near the source of money creation, 3) the system rewards large and well-connected entities at the cost of small and poorly-connected entities, 4) liabilities gradually shift from the private sector to the public sector to keep the system from ever clearing out debt, and 5) this process suppresses volatility for a while until most of it comes out all at once.

But, before we get to all that, we need to start at the foundation and work our way up.

THE FEDERAL RESERVE SYSTEM 101

The financial system consists of a series of nested ledgers. In other words, it's a series of smaller ledgers built upon larger ledgers.

At the foundation of the system in the United States (and to some extent the rest of the world, due to the U.S. dollar's world reserve currency status) is the

Federal Reserve System, which serves as the central bank of the United States. The Federal Reserve System (commonly known as "the Federal Reserve" or "the Fed") is a hybrid public/private organization that was created by the U.S. Congress with the Federal Reserve Act of 1913 and modified several times in further legislation. The Federal Reserve controls the base ledger for the modern financial system.

From the private sector side, the Federal Reserve consists of twelve regional federal reserve banks. These regional federal reserve banks act as the "bankers' banks" for their regions, and they also put paper currency into circulation. The most important of these twelve regional federal reserve banks is the Federal Reserve Bank of New York, because it is as large as the other eleven combined, and it performs the Federal Reserve's open market operations. Private sector commercial banks hold stock in these regional federal reserve banks, get to elect most of the reserve banks' board of directors, and receive a dividend yield on their invested capital.[198]

From the public sector side, there is a seven-member Federal Reserve Board of Governors. These governors are appointed by the president of the United States, confirmed by the Senate, and hold 14-year terms. As an entity, this Board of Governors along with their extensive support staff collectively operates as a federal government agency based in the nation's capital, and they govern the Federal Reserve System. The most important governor is the Chair of the Board of Governors of the Federal Reserve System, who holds the highest rank in the Federal Reserve. After paying operating expenses and a dividend to member banks, all surplus profits of the Federal Reserve are sent to the U.S. Treasury Department.

The Federal Open Market Committee (FOMC) is the Federal Reserve's body of twelve individuals that meets eight times per year and sets the monetary policy for the nation and, by extension, affects vast portions of the global financial system as well. The seven members of the Board of Governors sit on the FOMC, the head of the Federal Reserve Bank of New York sits on the FOMC, and then the four remaining seats are filled by a rotating subset of the heads of the other eleven regional federal reserve banks. This is designed in such a way that the public sector representation has the majority (seven) of the seats on this committee, and the private sector representation has the minority (five) of the seats.[199]

A LAYERED STACK OF IOUS

The asset side of a typical private sector commercial bank primarily consists of loans, securities, and cash. A mortgage, for example, is a liability for a consumer and an asset for a bank. The bank owns this claim of future dollar payments from the consumer, and the consumer has a liability to pay those dollars to the bank. Other types of loans include business loans, personal loans, credit card loans, student loans, auto loans, margin loans, and so forth. For securities, banks often hold a significant amount of U.S. Treasury securities and other types of bonds. Most of a bank's cash, other than a tiny amount of vault cash that they keep on hand, is held with the Federal Reserve as bank reserves in digital form.

The liability side of a typical private sector bank primarily consists of consumer and business deposits. Individual people and businesses hold checking accounts, savings accounts, and certificates of deposits at banks. These represent assets for the consumers and businesses, while representing liabilities for the commercial bank. By holding cash at a bank, a depositor is giving that bank a low-interest rate loan.

To remain functional, a bank must have more assets than it has liabilities, must follow strict regulations set by the U.S. federal government and the U.S. Federal Reserve, and its assets should pay higher interest rates than its liabilities, which along with fees is where it generates its profit.

The Federal Reserve's combined balance sheet has both assets and liabilities, much like any normal bank. On the asset side, they own U.S. Treasury securities, mortgage-backed securities (ever since the 2008 subprime mortgage crisis), and a small percentage of other assets. On the liability side, all physical banknotes represent direct liabilities of the Federal Reserve, and cash reserves that commercial banks hold in their Federal Reserve accounts are also direct liabilities of the Federal Reserve.

Figure 14-A shows a simplified diagram of the U.S. financial system, representing a chain of assets and liabilities.

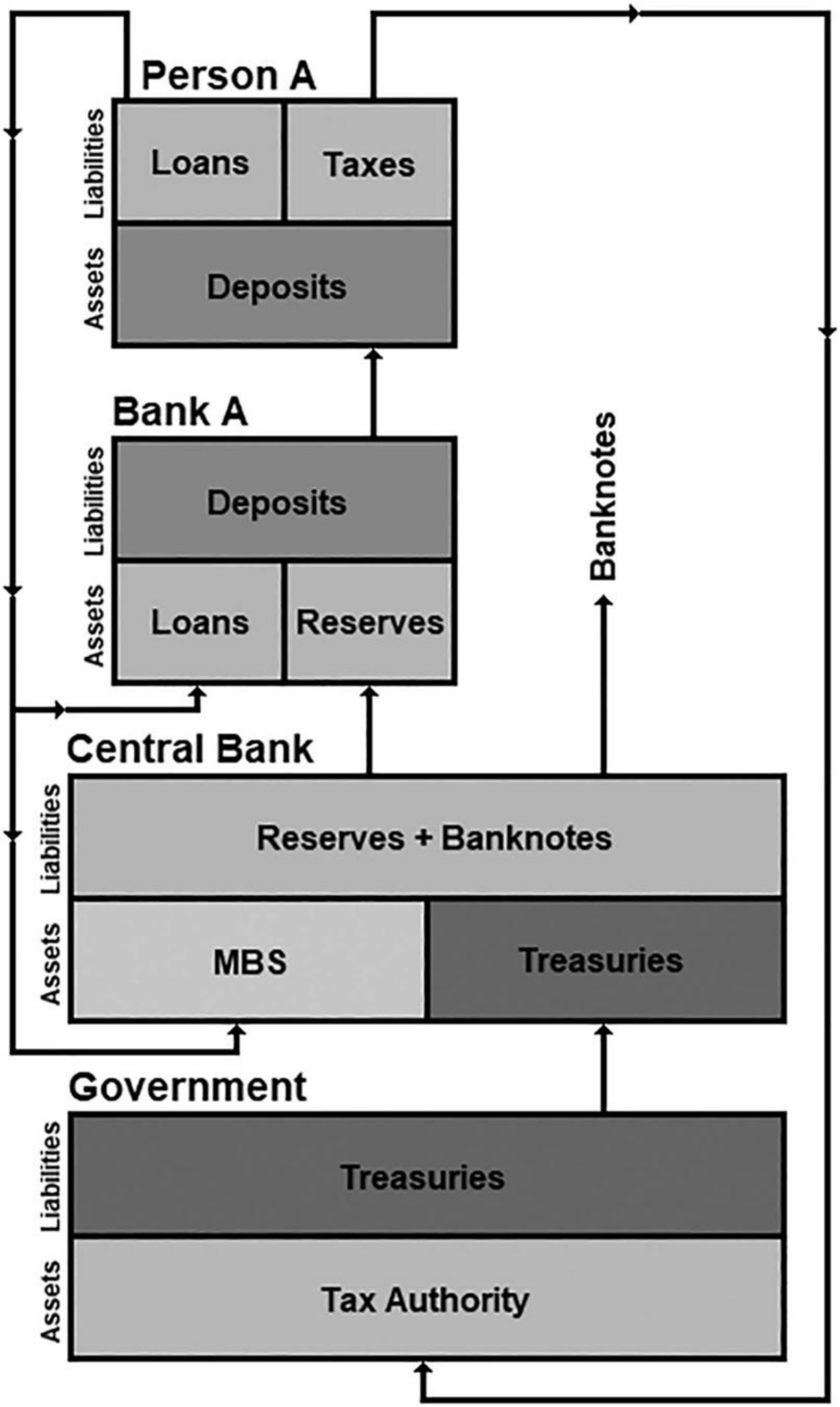
Person A
Liabilities
Loans
Taxes
Assets
Deposits
Bank A
Liabilities
Deposits
Assets
Loans
Reserves
Banknotes
Central Bank
Liabilities
Reserves + Banknotes
Assets
MBS
Treasuries
Government
Liabilities
Treasuries
Assets
Tax Authority

Figure 14-A

At this point, we can notice a potential problem: The whole thing is circular. The financial assets that underpin even the core of the system are themselves liabilities. It's liabilities all the way down.

There's an old joke about a woman claiming that the world rests on a giant turtle. When asked what the giant turtle stands on, she says another giant turtle. When asked what that second giant turtle stands on, she exasperatedly says, "it's turtles all the way down!" Variations of this story trace back to at least 1838, although back then it was rocks rather than turtles.[200]

If you have a bank account, that's an asset for you and a liability for your bank, and it just consists of an entry in that bank's ledger. That bank account is backed up by the bank's assets, which consist of various borrowers' liabilities to the bank. The bank, meanwhile, stores its excess cash reserves as an asset at the Federal Reserve, which again is just an entry on the Federal Reserve's ledger. These cash reserves, being a liability of the Federal Reserve, are backed up by the Federal Reserve's assets, which primarily consists of U.S. Treasury securities. These U.S. Treasury securities are liabilities of the U.S. federal government and are primarily backed up by the U.S. federal government's tax authority on citizens and businesses within its jurisdiction.

In some sense, the circularity of the financial system is almost poetic; it represents how dependent we all are on one another. However, it's also very fragile. Everything is a claim of a claim of a claim, reliant on perpetual motion and continual growth to not collapse. For such a collapse to happen in the United States seems almost unthinkable to many, but it happens in smaller countries around the world all the time and has happened to big countries in the past.

Importantly, as described in prior chapters, the system wasn't always circular like this. Up until 1913 (and to a certain degree all the way up until 1971) the whole financial system was built on gold and was instead a series of nested claims that ultimately represented the ability to redeem a certain amount of gold. Gold itself is an asset for the holder and a liability for nobody else; it represents the accumulated energy that was used to extract it from the earth and refine it into usable form, for which it has many applications. In that type of gold-backed system, everything is ultimately underpinned by an unencumbered asset, whereas in the current system, everything is ultimately underpinned by government bonds, which are themselves liabilities.

FEDWIRE

When people and businesses send money to each other from their bank accounts, their banks must communicate and settle those transfers behind the scenes. In other words, when you make a payment and it seems finished to you, the banks still have some back-end work to do.

One of the things that banks have historically done is batch many small transactions into a set of bigger transactions. If I give a merchant $45 using a credit card, and they buy $27 worth of supplies from another merchant, these little transactions get stored as short-term debt on the books of our financial institutions until they are settled into bigger settlement transactions.

Even various fintech companies that perform fiat currency payments and other services are connected to banking rails, rather than going around banking rails or otherwise competing with banking rails. Banks have accounts with the Federal Reserve, and various fintech companies have accounts at banks or become banks themselves, and so every customer is using banks and these settlement systems without necessarily realizing it.

Until the early 1900s, these large settlements between banks were often performed with the physical transfer of banknotes and gold, via armed transport. In the 1910s decade, the Federal Reserve began using a Morse code system to minimize the need for that type of physical transport. Banks, storing their reserves at the Federal Reserve as an entry on the Federal Reserve's ledger, could settle with each other using a secure telecommunication system, and the Federal Reserve would simply update the reserve ledger to acknowledge the fact that one of its member banks sent money to another one of its member banks.[201]

This settlement system operated by the Federal Reserve has continued to be updated over time and is now known as Fedwire. In 2022, Fedwire processed over $1.06 quadrillion ($1,060 trillion) worth of gross settlement volumes for thousands of individual U.S. commercial banks. This consisted of over 196 million settlements averaging $5.41 million each in size.[202] When people and businesses send small and medium-sized amounts of money to each other, many of those transactions are ultimately being batched together and settled between banks with these huge settlements.

In 2023, the Federal Reserve developed FedNow, which allows depositors at banks to send money to each other in real time. Banks still serve as middlemen for this operation, and the Federal Reserve moves bank reserves around in the background, but this new system skips over some of the transaction batching services that banks have historically been relied upon to do. As with most banking system updates, FedNow gives more granular surveillance capabilities to the Federal Reserve compared to what they currently have for Fedwire, since they will have more information on individual entity payments between institutions rather than just institutional-level batched settlements.

There is a major secondary settlement system in the United States known as the Clearing House Interbank Payment System or ("CHIPS") which is a private sector alternative. This system is owned by several banks and serves fewer than 50 large financial institutions out of the thousands that exist, but still processes hundreds of trillions of dollars' worth of volumes per year due to how large of a share of payments that those several dozen institutions account for.[203] Together, Fedwire and CHIPS perform most of the settlement volume in the United States. Virtually all transactions that we do as individuals and businesses on higher ledgers of the system get settled through those systems at or near the base layer of the system.

THE INTERNATIONAL CONNECTIONS

Other countries have similar setups for their financial systems. What they usually have in common is that they have a central bank that holds the domestic financial system's bank reserves and physical cash as its liabilities (the monetary base), which are underpinned by government debt and other assets. They also operate or facilitate a settlement system between banks. The oldest still-existing central bank is the Riksbank of Sweden, and the second oldest is the Bank of England.

What makes other countries different than the United States is that their central banks also usually tie into the U.S. Federal Reserve System as described in Part 3 of this book, since the U.S. dollar is the current world reserve currency. In addition to holding their own country's debt as part of its assets, a central bank outside of the United States typically holds U.S. Treasury securities as assets as well. They also usually hold some government bonds of other large countries.

Various entities throughout the world including banks, corporations, and governments, often have dollar-denominated debts. As of this writing, the Bank for International Settlements estimates that there is approximately $13 trillion in dollar-denominated debt held by non-U.S. entities.[204] However, it's important to note that most of this debt is not owed to U.S. entities. Instead, European entities, Japanese entities, Chinese entities, and various international entities often lend to other entities in dollars, even though neither the lender nor the borrower are based in the United States. This is especially the case when lenders in developed countries lend money to entities in developing countries.

For this reason, although the U.S. Federal Reserve primarily operates the centralized domestic ledger for the United States, it effectively operates the main ledger for the world. Nearly 90% of currency exchange volume in the world involves the dollar, nearly 60% of international currency reserves are dollar-denominated, and nearly 50% of global trade invoicing and cross-border loans are denominated in dollars.[205] All dollars are nested claims on banks that ultimately lead back to claims on the U.S. monetary base, which is the liability side of the Federal Reserve.

Many central banks still hold gold, although gold represents a smaller share of central bank assets than it did in the gold standard era. The global financial system is therefore now rather circular: Central banks hold fiat currency deposits and government bonds from other countries around the world as part of their assets, which are themselves liabilities of other central banks and governments. As a result, financial systems of countries around the world are all tied into this combined global structure, which is in significant part built around the U.S. Federal Reserve System.

Although much faster than the pre-telecommunication era, sending money internationally at scale today is often a slow, expensive, and opaque process by modern standards. Wire transfers often get delayed or cancelled, and it's hard to trace where the problem occurred. This is because such transfers often must hop between several correspondent banks, perform various currency conversions, and rely on trust between banks to varying degrees. The most common payments messaging system between banks is the SWIFT system, which was founded in 1973 and still operates similarly to how it did decades ago. Various fintech companies and money transfer businesses that run on top of banking rails can speed up payments for smaller users, but the average international fee for sending remittances is over 6%.[206]

[198] Board of Governors of the Federal Reserve System, “Who Owns the Federal Reserve?”

[199] Board of Governors of the Federal Reserve System, “Federal Market Open Committee.”

[200] Garson O’Toole, “Tortoises All the Way Down,” *Quote Investigator*, August 22, 2021.

[201] Frederick Schroeder, “Developments in Consumer Electronic Fund Transfers,” *Federal Reserve Bulletin* 69, 6 (June 1983).

[202] The Federal Reserve, “Fedwire Funds Service: Annual Statistics.”

[203] The Clearing House, “About CHIPS.”

[204] Bank For International Settlements, “BIS International Banking Statistics and Global Liquidity Indicators.”

[205] Bafundi Maronoti, “Revisiting the International Role of the Dollar,” *BIS Quarterly Review*, December 2022.

[206] World Bank, “Remittance Prices Worldwide Quarterly,” 7.

CHAPTER 15

HOW FIAT CURRENCY IS CREATED AND DESTROYED

While fiat currency has no significant cost to its production, there are specific rules and mechanisms that dictate how fiat currency is created and destroyed. For the most part, it is created whenever new debt is created, and is destroyed whenever debts are defaulted on or paid back. And to complicate matters, since the modern financial system uses fractional reserve banking, there are multiple definitions of money, with “base money” and “broad money” being the two most relevant definitions to understand.

The supplies of these two types of money have grown significantly over time. In 1913 when the Federal Reserve was created, there was $2.79 billion in base money and $19.31 billion in broad money.[207] At the end of 2022, there was $5.4 trillion ($5,400 billion) in base money and $21.4 trillion ($21,400 billion) in broad money.[208] This chapter walks through these two different types of money, and how each type of money is specifically created or destroyed. The focus is on the United States, but the same idea applies nearly everywhere else.

BASE MONEY

The monetary base or “base money” is the foundation of the fiat currency system and consists of the combination of 1) physical currency in circulation, and 2) cash reserves that the commercial banking system holds with the Federal

Reserve.

This monetary base is a direct liability of the Federal Reserve. When the system was originally created, this monetary base was redeemable for gold and backed up by a sizable fraction of gold, but since 1971 it hasn't been redeemable for or backed by anything. There is, however, a considerable amount of demand for U.S. dollars hardcoded into the financial system: It's the only currency that U.S. taxes can be paid with and it's the unit of account that everyone must use if they want to interact with the U.S. banking system. Additionally, the dollar has been relied upon for a high percentage of international cross-border trade for a long time, due to a strong network effect and lack of better options. In other words, for most of the past century, the U.S. Federal Reserve has operated the largest and most widely used ledger in the world.

Figure 15-A shows the amount of currency in circulation and the amount of reserves in the system. The combination of these two numbers represents the total monetary base since 1960.

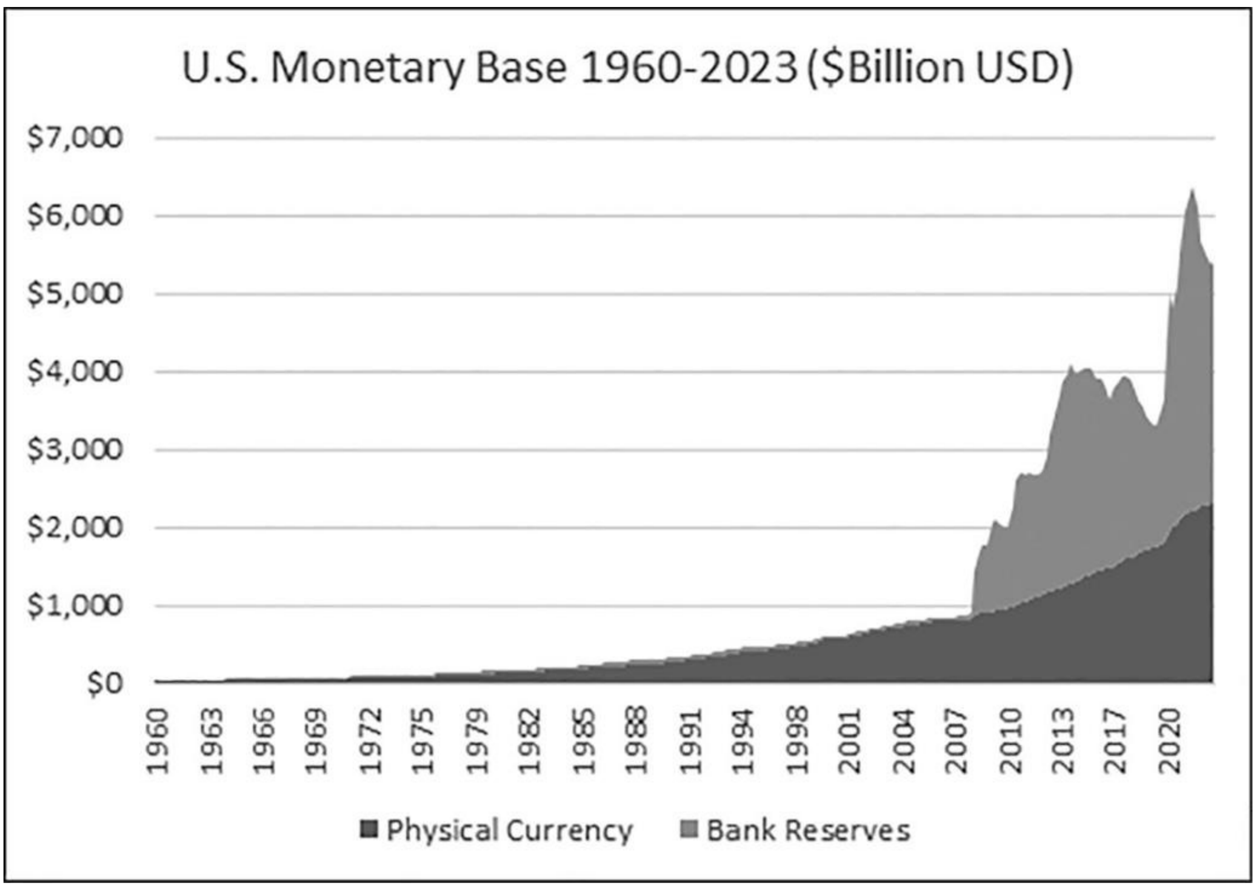

Figure 15-A[209]

As the chart shows, physical currency in circulation goes up in a rather smooth, exponential way. The amount of bank reserves used to go up at a similarly smooth rate until 2008 when it began to go up at a quicker pace due to the need for bank recapitalizations. A similar process of rapid recapitalization happened back in the 1930s as well. Some of these details will be discussed later in this chapter.

Bank reserves at the Federal Reserve are fungible (interchangeable) with each other. As people like you and I use various payment systems to transact with each other, our banks use reserves to settle with each other behind the scenes. Using Fedwire for example, banks that want to settle with each other can just tell the Federal Reserve to re-arrange the number of reserves they have listed for each bank on their ledger.

In principle, physical currency and bank reserves are also fungible with each other, and represent equivalent claims to the monetary base, subject to certain practical limitations. In theory, if we all wanted to go and take out some of our bank cash at once, it would come out of bank reserves. In practice, however, the amount of physical currency is limited at any given time and banks hold very little of it, so if there was a bank run for cash, depositors would quickly find themselves limited in how much cash they would physically be allowed (or able) to withdraw.

The U.S. Treasury Department creates coins and banknotes (via the Mint and the Bureau of Engraving and Printing, respectively), but the Federal Reserve is responsible for putting them into circulation. Each year, the Federal Reserve orders physical money from the U.S. Treasury based on how much it thinks the public will want in physical form, both to replace existing damaged money and to account for some fraction of dollars wanting to be withdrawn from banks in physical form.

In other words, the Federal Reserve determines the size of the monetary base, and what percentage of it exists in physical form for consumers.[210] As is described later in this chapter, the Federal Reserve has certain methods to create or destroy new bank reserves and thus increase or decrease the size of the monetary base.

BROAD MONEY

The broad money supply is far larger than the base money supply and represents money that the public holds. This broad money calculation consists of currency in circulation (which is also part of the base money calculation), but then also includes the massive amounts of checking deposits, savings deposits, and certifications of deposit that people and businesses hold at commercial banks (collectively referred to as “bank deposits”).

As shown by Figure 15-B, what makes bank deposits different than physical currency and bank reserves, is that rather than being a direct liability of the Federal Reserve, they are instead a liability of a specific commercial bank.

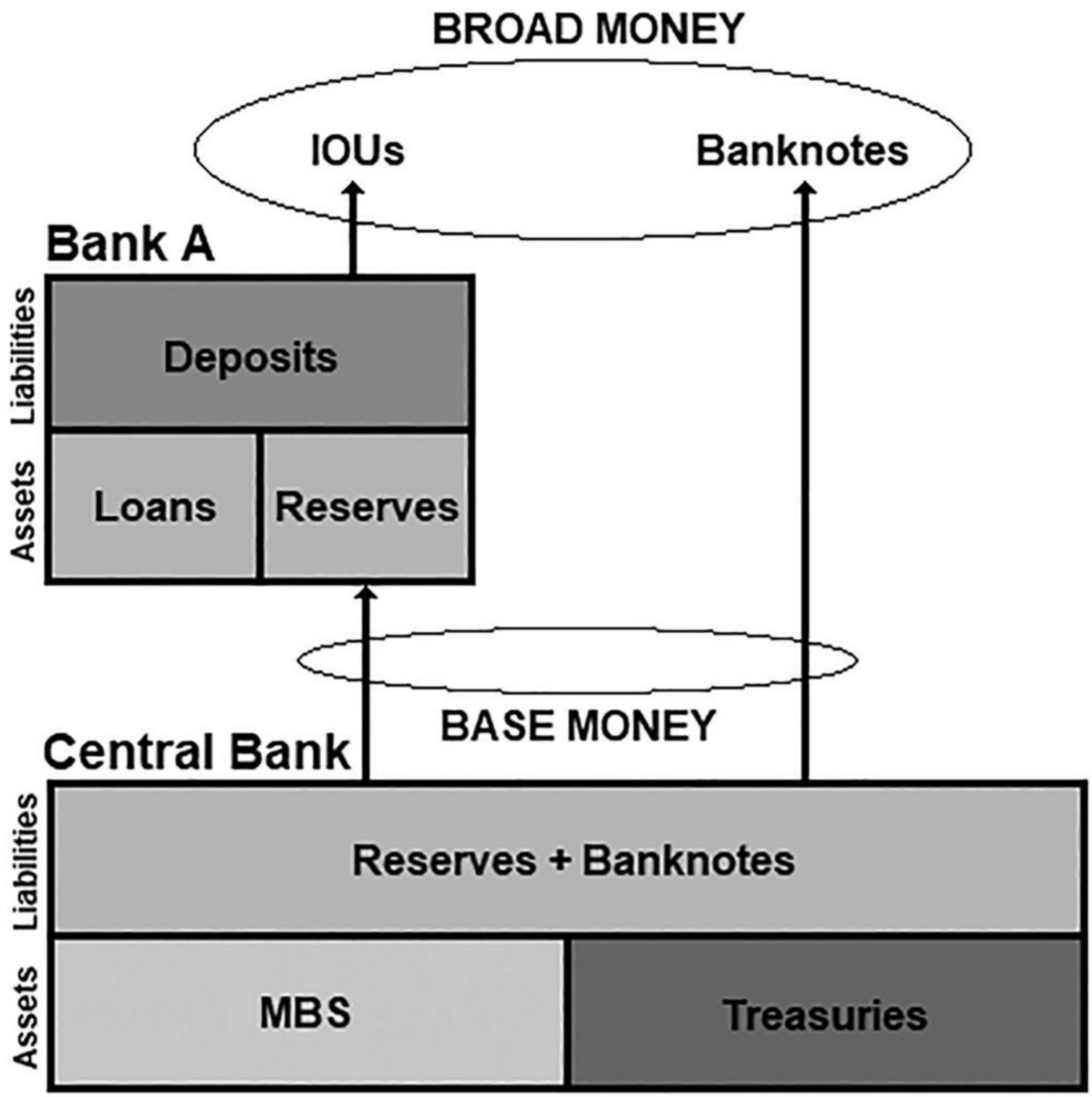

Figure 15-B

Figure 15-C shows the amount of broad money in the U.S. financial system since 1990.

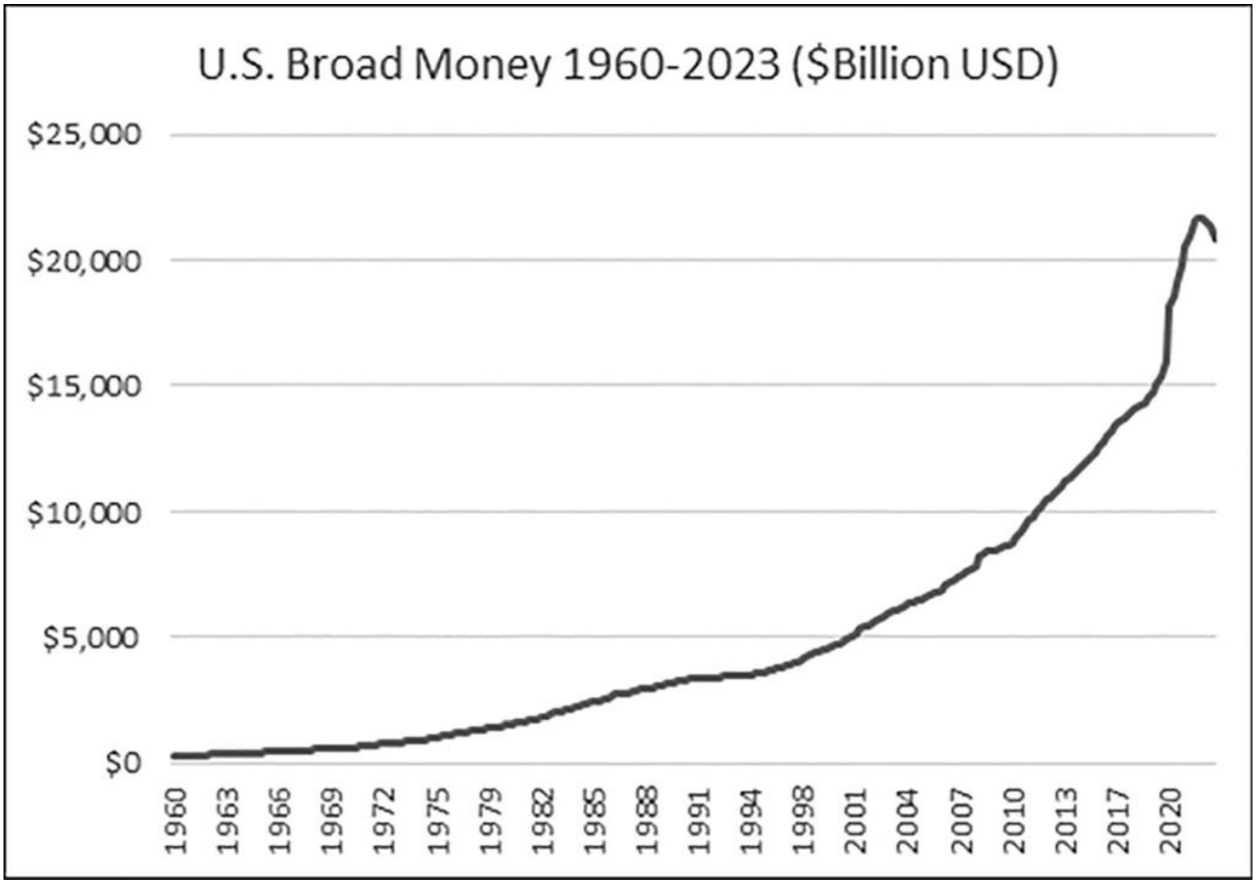

Figure 15-C[211]

Broad money represents the big set of money that people and businesses directly use to transact with each other, store our savings in, and define as our "money." We often think that a dollar is interchangeable with another dollar, but really when we go from interacting with physical dollars to bank account IOUs, we switch from owning a direct liability of the Federal Reserve to a fractional claim for a direct liability of the Federal Reserve.[212]

If a particular commercial bank goes bankrupt, then consumer and business deposits at that bank may be defaulted on; thus, broad money can be destroyed by a bank failure. This happened on a massive scale in the 1930s during the Great Depression, and so the Federal Deposit Insurance Corporation (FDIC) was set up in 1933 to try to prevent that from happening on a widespread scale again. The FDIC is a government agency insurance system that banks pay into which insures customer deposits up to $250,000 per account if a bank fails.

However, the FDIC is primarily meant to improve consumer confidence regarding the risk of individual bank failures and thus prevent bank runs, rather than to actually backstop a widespread multibank failure. The FDIC only has enough funds to cover a very small percentage of bank failures if a widespread financial crisis were to occur. In practice, such an emergency would likely result in a massive combined fiscal and monetary response by the Treasury and Federal Reserve to print new money and bail out the system to prevent a deflationary collapse and riots — with the bailouts during the 2008 and 2023 financial crises being recent examples. However, that's above the authority of the FDIC itself, and so without an act of Congress, most bank deposits are indeed at risk if there is a widespread failure of the highly leveraged commercial banking system.

For both base money and broad money, most countries currently work the same way as the United States. A country's central bank manages the base money of the system, and the commercial banking system operates the larger amount of broad money that represents an indirect and fractionally reserved claim to this base money.

THE RELATIONSHIP BETWEEN BROAD AND BASE MONEY

While the Federal Reserve determines the size of the U.S. monetary base, including what percentage of it may exist in the physical form of banknotes, changes in the amount of broad money in the system depend on forces outside of their direct control, such as government deficits and commercial bank lending practices. In other words, the Federal Reserve does not directly control the size of the broad money supply or the ratio of broad money to base money, even though they do control the amount of base money in the system. They can, however, influence the size of the broad money supply through their various monetary policy tools.

The purpose of modern commercial banks is to "multiply" base money into broad money and make a profit while doing so. We can call this the "money multiplier," which is defined as the broad money supply divided by the base money supply. Figure 15-D shows the money multiplier since 1870.

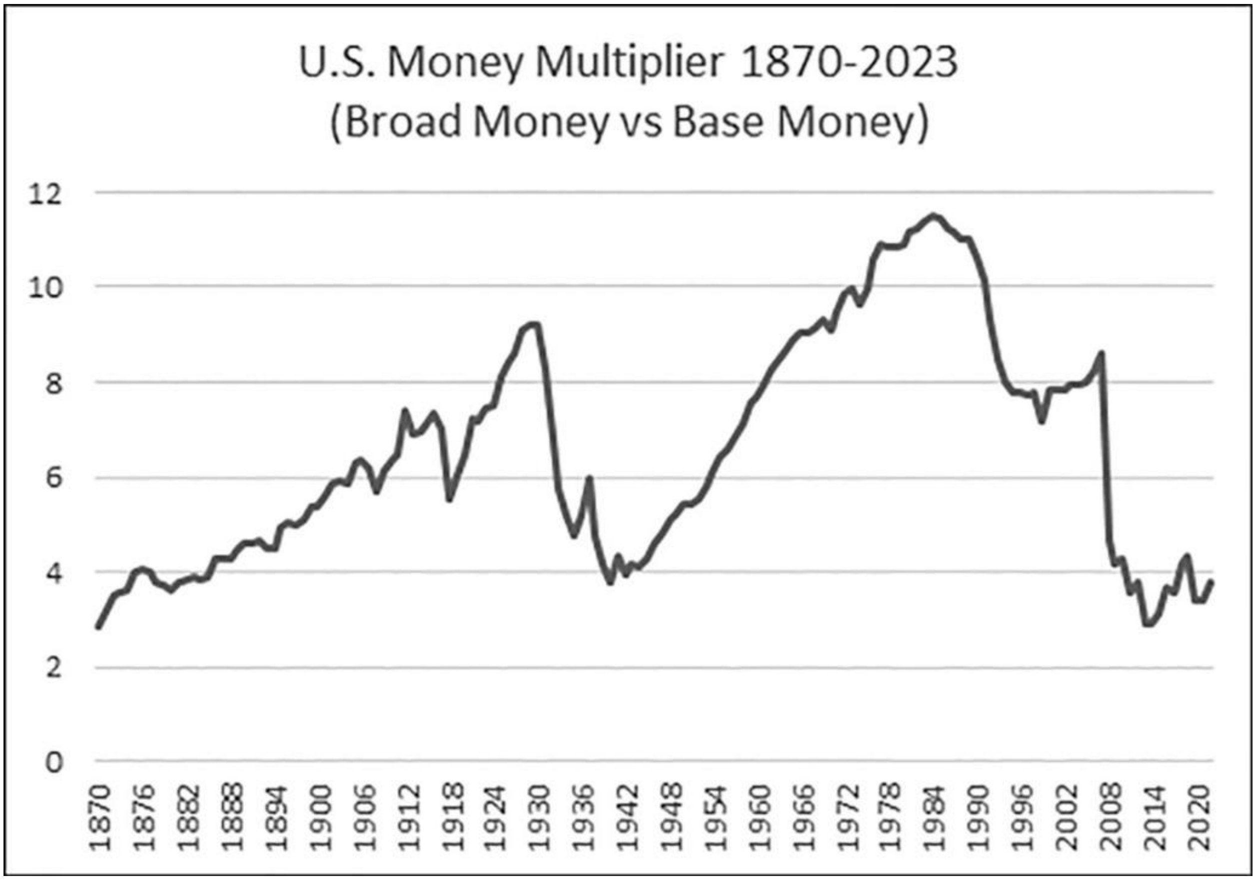

Figure 15-D[213]

When a bank makes a loan to someone to buy an asset with (such as a house), it becomes a new deposit in the bank account of the seller of that asset, and the lending bank sends the reserve amount to the seller's bank; the process increases the total amount of commercial bank deposits and broad money in the system. So, when they "loan reserves," banks collectively don't actually reduce total bank reserves in the banking system; they just lever those reserves up with a higher money multiplier and change the location and/or ownership of those reserves. To put it simply, lending creates deposits.[214]

Any individual bank can leverage itself by lending money or buying securities, and thus reducing its cash reserves at the Federal Reserve. However, when they make those loans or buy those securities, they create deposits somewhere else in the financial system, and those deposits result in reserves shifting from the lending bank to the bank that is receiving those deposits. Similarly, a bank could sell assets and increase its cash reserves, but in doing so, some other bank deposits elsewhere in the system would be drained to buy those assets, and reserves would shift toward the seller.

Therefore, the banking system can't decide to collectively increase or decrease the system-wide amount of bank reserves, even though any individual bank can alter its own level of reserves. Banks can collectively increase the money multiplier (the broad money supply divided by base money) by making more loans, but they can't change the total system-wide amount of bank reserves. They can just move bank reserves around, leverage them up, or deleverage them, by changing how many deposit IOUs they create on those reserves.

Similarly, the U.S. Treasury Department can determine the size of its cash account at the Federal Reserve, which for most purposes can be considered as a special subset of bank reserves. To increase the size of their cash account at the Federal Reserve, the U.S. Treasury can issue Treasury bonds, bring in a lot of cash, and then hold the cash in that account at the Federal Reserve for a while before spending it. This sucks other bank reserves out of the system, on a 1:1 basis with the Treasury cash account increase. When they eventually reduce the Treasury cash account by spending more than they take in, that money goes into peoples' and companies' bank accounts, and thus winds up back in other bank reserves through the settlement process.

The public can theoretically pull money out of excess bank reserves into physical currency, or deposit physical currency into banks which can become bank reserves. In practice, however, physical currency is limited on purpose, so if the public collectively tries to pull bank reserves out into physical currency, they get told by the bank teller that they can't — due to a nationwide shortage of physical currency or maximum (daily) withdrawal limits. The Federal Reserve each year decides how much more currency to put into circulation, and thus it has firm control on the ratio between currency in circulation and bank reserves, as the two parts of the total monetary base.

During very healthy banking environments with high monetary velocity and a lot of trust between banks, the banking system can function smoothly with a high money multiplier and relatively little reserves in the system. It's not inherently stable, but the unstable parts of the system are not coming to the forefront. This is because whenever a bank needs liquidity to meet customer deposit withdrawals, it can sell assets or borrow from other banks. It's like a game of musical chairs with the music playing loudly, and so it keeps working. However, when the system becomes overleveraged and/or when banks don't trust each other much anymore due to the possibility of insolvency, banks are more reluctant to lend to each other, and the music starts to slow or stop entirely. At that point, the high ratio of broad money to base money becomes a problem, and deposits risk being defaulted on unless the central bank creates more base money.

The Federal Reserve can create new base money by performing quantitative easing, or "QE" for short. To do this, the Federal Reserve creates new bank reserves out of thin air and buys existing assets, like Treasuries or mortgage-backed securities with those new reserves. It's an asset swap, but one side was created out of thin air during the swap. After creating the reserves and performing this asset swap with them, the new reserves become owned by a commercial bank (and thus become the Federal Reserve's liabilities), and the securities become owned by the Federal Reserve (and thus become the Federal Reserve's assets). In this process, the Federal Reserve increases their total assets (the securities they are buying) and increases their total liabilities (the new reserves they are creating) by the same amount. Their primary liabilities represent the monetary base of the country, which are now larger after this process is performed.

The Federal Reserve can also decrease the amount of existing base money by performing quantitative tightening, or "QT" for short. To do this, they sell Treasuries or mortgage-backed securities for reserves and therefore delete those reserves. More specifically, instead of directly selling them, they usually let some Treasuries or mortgage-back securities mature, which means their asset expires and pays back its principle, which turns into reserves, and then they delete those reserves rather than using them to reinvest back into similar assets. In this process of selling securities or letting securities mature without reinvestment, both the Federal Reserve's assets and liabilities decrease.

In a vacuum, neither QE nor QT alone necessarily affect the broad money supply significantly; they primarily affect the monetary base. However, if the U.S. federal government is running very large fiscal deficits and the Federal Reserve is creating new bank reserves to buy the Treasury bond issuance on the secondary market to fund those deficits, it directly creates new broad money (and thus goes around the bank lending channel) in addition to creating new base money.

On the other hand, if the U.S. federal government were to run big fiscal surpluses on a sustained basis (i.e., tax more than they spend), at a time when banks aren't lending much either, they can theoretically decrease the total amount of broad money. Historically this occurs only very rarely and briefly. Additionally, widespread bank collapses without any bailout or FDIC insurance can also theoretically reduce broad money, which happened in the early 1930s but has otherwise been avoided.

BANK RESERVE ACCOUNTING EXAMPLES

The rest of this chapter goes deeper into the details of base and broad money creation. I'll work through six examples of bank lending, QE, and fiscal deficits, to help show which types of actions by banks, the Federal Reserve, and the U.S. federal government can influence the amount and location of bank reserves and broad money supply in the financial system. (Feel free to skip to the end-of-chapter summary if these details are unimportant to you; this level of detail doesn't have to be understood for the rest of the book to make sense.)

I originally created these examples in November 2020 during the COVID-19 pandemic as part of an article called "Banks, QE, and Money-Printing"[215] to show why the fiscal stimulus and monetary stimulus at the time would likely be inflationary for consumer prices, and how it differed from the type of quantitative easing that occurred after the 2008 crisis. Many analysts at the time were brushing off the possibility for serious price inflation because they underestimated the importance of fiscal spending as a transmission mechanism, underestimated the difference in importance between broad money and base money, and therefore thought that this round of quantitative easing would be similar to what happened in 2008.[216] By the second half of 2021, we indeed experienced rather high levels of consumer price inflation, which eventually reached multi-decade high levels of consumer price inflation in 2022.[217]

For each example, I have two people, Mary and Sara, the two banks that they do business with, the Federal Reserve, and the U.S. Treasury Department. Each of these six entities has a column that represent each of their assets and liabilities "A | L."

Each example is a small, closed-loop financial system. Each block in an entity's asset or liability column represents $1,000 in value.

- "D" represents a $1,000 customer bank deposit.
- "R" represents a $1,000 cash reserve allocation that a bank has at the Federal Reserve.
- "T" represents a $1,000 U.S. Treasury bond: U.S. federal government debt.

- Other assets — like a $1,000 used car, “C,” or a $1,000 car loan, “L,” — are sometimes used as well.

A deposit block “D” is an asset for a consumer, and is simultaneously a liability for their commercial bank, since the bank holds it on behalf of the consumer and owes it to them on demand.

Similarly, a reserve block “R” is an asset for a commercial bank, and they keep it at the Federal Reserve. The Federal Reserve lists it as a liability, owed to the bank who deposited it with them.

Likewise, a Treasury bond “T” is an asset for whoever holds it, whether a consumer, or a commercial bank, or the Federal Reserve, and is a liability of the U.S. Treasury.

A bank loan block “L” or mortgage block “M” is an asset for the bank that lent it and is a liability for the consumer who borrowed it from their bank.

EXAMPLE 1: A BANK LOANS MONEY

This is the simplest example to show how banks create deposits and broad money without reducing the number of reserves in the system. It involves Mary buying a used car from Sara with a loan that Mary takes out from her bank.

Figure 15-E shows this exchange, with a beginning, intermediate, and ending state, and a description afterward, so you can go back and forth between the visual and the description. The underlined letters represent ones that recently changed:

Bank Loan- Beginning State

Mary A	Mary L	Mary's Bank A	Mary's Bank L	Sara A	Sara L	Sara's Bank A	Sara's Bank L	Federal Reserve A	Federal Reserve L	U.S. Treasury A	U.S. Treasury L
D		R	D	D		R	D	T	R		T
		R		D		T	D	T	R		T
				D		T	D	T	R		T
				C		T					T
											T
											T

System Deposits = 4D = $4,000
System Reserves = 3R = $3,000

Bank Loan- Intermediate State

Mary A	Mary L	Mary's Bank A	Mary's Bank L	Sara A	Sara L	Sara's Bank A	Sara's Bank L	Federal Reserve A	Federal Reserve L	U.S. Treasury A	U.S. Treasury L
D	L	R	D	D		R	D	T	R		T
D		R	D	D		T	D	T	R		T
		L		D		T	D	T	R		T
				C		T					T
											T
											T

System Deposits = 5D = $5,000
System Reserves = 3R = $3,000

Bank Loan- Ending State

Mary A	Mary L	Mary's Bank A	Mary's Bank L	Sara A	Sara L	Sara's Bank A	Sara's Bank L	Federal Reserve A	Federal Reserve L	U.S. Treasury A	U.S. Treasury L
D	L	R	D	D		R	D	T	R		T
C		L		D		R	D	T	R		T
				D		T	D	T	R		T
				D		T	D				T
						T					T
											T

System Deposits = 5D = $5,000
System Reserves = 3R = $3,000

Figure 15-E

Beginning State

Mary begins with "D" in assets, meaning a $1,000 deposit in her bank, and no liabilities. Her bank (which is very unlevered) starts with her deposit "D" as a $1,000 liability, and then has two reserve block assets "R," collectively representing $2,000 held at the Fed.

Sara begins with "DDDC" in assets, meaning $3,000 in bank deposits at her bank "DDD," and a $1,000 used car "C," and no liabilities. Her bank starts with her deposit "DDD" as liabilities, and has its assets primarily invested in Treasuries "TTT" and one reserve block at the Federal Reserve "R."

The Federal Reserve holds the three blocks of reserves from the two banks as its liabilities and has three blocks of Treasuries as its assets. The banks use the Federal Reserve as their bank, in a similar way that Mary and Sara use their banks. In other words, the two banks store their cash reserve assets in their accounts at the Federal Reserve, which are the Federal Reserve's liabilities.

The U.S. Treasury Department, representing the financial arm of the overall U.S. federal government, has six blocks of Treasuries outstanding as its liabilities. For the sake of simplicity, it doesn't have any assets listed, but in reality, its assets would consist of working capital, various federal buildings and lands and military assets, and primarily its ability to tax citizens. In this example, its six Treasury liabilities are owned by the Federal Reserve and Sara's bank.

Between Mary and Sara's cash, there are four deposit "D" blocks in the total system, which are assets for them and liabilities for their banks. Likewise, there are three reserve "R" blocks in the system, which are assets for their banks and liabilities for the Federal Reserve.

Intermediate State

Now, for the intermediate state, Mary and Sara enter negotiations, and Sara agrees to sell her car to Mary for $1,000. Mary, however, only has $1,000 in deposits, and although she needs the car, she doesn't want to be completely cashless. So, she goes to her bank and takes out a $1,000 car loan "L." Mary's bank creates a $1,000 deposit "D" for Mary and creates a $1,000 loan liability "L" for her as well. For the bank itself, Mary's new deposit asset is its new liability, and Mary's new loan liability is its new asset. No reserves moved, but a new deposit was created.

Mary’s net worth is unchanged at $1,000 in total, but she now has $2,000 in deposits and $1,000 in loan liabilities, and thus is a bit more leveraged. Mary’s bank’s equity is unchanged as well, but it also leveraged itself up a bit, by creating a new asset and a new liability, since it expects that Mary will be able to pay the loan back with interest.

Neither the Federal Reserve nor the U.S. Treasury are involved yet.

There are now five deposit “D” blocks in the system rather than four, because Mary’s bank is more levered with an additional asset and liability. It created new broad money by lending a new deposit into existence. However, there are still three reserve “R” blocks in the system.

Ending State

For the ending state, Mary wires Sara $1,000 for the car, and therefore gives her the new deposit “D” that she just received from her bank loan. Sara receives the wire in her bank account, and her bank credits this by giving her an extra $1,000 deposit asset “D,” which becomes a new liability for her bank. Behind the scenes, Mary’s bank sends a $1,000 reserve block “R” to Sara’s bank to honor the wire (by instructing the Federal Reserve, as the central ledger, to move the R from Mary’s bank reserve account to Sara’s bank reserve account). So, Sara’s bank now has a new liability “D” in the form of Sara’s new deposit, but also has a new reserve block “R” as its new asset. Sara’s bank doesn’t have any creditworthy clients asking for loans currently, so it keeps its new reserve block at its Federal Reserve account for now.

The Federal Reserve’s ending state is unchanged on net, except that it updated its bookkeeping for its two client banks when Mary’s bank sent Sara’s bank a $1,000 reserve block “R.” The Federal Reserve used to attribute “RR” to Mary’s bank and “R” to Sara’s bank on its ledger, but now it attributes “R” to Mary’s bank and “RR” to Sara’s bank. These reserve blocks are liabilities for the Federal Reserve and assets for its client banks.

The U.S. Treasury’s ending state is also unchanged, and unlike the Federal Reserve, it wasn’t even aware of the transaction at all.

In the final ending state, just like the intermediate state, there are still three reserve blocks “R” in the system, and there are five deposit blocks “D,” which is one extra deposit block compared to the beginning state, created by Mary's bank loan.

The point of this example is to show how, when a bank uses its reserves to lend money, the reserves aren't destroyed. The money shows up in another bank, and the reserve amount is sent there. The overall number of reserves or base money in the system is unchanged, but the system becomes slightly more levered, and has more consumer deposits and therefore more broad money. In other words, the money multiplier ratio (D-to-R, broad money to base money) increased from 4-to-3 to 5-to-3.

Any bank can increase or decrease its own number of reserves by buying or selling assets or making loans. However, those reserves get moved around to or from other banks rather than created or destroyed. Banks can, however, create or reduce the number of deposits leveraged on those reserves, depending on how much risk it wants to take and how many creditworthy opportunities it sees to lend money for.

EXAMPLE 2: THE FEDERAL RESERVE PERFORMS QE FROM BANKS

This next example is a bit more realistic, with a more levered banking system. It involves the Federal Reserve performing quantitative easing on the banking system, meaning it creates new reserves to buy existing assets from the banks. The reason it might do this is because there are too many claims for base money relative to base money, and in general banks are stuffed full of illiquid assets like mortgage loans, and so the Federal Reserve wants to pull some of those illiquid assets onto its own balance sheet and create new liquid assets (an increase in reserves) for the banking system.

Figure 15-F shows the beginning and end state, and excludes the intermediate state:

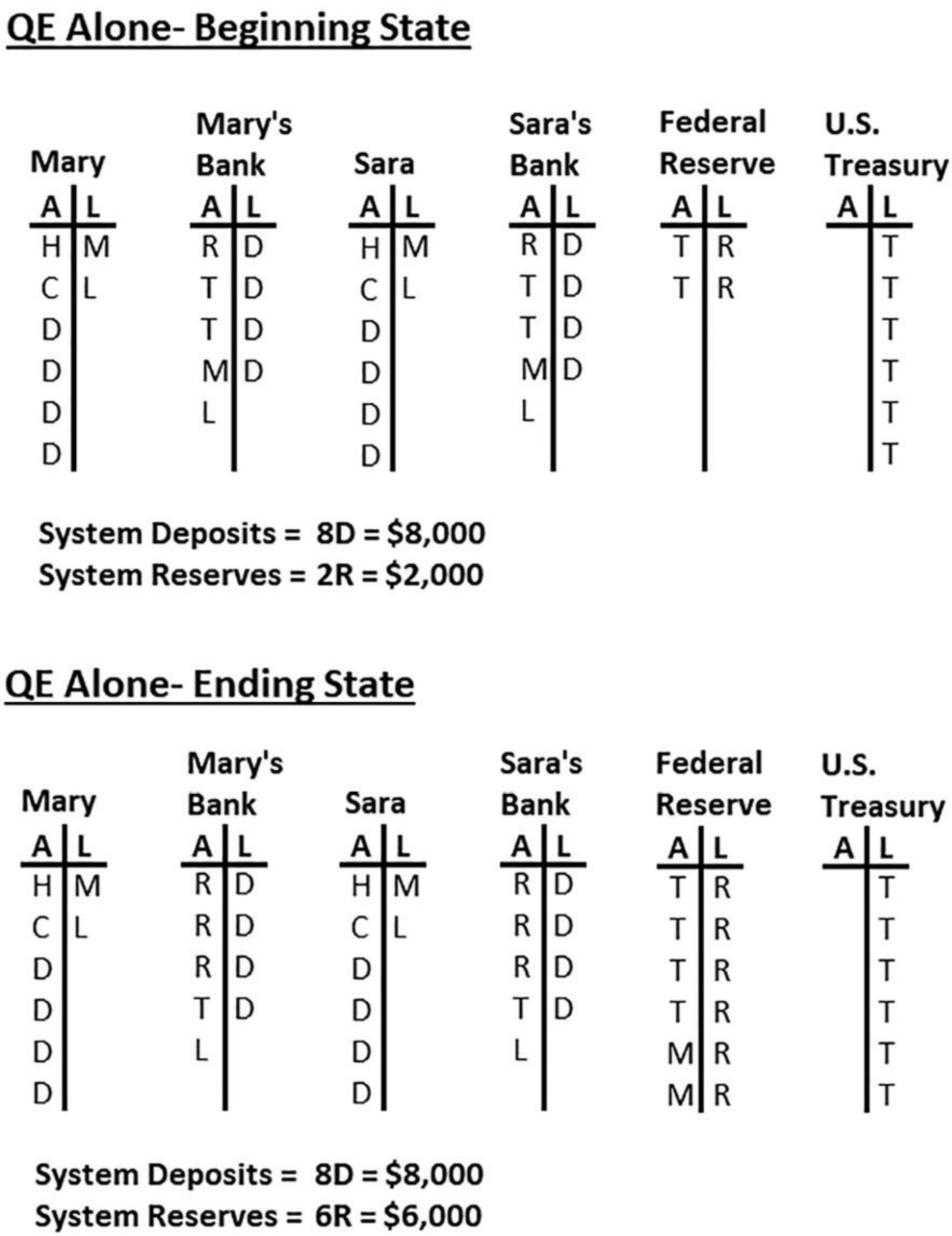

Figure 15-F

Beginning State

Sara and Mary are identical to each other in this example. For assets, they each have a house, “H,” a car, “C,” and $4,000 in cash deposits, “DDDD,” at their banks. For liabilities, they also have a car loan, “L,” and a mortgage loan, “M,” owed to their respective banks.

The banks are identical to each other in this example. They each have their $4,000 customer deposits “DDDD” as liabilities owed to Mary and Sara respectively. For assets, they each have “RTTML,” meaning one reserve block, two Treasury blocks, one mortgage loan block, and one car loan block. The banks are rather highly levered, with lots of assets and liabilities relative to their sole reserve block.

The Federal Reserve is small, with just “RR” in liabilities for their member bank reserve accounts, one for each, and “TT” in assets.

The U.S. Treasury has “TTTTTT” in liabilities, which are owned by the banks and the Federal Reserve.

There are eight deposit blocks “D” in the system, and two reserve blocks “R.” So, the system money multiplier is levered 8-to-2.

Ending State

In this example, the Federal Reserve realizes that both Mary’s bank and Sara’s bank have just one reserve block each. Assuming the banks are each required by regulations to have at least one reserve block, this means they can’t really lend any more, and can’t create more broad money. Even without liquidity requirements, the banks might simply not feel comfortable that they’ll be able to meet liquidity needs (deposit withdraws) without having some reasonable percentage of reserves to deposits. The Federal Reserve wants banks to be able to lend. So, the Federal Reserve decides to recapitalize the banking system by giving them plenty of excess reserve blocks. Unlike the fiscal authority (Congress and the President), the Federal Reserve can’t, however, legally just give free money to banks; it must take something in return.

The Federal Reserve creates four new reserve blocks out of thin air and gives two to Mary’s bank and two to Sara’s bank. These new reserve blocks become liabilities of the Federal Reserve and become assets for the banks. In return, the Federal Reserve takes one mortgage block and one Treasury block from each bank. The Federal Reserve therefore adds “TTMM” to its assets and “RRRR” to its liabilities.

The banks are now more comfortable, with plenty of excess reserves as assets, and fewer Treasuries and mortgages. The asset side of their balance sheets is more liquid now since reserves are more liquid than Treasuries and mortgages. If they want to loan money or buy more securities, they now have plenty of excess reserves with which to do so without getting too low on liquidity. However, they haven't lent any more money yet, so the number of deposits or broad money in the system remains unchanged. Underneath the surface, the banks are just less leveraged and more liquid, with plenty of reserves relative to deposit liabilities and overall assets.

Mary and Sara didn't notice anything from beginning to end in this example. They have the same assets and liabilities that they started with. They weren't even aware that this happened.

The Federal Reserve is more leveraged now, with more assets and liabilities than it started with, but the same amount of equity.

The U.S. Treasury didn't change on net, except that it now attributes ownership of two of its Treasury bond liabilities to the Federal Reserve instead of to the private banks, since the Federal Reserve bought a Treasury "T" from each of the two banks.

There are still eight deposit blocks "D" in the system, but the number of reserve blocks "R" increased from two to six. So, the money multiplier in the system is now 8-to-6. The amount of broad money hasn't changed, but the amount of base money grew, due to the Federal Reserve's decision to buy bank assets with new reserves. The banking system has been recapitalized and has a lot more lending power now.

This is why, although many people think quantitative easing by itself is inflationary on consumer prices, it generally isn't. The money isn't getting out to consumers like Mary and Sara yet; it's just internal to the banking system. This quantitative easing process sets the long-term stage for inflation as an early foundation by increasing the monetary base and overall bank liquidity, and therefore it's being "anti-deflationary" by preventing a bank collapse and ensuring they have plenty of liquidity and lending capacity — but it's not yet inflationary.

Inflation would likely come if Mary and Sara have a lot more deposit money chasing the same amount of goods and services. However, neither Mary nor Sara has more deposit money than they started with, so there's no reason for anything to be inflationary. The amount of consumer deposits in the system hasn't changed.

EXAMPLE 3: THE FEDERAL RESERVE PERFORMS QE FROM NONBANKS

This third example starts with a simpler system again, very similar to Example 1. However, instead of having a car as an extra asset that she had in the first example, Sara has a Treasury bond.

Sara decides to sell her Treasury bond, but there aren't many buyers for it at the moment. So, the Federal Reserve steps in and performs QE to buy it from her. The result ends up slightly different compared to the Federal Reserve buying a Treasury bond from the banking system. This is depicted in Figure 15-G.

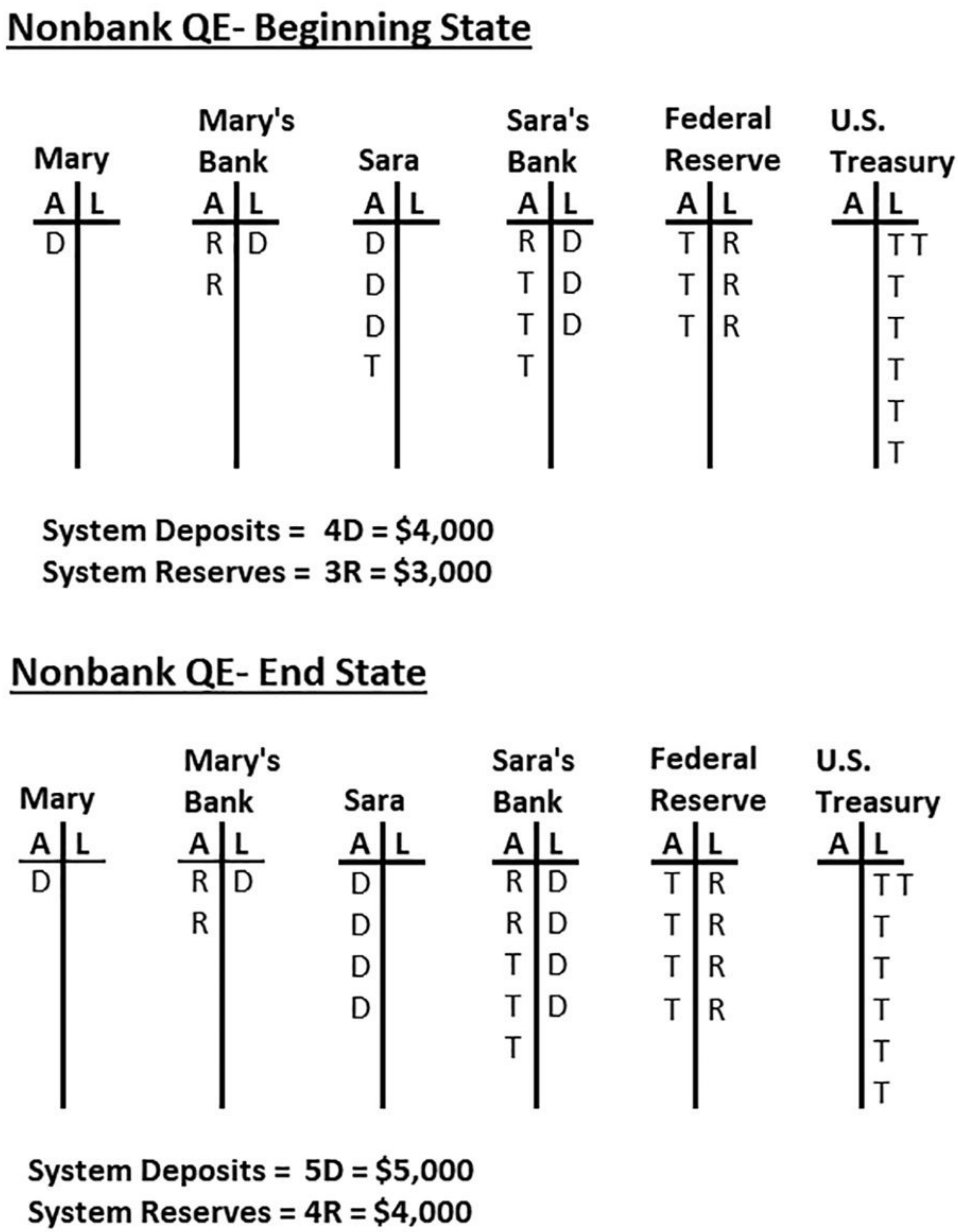

Figure 15-G

Beginning State

Everything begins similarly to Example 1, except Sara has a Treasury bond instead of a car. There are four “D” deposits in the total system, and three “R” reserves to start.

Sara decides to sell her Treasury bond, but neither Mary nor either bank particularly want to buy it. If a lot of people sell Treasuries at once, it can cause a liquidity crisis, which is what happened for example in the United States in March 2020 and in the United Kingdom in September 2022.

So, the Federal Reserve decides to buy it and prevent a liquidity crisis. The Federal Reserve creates a new bank reserve “R” out of thin air: It tells the bank to buy Sara’s Treasury bond “T” with a new deposit “D,” and then to give the Treasury bond to the Federal Reserve, and the Federal Reserve hands the bank the new bank reserve “R” in the process.

The Federal Reserve, therefore, bought Sara’s Treasury bond with a brand-new reserve block, using the bank as the intermediary (so Sara and the Federal Reserve never talked to each other; Sara sold the Treasury bond to her bank for a deposit block “D,” and her bank sold that Treasury bond to the Federal Reserve, who bought it with a new reserve block “R”).

Ending State

After the bank completes this task, Sara has the same net worth as she started the example with but replaced her Treasury “T” with an extra deposit “D.” Her bank also has the same equity as it started the example with but grew a bit bigger in terms of both assets and liabilities, with an extra reserve block asset “R” and an extra deposit block “D” as liability to Sara. Its equity is unchanged.

The Federal Reserve grew a bit bigger as well, with an additional Treasury asset “T” and an additional reserve liability “R,” which it lists as an asset for Sara’s bank. Its equity is unchanged.

The U.S. Treasury didn’t change on net, except that it now recognizes Sara’s initial Treasury “T” as owned by the Federal Reserve instead of Sara, since the Federal Reserve bought it.

Whether this is stimulatory for the economy or not depends on what Sara wants to do with her extra cash. She had “DDDT” and now she has “DDDD” as her assets. It’s still worth $4,000 but it’s a bit more liquid now. If the reason for her selling the Treasury was to raise more cash to do something big, like start a business or lend money to her friend to start a business, then it might be stimulative. The Federal Reserve helped keep the Treasury market liquid, which allowed her to sell it despite a lack of real buyers. However, if she merely holds the money in an extra "D" deposit rather than the Treasury "T," then she's not using the money any differently. It then becomes a question of what her bank does.

Sara's bank now has an extra reserve asset block and an extra deposit block liability compared to the beginning state, meaning it's a bit bigger and has more lending power relative to its liquidity. It could finance a corporate loan, or a consumer loan, which could stimulate the economy. Or, if it thinks the economy is too risky, or if none of its creditworthy corporate or consumer clients are asking for a loan, it might just sit on its safe "RRTTT" assets and do nothing. In that case, this example wouldn't affect the economy much.

There are now five "D" deposits in the system compared to the beginning state that only had four. In addition, there are four "R" reserve blocks in the system compared to the beginning state that only had three.

So, there's more liquidity in the system, with an increase in both base money and broad money. However, none of that broad money moved yet, and is just sitting there with Sara and her bank. Broad money velocity is low, in other words. There is more inflationary potential in the system, due to there being more broad money and reserves, but no consumer price inflation yet. Sara isn't any richer; just slightly more liquid.

In this example, the Federal Reserve directly increased the amount of broad money in the system without banks doing any private lending, and without the federal government doing any spending, but it remains unclear if it will be impactful or not (subject to what Sara and/or her bank do with their extra liquidity). And even if it was impactful, the Federal Reserve wouldn't be able to repeat it a second time, because neither Mary nor Sara (the two private, nonbank entities) have any more Treasury bonds to sell to the Federal Reserve.

If anything, it's likely to be somewhat inflationary on asset prices, because Sara is flush with cash, and perhaps more willing to buy stocks, or buy more Treasuries, etc. She's a saver and this might not make her spend more, but it might shift how she invests with her extra liquidity.

EXAMPLE 4: NONBANK-FINANCED HELICOPTER MONEY

The first three examples were separate cases, each meant to illustrate a different scenario.

These final three examples (Examples 4, 5, and 6) will build on each other to show what happens when the U.S. Treasury gets involved with deficit spending, with differences depending on who finances that spending by buying the Treasury debt.

Example 4 begins with a relatively unlevered system. However, the economy is in a recession, and Mary just lost her job and only has a little bit of money in her bank account. She is making her frustration known to her elected officials, so Congress authorizes the U.S. Treasury to send everyone $1,000 in stimulus checks, right to their bank accounts. This is known in economics as “helicopter money,” which originally referred to a thought experiment of dropping new money out of helicopters on consumers.[218] The Treasury finances this by issuing Treasury bonds, which Sara (who has plenty of money and hasn’t lost her job) buys. This is depicted in Figure 15-H.

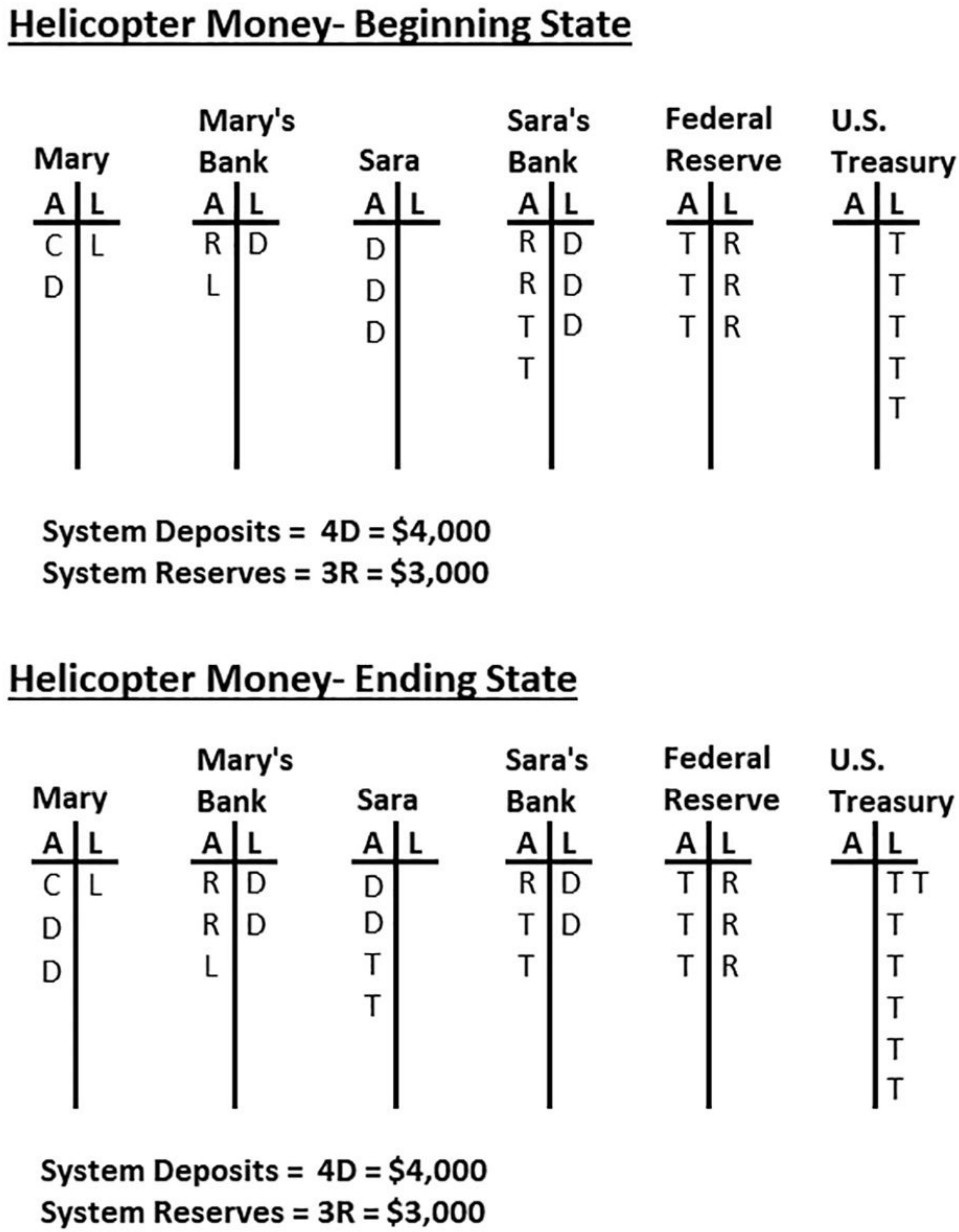

Figure 15-H

Beginning State

Mary has a car “C” and a deposit “D” as assets, and a car loan “L” as a liability. Mary’s bank has a reserve block “R” and Mary’s car loan “L” as assets and has Mary’s deposit “D” as its liability.

Sara has three blocks of deposits “DDD” as her assets, and no liabilities. Sara’s bank has a blend of excess reserves and some Treasuries as assets “RRTT” and has Sara’s three deposit blocks “DDD” as its liabilities.

The Federal Reserve has the banks’ three total system reserve blocks as its liabilities and holds three Treasuries as its assets.

The U.S. Treasury has five Treasury bonds outstanding as liabilities, which are owned by the Federal Reserve and Sara’s bank.

Total system deposits are 4D = $4,000, and total system reserves are 3R = $3,000.

Intermediate State (not shown)

Although it is the originator of currency, the U.S. federal government in most cases legally has to finance its spending by receiving taxes or issuing Treasury debt to settle its account.[219]

So, the U.S. Treasury sends a $1,000 deposit “D” block each to both Mary and Sara, deposited in their bank accounts. Both Mary and Sara are happy, because their net worth goes up by $1,000 each. Their banks get money deposited into them, and haven’t loaned any out yet, so they just keep this new cash at their Federal Reserve account as new reserves.

However, this is just a brief intermediate state. The Treasury now issues new Treasury bond liabilities “TT” to pay for the expenditures it just made. Sara then decides to use two of her deposit blocks “DD” to buy those two Treasury securities “TT,” since they are yielding slightly higher rates than her bank deposit account yields.

If we imagine it happening simultaneously, what happened is that the U.S. Treasury extracted two deposit blocks from Sara (and therefore extracted two reserve blocks from Sara’s bank, as Sara’s bank settled the transfer with the U.S. Treasury), and the U.S. Treasury gave Sara two Treasury bond blocks as assets in return. At the same time, the U.S. Treasury gave both Mary and Sara one deposit block each, and therefore gave one reserve block to Mary’s bank, and one reserve block to Sara’s bank, to settle the transfers.

Ending State

By the end of the transfers, both Mary and Sara are $1,000 richer than when they started. Mary’s assets simply went from “CD” to “CDD” as she gained a deposit block. Sara’s assets went from “DDD” to “DDTT” because she gained a deposit block but used two deposit blocks to buy two Treasury bonds.

Mary’s bank is slightly bigger than when it began this example, because Mary received a deposit block “D” and her bank was credited with a reserve block “R” to settle it (but also owes an extra liability “D” owed to Mary), and Mary hasn’t spent it yet. So, Mary’s bank has the same equity (both its assets and liabilities increased by the same amount), but its overall combined assets and liabilities are bigger, and it has more lending power now because of that.

Sara’s bank is slightly smaller than when it began, because although Sara and her bank received a deposit and reserve block respectively, Sara sent two deposit blocks to the Treasury to receive the Treasury bond, and therefore Sara’s bank sent two reserve blocks to the Treasury, which were then given back out, one to Mary’s bank and one back to Sara’s bank. Sara’s bank has the same equity, but is simply smaller, as both assets and liabilities decreased, and its lending power is decreased.

The Federal Reserve is unchanged, except that it updated its bookkeeping for one of the reserve blocks “R” originally attributed to Sara’s bank to now being attributed to Mary’s bank instead. Its overall amount of Treasury bond assets and reserve liabilities remains unchanged.

The U.S. Treasury is more leveraged, with an extra “TT” in debt liabilities outstanding, owed to Sara.

Total system deposits are 4D = $4,000, and total system reserves are 3R = $3,000, meaning that neither the total number of deposits nor reserves changed in the system from the beginning state to the end state. Deposits and reserves were just moved around a bit within the system.

EXAMPLE 5: FED-FINANCED HELICOPTER MONEY

Example 5 starts exactly where Example 4 left off and builds from there.

Both Mary and Sara are happy because they got some extra money in the previous example. However, Sara is just prudently saving her money due to uncertainty about the economy, and Mary still doesn't have a job, so she is also just saving her money; their favorite restaurants and vacation spots are closed due to a virus pandemic anyway.

Some politicians want to give $1,000 to everyone every month for the next year, due to so many displaced workers like Mary having so little money and no jobs. Other politicians say, "No, that's too much federal debt, let the economy try to heal itself." The politicians argue for a couple months and then eventually compromise and decide to send everyone $1,000 one more time, to see if that helps. So, Congress authorizes the U.S. Treasury to send out another round of $1,000 to everyone.

This time, instead of Sara buying the new Treasury liabilities with her existing deposits, the Federal Reserve buys the new Treasury liabilities with new reserves. This is depicted in Figure 15-I.

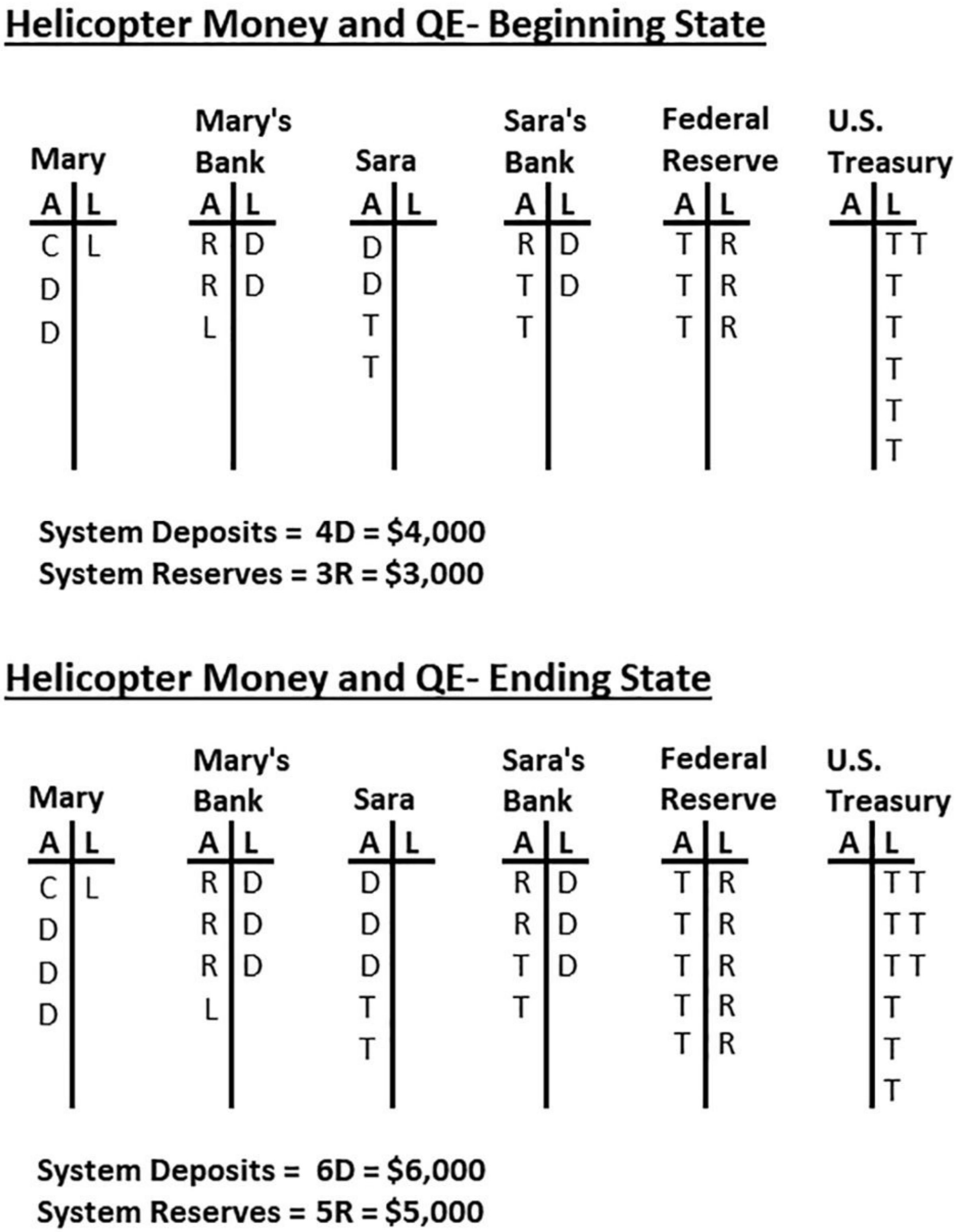

Figure 15-I

Beginning State

Sara already owns a lot of Treasury bonds and sees that the U.S. Treasury will become even more indebted after it sends out all of this money without raising taxes, so she doesn't want to buy any more Treasury bonds. So, how will the U.S. Treasury finance this second round of helicopter money?

Well, because there is a lot of new Treasury bond issuance but nobody wanting to buy it at current prices, the Treasury bond market suddenly becomes illiquid, and Treasury bond prices start to fall (meaning yields start to rise). Sara and her bank both get nervous because they own a lot of Treasury bonds.

The Treasury bond market briefly looks like it did in March 2020 — totally illiquid, with yields extremely volatile.

However, this problem doesn't last long, because the Federal Reserve says, "It's fine, everyone! We'll buy the extra Treasury bond issuance by creating new bank reserves. Relax."

So, the Federal Reserve creates two new bank reserve blocks "RR" and gives them to the Treasury in exchange for the new Treasury debt liabilities, "TT," which become the Federal Reserve's assets. Technically, the Federal Reserve can't legally buy directly from the Treasury, so they agree to transfer the securities through one of the banks as a brief pass-through entity.

The U.S. Treasury then sends a $1,000 deposit "D" each to Mary and Sara and settles this by sending a reserve block "R" to each of Mary's and Sara's banks.

Ending State

Mary and Sara are both $1,000 richer, again. They each have a new $1,000 deposit "D."

Mary and Sara's banks are both bigger, although their equity didn't change. They each have an extra $1,000 reserve block "R," but also each have a new $1,000 liability block to their customer deposits "D."

The Federal Reserve is bigger and more levered, with $2,000 more assets in the form of Treasuries "TT," and $2,000 more liabilities in the form of reserves "RR" that they hold for the banks. Their equity is unchanged.

The U.S. Treasury is bigger and more levered, with $2,000 "TT" in more debt liabilities outstanding.

System-wide deposits (broad money) increased compared to the beginning state, from 4D = $4,000 to 6D = $6,000. System-wide reserves (base money) also increased compared to the beginning state, from 3R = $3,000 to 5R = $5,000.

This was outright money-printing, both in terms of broad money and base money. Mary and Sara are richer, and their banks are bigger. Money was injected into the system, without being extracted from anywhere else in the system, because the deficit spending was financed by the Federal Reserve creating new bank reserves to buy the Treasury bonds (i.e. the deficit spending was "monetized").

The Treasury and Federal Reserve can perform this repeatedly if they want, any number of times, although they both know that if they do it too much, it could cause major consumer price inflation.

Whether it is inflationary for consumer prices, however, depends on whether Mary and Sara still have confidence in the value of their deposits, and whether they go and spend them. It's also potentially inflationary for asset prices; Sara specifically is flush with assets and more likely to use some of her deposits to buy stocks or real estate or gold or bitcoin or collectibles than she was before, which can inflate their prices.

EXAMPLE 6: BANK-FINANCED HELICOPTER MONEY

Example 6 starts exactly where Example 5 left off; both Mary and Sara are happy because they received a second round of extra money.

The pandemic eased a bit, and Mary got a new job, but realizes she needs to keep more cash on hand in case she loses her job again in the future. She learned a lesson about saving.

Sara was already a saver and hasn't been spending extra money yet either. Sara, however, is considering going on a vacation or buying a car now that she's feeling a bit more confident with so much cash. She's also not sure about the value of her money, as she watches the broad money supply expanding so rapidly due to these helicopter checks that everyone is receiving. Car prices are starting to go up, probably due to so many people receiving stimulus checks, so there seems little reason to wait.

However, because the economy is still sluggish, with many people saving more than they used to, Congress decides to do yet another round of $1,000 helicopter checks to everyone, and issue $2,000 in new Treasury bond liabilities "TT" to pay for it. This is it, the final stimulus round!

Fortunately for the U.S. Treasury, the banking system has tons of excess reserves due to their previous round of helicopter spending that the Federal Reserve bought with new reserves, and so this time, the banks each agree to buy one Treasury bond “T” with one of their excess reserve blocks. This is depicted in Figure 15-J.

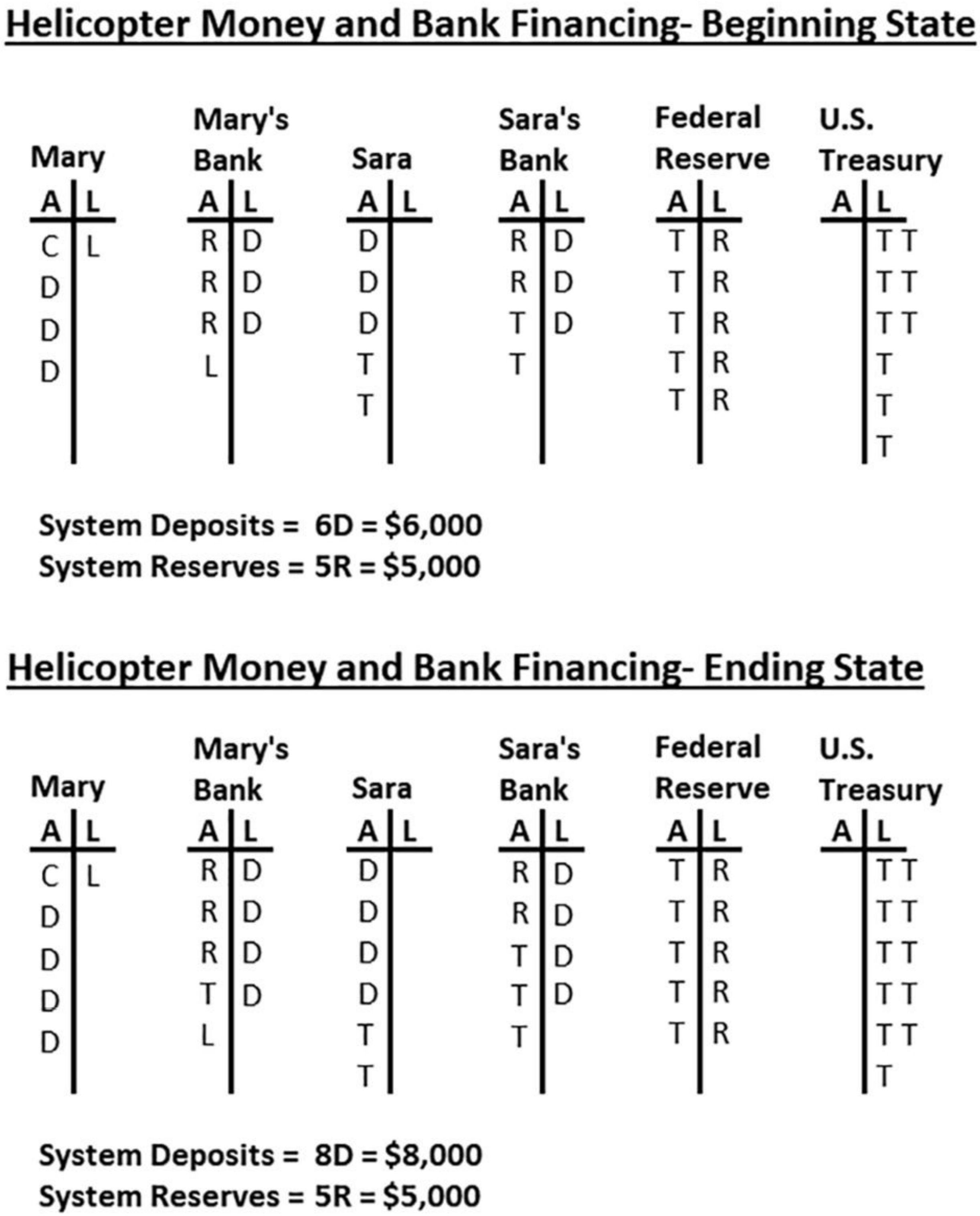

Figure 15-J

Beginning State

System-wide deposits are 6D = $6,000. System-wide reserves are 5R = $5,000.

Here's what happens if we imagine the process happening simultaneously. The U.S. Treasury sends Mary and Sara each a $1,000 deposit "D" block and sends their banks a $1,000 reserve "R" block each to settle it. The U.S. Treasury then issues two new Treasury bond liabilities "TT" to pay for it. The banks each send a reserve block "R" to the U.S. Treasury in exchange for one of those Treasury bonds "T."

Ending State

Mary and Sara are, yet again, $1,000 richer. They each have yet another deposit block "D" added to their assets.

Their banks have the same number of reserves they started with, because they each received a reserve block "R" from the U.S. Treasury's helicopter deposits to their customers, but since each bank also sent a reserve block "R" back to the U.S. Treasury to pay for the stimulus, they each ultimately received a Treasury bond "T" as an asset instead. They still have the same number of reserve blocks that they started with, but they each have an extra asset "T," and they each have an extra deposit liability "D" for their customers. So, they are a bit more levered overall.

The Federal Reserve didn't change at all from the beginning of this example, although it did some bookkeeping for the reserves moving around and ending back in the same place.

The U.S. Treasury is $2,000 or "TT" more in debt than it started the example with.

System-wide deposits increased by $2,000 ("DD") from 6D = $6,000 to 8D = $8,000. System-wide reserves are still 5R = $5,000. So, the money multiplier increased a bit, from 6-to-5 to 8-to-5. Broad money increased, but base money remained the same.

Will it be inflationary for consumer prices? It depends on what Mary and Sara do from here, but most likely at this point, yes. Sara now has tons of cash and is concerned about the value of that cash, so she decides to spend money on a vacation and buy a new car or stocks or real estate or gold or bitcoin — or something. And Mary decides to eat out at restaurants more now that she has more cash than usual. Other people seem to be doing the same; prices of things are inching up each month since everyone has extra spending money.

There is now $8,000 in total deposits (broad money) in the system, compared to the start of Example 4 where there was only $4,000 in deposits. However, the amount of goods and services in the economy has not doubled. So, if Mary and Sara and others decide to start spending their money, it could indeed result in a lot of money chasing a limited supply of goods and services, and therefore could push up consumer prices and be inflationary.

SUMMARY CONCLUSIONS FROM THESE EXAMPLES

If we analyze these six examples for how money is really "printed" within a fiat currency system, we can make several observations:

- Banks can create new deposits and increase the number of deposits (broad money) in the system by making new loans. Lending creates deposits. This lending doesn't change the amount of base money (e.g., bank reserves and banknotes) in the system, but it moves those reserves around from one bank to another, and levers up those reserves so that there is a higher ratio of claims (bank deposits) for base money than there is base money in the system. This is the money multiplier ratio, which refers to the ratio of broad money to base money. Although the banks can create new deposits and increase broad money by lending, and although this can be inflationary for prices due to the growth of broad money, it is not quite "money-printing" because the banks are simply making decisions regarding how much to lever themselves up relative to their cash reserve assets. They are also constrained by the possibility of loan defaults, liquidity requirements, and various regulatory standards for how much leverage they can have. The most unstable part of this arrangement is the fact banks make the implicit guarantee that their depositors will be able to withdraw their funds at any time, even though the bank doesn't have nearly enough dollars to cover a sizable portion of their depositors doing so. They provide the illusion of liquidity to an otherwise illiquid system, and this illusion gets shattered every few decades, resulting in more base money being created to support the proliferation of these deposits.
- The Federal Reserve has the power to create new bank reserves, and to therefore increase the total amount of bank reserves in the system. However, if it uses those new reserves to buy existing assets from banks, it doesn't

directly lead to more deposits (broad money) in the system. It instead de-levers banks and gives them more capacity to lend and create new deposits (broad money), but whether they will lend or not is up to them. On the other hand, if the Federal Reserve buys assets from nonbank entities like Sara (using the banking system as its intermediary), it can slightly increase deposits (broad money) in the system, but only to a limited extent, based on the limited amounts of nonbank entities' holdings of Treasuries that they can sell. When the Federal Reserve increases the monetary base, it is "money-printing," but it doesn't immediately affect the ability of people to consume more goods and services since it doesn't necessarily increase the broad money supply.

- When authorized by Congress to do so, the U.S. Treasury can give more deposits to somewhere in the system in the form of fiscal deficit spending, but deposits also get extracted back out of the system when nonbank entities like Sara buy the Treasury bonds that are used to fund this fiscal expenditure with new Treasury bond issuance. Therefore, this process doesn't necessarily create new deposits or new reserves. This is what people often refer to as the "crowding out effect," meaning that the U.S. Treasury can extract capital from somewhere in the economy and inject it somewhere else; at a large enough scale it can displace nonbank capital that might have otherwise been used more productively. This is not "money-printing" since it just moves things around and levers up the U.S. Treasury.

- If the U.S. Treasury (on behalf of Congress) and Federal Reserve work together, they can rapidly increase both the deposits (broad money), and bank reserves in the system (base money), without extracting deposits from anywhere in the system. In this process, the U.S. Treasury injects money into the economy by deficit spending, which creates new deposits, but instead of that money being extracted from deposits somewhere else in the economy, the Federal Reserve buys those new Treasury bonds with newly created bank reserves out of thin air, and thus levers itself with additional assets (the new Treasuries) and additional liabilities (the new reserves attributed to the banking system). When this happens, it doesn't matter if banks lend or not: Together, the U.S. Treasury and the Federal Reserve go around banks' lending decisions by just giving people and businesses more deposits (broad money). This outright increases the net worth of Mary and Sara in the examples and increases the size of their banks (including broad money supply and bank reserves, but the banks' equity remains unchanged) and levers up both the Federal Reserve and the Treasury. There is no limit to the amount that they can do this, other than the fact that it would eventually be inflationary if done too much and too rapidly relative to the amount of goods and services and productive capacity in the economy. This combination is the most inflationary form of "money-printing," although there are some checks and balances because fiscal changes must be passed by Congress and signed into law by the president of the United States.

- If the U.S. Treasury injects money into the economy with deficit spending, and the Treasuries to finance it are bought by commercial banks, it also increases the deposits (broad money) and increases the money multiplier. This can be done to a significant extent if banks start with excess reserves, because every time the federal government injects more money into the system, it creates more bank deposits, which replenishes the reserves that the bank spent buying Treasuries, and thus gives the banks more ability to buy additional Treasuries. This is rather inflationary, although to maintain leverage ratios and reasonable levels of liquidity, the banks need to start with plenty of excess reserves (which they likely received from prior Federal Reserve quantitative easing programs).
- QE alone, where the Federal Reserve buys existing assets mostly from banks, is an anti-deflationary form of money-printing; it re-liquifies the banking system and fills it up with excess reserves, which helps keep their deposits (broad money) redeemable, rather than letting them default and deflate during liquidity crises. It's not usually outright inflationary for consumer prices because it doesn't usually directly increase the broad money supply by much.
- Large fiscal deficits funded by QE (the central banks monetizing deficit spending by buying any of the excess Treasury bonds that have insufficient demand by the public), is usually inflationary for consumer prices because it gets money directly into the economy, into the broad money supply, and it can be done with no limit except for price inflation that it is likely to cause.

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207 Òscar Jordà et al., "Macrofinancial History."

[208] Federal Reserve Economic Data, "Monetary Base, Total"; "M3 for the United States."

[209] Federal Reserve Economic Data, "Reserves of Depository Institutions"; "Currency in Circulation."

[210] Sumner, *Money Illusion*, 48–49.

[211] Federal Reserve Economic Data, "M2."

[212] Bhatia, *Layered Money*, 92–94, 137–39.

[213] Jordà et al., "Macrofinancial History."

[214] Michael McLeay et al., "Money Creation in the Modern Economy," 14–15.

[215] Lyn Alden, "Banks, QE, and Money-Printing"; the examples also draw on the much-cited Bank of England paper from 2014, cited here as Michael McLeay et al., "Money Creation in the Modern Economy."

[216] See for instance reporting by Elizabeth Schulze, "Here's Why Economists Don't Expect Trillions of Dollars in Economic Stimulus to Create Inflation," *CNBC*; Lizzie O'Leary, "Financial Panic: Inflation Isn't a Risk," *Washington Post*. Additionally, economists like Paul Krugman, "Covid's Economic Mutations," *New York Review of Books*; Ben Bernanke, *21st Century Monetary Policy*, Ch 10; and Richard Clarida et al., "The COVID-19 Crisis and the Federal Reserve's Policy Response," 7–8.

[217] Even astute Fed critics as George Selgin remarked that the risk for inflation, a few months before it took off, "far from being imminent, appears remote at present." George Selgin, "The Fiscal and Monetary Response to COVID-19," 13.

[218] Milton Friedman, "Optimum Quantity of Money," 4–7.

[219] George Selgin, "On Empty Purses and MMT Rhetoric," *Alt-M*, May 5, 2019.

CHAPTER 16

PRICING AS A MECHANISM FOR ORGANIZATION

When a monetary system is analyzed, it must be analyzed from the perspective of both the issuers of the money and the users of the money, and those two groups have different goals.[220] Most of this book is written from the perspective of the user, so let's take a moment to explore fiat currency from the perspective of the issuer.

A user typically wants to hold money that appreciates in value, that is easy to hold and pay with, that is private, and that is difficult or impossible to freeze or confiscate. A modern currency issuer, in contrast, generally wants to issue money that smooths out near-term volatility, that pulls demand from the future into the present, that is easy to surveil, that can be frozen or confiscated by authorities easily, and that gives the issuer a lot of flexibility to spend money even at times when nobody wants to finance them.

Strong periods of economic growth lead to greater production of goods and services but may also lead to greater speculation and leverage that tends to amplify the impact of that economic growth during the good period. In other words, people start offering too much credit, taking out too much debt, and investing into projects that (when analyzed in a more sober mindset) are unlikely to be successful — which we can collectively call "malinvestment." Ultimately, the period of growth comes to an end, as speculation and leverage and malinvestment reach unsustainable levels. The situation, both economically and financially, begins to go into reverse. The leverage that exaggerated the upside of economic expansion now begins to exaggerate the downside of economic contraction. Plus, external shocks such as natural disasters or wars can also negatively impact the economy randomly, and cause some of this leverage to unwind at any time.

One question that many economists argue over is whether business cycles happen naturally or if central bank actions cause them to occur. My interpretation of history is that both are true to varying degrees, so we'll walk through both perspectives.

Imagine that you are a government analyst or policymaker. You study history and you notice that the economy tends to go through these ebbs and flows and faces various external shocks. Life is volatile, in other words, and groupthink tends to come in waves. Worse yet, economic recessions tend to feed on themselves and create a vicious cycle. When business revenue decreases, employers reduce jobs, and jobless people consume less, resulting in even less business revenue, which results in even more job losses. Having interpreted it this way, you propose that the government, being separate from the private sector thanks to an enforced monopoly on taxes and money creation, could soften these highs and lows. When the private sector is defaulting and/or refusing to allocate capital, the government could step in and allocate capital to important things anyway. When the private sector is booming and/or allocating capital poorly, the government could make credit harder to get and slow that type of euphoric malinvestment, while also increasing taxes and cutting spending to build a surplus of savings to cushion the next downturn. Therefore, from this line of reasoning, the best combination of economic prosperity would occur when the government works as a countercyclical force against the private sector: investing when the private sector fails to do so, and building a reserve when the private sector is investing too much and too haphazardly.

In other words, at least as far as this Keynesian vision goes, the government (and their central bank) take an active management approach to their currency. If the currency supply is inflating due to credit growth, they try to decrease the new supply of currency by running fiscal surpluses (via the government) and by raising interest rates to slow down commercial bank lending (via the central bank). If the currency supply is deflating, they try to increase the new supply of currency by running fiscal deficits and by lowering interest rates to accelerate bank lending. The goal for this whole process is for the money supply to grow at a smooth and moderate pace, without big contractions or big accelerations that destructively feed on themselves. The peaks and troughs of the private sector are dulled, and external shocks are smoothed over — or at least that's the plan.

This theory works well on paper, assuming that government and central bank officials are more detached, intelligent, and/or long-term in their thinking than people in the private sector in aggregate, or at least that their incentives are more aligned with long-term planning. A problem obviously arises if they are not, and realistically that's usually the case. Authoritarian governments often have a clear lack of incentive alignment with their subjects. Democratically elected government officials, meanwhile, are focused on winning the next election. None of these lawmakers have an incentive to run a surplus now and slow down the economy to create a reserve of capital from which they could backstop a weak economy later. And if they were to try, they'd likely get voted out of office because people in aggregate always want less taxes and more services in the present. So, instead what happens in practice is that governments run moderate fiscal deficits most of the time, and bigger fiscal deficits during recessions and crises. Rather than a mix of fiscal surpluses and fiscal deficits, it's a mix of fiscal deficits and bigger fiscal deficits.

These nonexistent surpluses lead to a second problem. If the private sector in aggregate is financially constrained in a bear market, and the government has no surplus stockpile of savings from which to draw on, how will the government be able to borrow enough money to inject money into necessary parts of the economy? We already saw in a prior chapter of this book that the British government had trouble raising honest funds to fight World War I, and they were the issuer of the world reserve currency at the time. Wouldn't most governments run into trouble raising capital during a recession or war if private sector companies are also running into trouble raising capital, since most of the potential lenders are themselves either leveraged or risk-averse or without spare funds? In a fiat currency system, a government solves this problem by working with its central bank to create money out of thin air when needed. They can issue more bonds to spend more, and if the government bond market becomes illiquid due to lack of sufficient buyers, their central bank can create more base money to buy those bonds and, as the lender of last resort, re-liquify the government bond market. Therefore, the government and central bank together can inject brand new money into the economy. If they are not judicious with this approach, they have unlimited financing up to the point of causing runaway inflation.

In a gold-backed monetary system, where money inherently has a cost and no entity can create new base money for free, the government is just the largest entity out of many similar entities, and with a different mandate. In a fiat-based system, where currency is issued at no cost by the combination of the government and the central bank that it controls, they can dramatically expand the monetary base during recessions or wars and spend new money into the economy by diluting existing cash and bond savings. They can attempt to act as a countercyclical force on the private sector even when there isn't much demand for their government bonds.

During economic expansions, most people are employed, available labor is scarce, and therefore wages tend to rise. During economic contractions, wages fall or stagnate and there are plenty of people sitting around looking for work that can't find any. If the government can print money, devalue the savings of other people, and use that money to put unemployed people back to work during economic contractions, couldn't that smooth out and soften these economic cycles? Rather than having bank failures where some people lose a lot of money, why not soften the recession at the cost of everyone's savings being diluted a little bit? That type of thinking is how economists who endorse top-down economic management tend to perceive the risks and rewards of deciding to intervene.

Sometimes they go overboard with their stimulus and cause too much demand for goods and services, or external supply shocks occur that are too big to manage, and the grand designs of government officials and central bankers run into the inevitable difficulties in the real world. With too much money chasing too few goods and services, leading to the price inflation that follows, many central planners blame corporate greed as the problem rather than their own policies, and embrace price controls. If prices are going up after their creation of new money, why not just mandate low prices? That way, from their perspective, most of the costs of the stimulus will be put on corporations rather than the public. But of course, that causes all sorts of incentive problems: The corporations themselves have expenses, and to increase the supply of goods and services they need to have both a profit incentive to do so and the financial capacity to do so. Without both of those conditions being met, the supply of goods and services is more likely to stagnate.

On the other side of this viewpoint are the economists who view most business cycles as being caused by the central bank in the first place. Critics of this sort of centralized approach point out how — repeatedly and nearly universally — central bank policymakers wind up exacerbating the business cycles rather than smoothing them over. Their actions to smooth over a recession end up contributing to the next period of economic overheating that occurs, and their actions to subdue an overheating economy end up contributing to the next recession, and thus they get trapped into a constant loop of putting out fires that they themselves caused. A highly leveraged economy is a more fragile economy, and central banks are the key enablers of high systemwide leverage. This line of reasoning mostly comes from economists in the Austrian tradition, but in recent years even people from completely different backgrounds have been critical of attempts by the Federal Reserve to manage the growth rate of the economy. In early 2023, for example, Democratic Senator Elizabeth Warren grilled the chairman of the Federal Reserve Jerome Powell with questions about his plans to rein in inflation by tightening monetary policy in a way that was intended to lead to a higher unemployment rate.

After the 2000 dot-com bubble rolled over, the Federal Reserve cut interest rates all the way down to 1%, which was the lowest level that rates had been for decades. They did this even though it was the mildest recession in decades — both in terms of economic contraction and in terms of the unemployment rate. These ultra-low interest rates were unnecessary, and subsequently encouraged people to borrow money for real estate at cheap levels, including with adjustable-rate mortgages. From 2004 to 2006, after a lot of new debt was taken out, the Federal Reserve then began quickly raising interest rates, which started causing people to default on their mortgage payments. Rather than being any sort of countercyclical force, this big whipsaw in interest rates was a significant procyclical contributor, among many other factors, to the calamitous 2008 subprime mortgage crisis.

Similarly, during the 2020 COVID-19 crash, the Federal Reserve cut interest rates to zero and injected enormous amounts of liquidity into the financial system. When asked by a U.S. congressman about the potential for price inflation after such a large surge in broad money supply growth, the Federal Reserve's chairman Jerome Powell said that he doesn't see a high likelihood for serious price inflation, and that we may have to unlearn the importance of monetary aggregates.[221] The Federal Reserve's official interest rate projections for several years out were very low, and the chairman infamously said, “We’re not even thinking about thinking about raising rates.”[222] In late 2021, when price inflation was over 6%, the Federal Reserve was *still* holding interest rates at zero and expanding the monetary base to buy government bonds. When price inflation started to get out of hand in early 2022, the Federal Reserve admitted it was becoming a serious problem, and then completely changed their path of monetary policy to try to address it. They started rapidly reducing the monetary base by effectively selling bonds that they had previously bought (through the process of maturation), and increased interest rates at the fastest pace in decades, which went against what they had previously forecast that they would do. This rapid change in both money supply and interest rates sucked liquidity from small banks toward large banks and money market funds and led to massive unrealized losses by banks who had bought long-duration government-backed bonds in 2020 and 2021 at low interest rates. Ultimately, this rapid drawdown in liquidity contributed to the second-biggest bank failure in American history in early 2023, along with a string of other bank failures — which forced the Federal Reserve to provide an emergency liquidity facility and take other actions to prevent further bank contagion from spreading through the financial sector. In addition, the Federal Reserve’s higher interest rates led to higher interest expenses for the government, which meant larger fiscal deficits at a time when fiscal deficits were the driving force of inflation (rather than excessive amounts of bank lending).

Ultimately, I view this primarily through a lens of technology, especially as it relates to the significant gap in speed between transactions and settlements that has existed since the second half of the 19th century. Since central banks operate the primary ledger systems that the world uses for domestic and international commerce, then of course they are going to actively manage them, and therefore of course they will make plenty of mistakes. All the incentives are aligned in that direction, and so that’s how it plays out in countries all around the world whether we like it or not. This is an inevitable condition that we find ourselves in, unless or until we develop and adopt a better ledger system.

PRICE STABILITY VS COORDINATING SIGNALS

An overarching goal of most central bankers is price stability. They’re willing to rapidly expand or contract the money supply if it means maintaining price stability, which they define as a gradual loss of purchasing power. According to neoclassical economic theory that forms the basis of most central bankers’ worldviews, price stability is inherently a good thing — but is it? Our world is an inherently volatile place, and price changes give consumers and producers a constantly updating signal for which goods and services are scarce and which goods and services are abundant, so that they can adjust accordingly. Friedrich Hayek and other economists have emphasized this in their work.[223]

Usually, consumers will use less of what is scarce and expensive and will use more of what is abundant and cheap. Conversely, producers will produce more of what is scarce and expensive and produce less of what is abundant and cheap. And generally this takes time; consumers and producers likely need to determine that these price changes are persistent before they change their behavior. Removing that volatility from the system with changes in the money supply and interest rates, or with outright price controls, reduces or eliminates that coordinating signal.

In many ways, this is a problem of information bandwidth. Ten million individuals have all sorts of varied and localized expertise, based on their knowledge of their profession, tailored to the region that they operate in. Each one is considering a small amount of real-time information and is continuously making decisions from that information based on experience, and this adds up to an enormous amount of coordinated activity. Does a small group of centralized, academic policymakers in a room located in their nation's capital — akin to a council of elders — have a better grasp on how to allocate their country's labor and capital than the millions of people do at the individual level?

Imagine a gasoline pipeline system that supplies various U.S. states with gasoline. One day, it encounters a mechanical problem, and stops supplying gasoline to an entire state. The supply of gasoline in that state suddenly becomes scarce, while demand for it is still significant, and so the price of gasoline spikes to very high levels.

Amid public outrage, the natural reaction for many lawmakers is to view this as unfair, and to try to set price caps on the price of gasoline. Should hoarders of gasoline be rewarded? Should wealthy people be able to access gasoline when working class people can't afford it? For many people, their conscience and intuition both say no, and thus they support top-down economic planning to spread the gasoline more fairly, with quotas and price controls and a reduction in the ability of individual consumer and businesses to make decisions to buy and sell gasoline at prevailing market prices.

But could that well-meaning policy ironically slow down the resolution to the problem, and hurt some of those who it attempts to benefit? If the price of gasoline spikes, then people who can't afford it or who don't need to afford it, stop using it. Very important use-cases (say, traveling nurses or the shipment of key goods) naturally continue to be paid for, and those buyers will absorb the cost or pass their prices down the supply chain to their customers, if applicable. Wealthy people also continue paying for it.

The higher that the price of gasoline in that state spikes, and the longer that it remains elevated, the more it incentivizes holders of gasoline in other states to take the gasoline they have, bring it to the state with a shortage, and sell it for a profit. If the price of gasoline only spikes by a small amount, it might encourage the marginal seller in bordering states to come in with some gasoline, but not much. On the other hand, if the price of gasoline spikes enormously and for a prolonged period, it encourages gasoline suppliers across a wider region to travel to that state with their spare gasoline and flood it with new supply until prices normalize. High prices serve as a signal to people throughout the surrounding area to bring in any spare gasoline to it, and therefore help fix the problem with additional supply until the pipeline is fixed. Simultaneously, high prices serve as a signal to consumers within the area to reduce their use of gasoline as much as possible for anything that is not critical.[224]

In other words, the central planners' desire to quell short-term price spikes can ironically reduce the speed with which supply/demand imbalances are resolved by natural market forces. Artificially capping the price of gasoline results in shortages and reduces the area from which it makes sense for suppliers in other states to transport spare gasoline to that shortage state, and the urgency with which they might be interested in doing it. On the other hand, letting the private market work through the supply/demand mismatch can incentivize sellers of gasoline from longer distances to come and quickly supply more gasoline, which helps hammer down that supply/demand price gap.

This example is basically what happened to Europe in 2022, except it was natural gas rather than gasoline. Russia invaded Ukraine, and in the process, Europe lost most of its ongoing natural gas import capacity from Russian pipelines for geopolitical reasons. The price of natural gas in Europe spiked to unbelievably high levels, and so did the price of electricity which in significant part is generated by natural gas. In response, liquified natural gas exports from all around the world began changing course and prioritizing Europe as a destination, because that's where the highest selling prices were. Europe was subsequently flooded to their maximum import capacity with liquified natural gas. It also encouraged an acceleration of building new gas export and import terminals to expand the total capacity for future years. If Europe had implemented price caps, then there would have been no incentive for global liquified natural gas providers to re-route their supply there, and the supply-demand mismatch would have been worse, with acute shortages. Those high prices were painful, but they were also a signal to the entire world to coordinate and fix the problem over both the short term and the long term.

Suppose that ten million people in a country make economic decisions, and they each buy five things per day. That's 50 million transactions per day, or 18.25 billion transactions per year, nationwide. Can a central committee of elders allocate prices better than those ten million decentralized people can? Most evidence suggests no; ten million people can incorporate real-time information and allocate prices better than a detached central committee of a handful of individuals. That is why politburos are not the most efficient form of economic planning; regardless of how wise and intelligent those individuals may be, they are incapable of processing and organizing the amount of information that ten million everyday people can with their various specific expertise.[225]

In their book *Bitcoin is Venice*, Allen Farrington and Sacha Meyers elegantly described pricing as an information compression mechanism:

> Provided with information, individuals can, and do, produce a price. But given a price, nobody-- never mind a third-party observer or even an entire market-- can reproduce the information that created it. And this is the whole point. The "function" from information to price is not random, not ill-defined, and certainly not an "aggregation." Rather, it is a very specific kind that serves a very specific purpose: It is the perfect compression of economically relevant information. It strips the noise of subjective values, preferences, and interpretations of reality down to pure objective signal, the same for everybody, and hence that the algorithm of the market can aggregate, entirely indifferent to its source or what went into its construction.[226]

Pricing doesn't directly give you information on *why* it is the way it is. Pricing merely incentivizes you to act rationally in a rapid manner, regardless of whether you understand the details of the supply and demand situation or not. Price is the mechanism for how tens of millions, hundreds of millions, or even billions of people can unknowingly work together in relative harmony to fix a supply and demand problem, even without most of them understanding the nuances of the situation. They are quickly acting in unison on compressed, efficient, high-signal information, stripped of the details or the need to understand them. Meanwhile, as all of those people unknowingly work together to solve a problem in the near term, a smaller subset of participants with domain expertise can look more deeply into the problem and see what details might be causing the pricing that the market is experiencing. They can use that knowledge to help further solve the problem and make a profit, or share that knowledge with others who can.

The desire of central planners to override that natural coordination system of price might seem smart at first, but unless perfectly handled, it is likely to lead to mild, short-term gains but severe, long-term losses. By delaying the decentralized organization that naturally arises from this pricing information, central planners can improve prices in the near term, but likely end up delaying the fixes that need to happen on both the supply side and the demand side in order to achieve an abundant equilibrium.

That doesn’t mean that government authorities must be inactive in the face of crisis, though; it just means that price controls are rarely an effective part of their response. Governments themselves can respond to price signals with mobilization of their resources toward a supply response. Examples such as bringing food and water to an area struck by a natural disaster or bringing fuel to an area struck by acute shortages are more in line with solving the underlying problem than various attempts to indirectly fix the problem through price manipulation. These solutions require the foresight to build and maintain reserves during good times.

THE PRICE OF MONEY AND A RELIABLE MEASURING STICK

We can extend the same concept of pricing as a coordination mechanism to the price of money itself, which central banks control. Central banks rapidly change the supply of money and/or the price of money to try to dull price signals, but I contend that such policies are usually more harmful than not.

In a decentralized system, the price to borrow money depends on multiple factors, including how creditworthy you are but also how abundant or scarce credit generally is at the time. If there are few people that want to borrow money relative to how much money lenders have, then lenders will likely be willing to lend at low interest rates and with attractive terms. On the other hand, if there are a lot of people that want to borrow money relative to how much money lenders have, then lenders will be strict with their lending standards and charge higher interest rates.

In a centralized system, central banks can create or destroy base money and (mostly) set the price to borrow wholesale money. For example, twelve people on the FOMC of the Federal Reserve heavily influence the price of money for 330 million Americans, as well as for billions of people in the world who indirectly are affected by the U.S. dollar as the world reserve currency. This can unnaturally increase the amount of loans that occur, or reduce the amount of loans that occur, depending on whether the price of money is set too high, too low, or just right. It can also hurt some regions more than others if they would naturally have had different market-based interest rates but instead are being forcibly offered the same interest rates.

Prior to the 2008 crisis, the Federal Reserve would change interest rate boundaries (the wholesale price of money) as its primary tool for transmitting monetary policy. After 2008, they began using changes in both interest rates and changes in the size of the entire monetary base (the supply of base money) for transmitting monetary policy, which (especially when done rapidly) is very disruptive for people, businesses, and banks trying to make contracts denominated in these units. Bank cash levels, for example, were rapidly whipped down in both 2019 and 2023 by the Federal Reserve, and this contributed to the 2019 repo spike and the 2023 bank liquidity problems respectively.

Centrally directed and rapidly created new money is basically a breach of contract for savers, who thought that the units they held would be reasonably stable. Conversely, centrally directed and rapidly destroyed existing money is basically a breach of contract for debtors, who took out debt in units they thought would be reasonably stable. It’s not just a question of whether money should be hard or weak; it’s also a question of how elastic, arbitrary, and rapidly changing its supply should be. In other words, it’s a question of who controls the ledger, and therefore a question of who has the power to rapidly harm either savers or debtors when they determine that it’s appropriate to do so.

Usually, fiat currency money supplies grow over time. A rapidly growing money supply usually distorts price signals, which can negatively affect the reliability of pricing as a coordination mechanism. Many central banks including the Federal Reserve have an official target of 2% price inflation per year. Price inflation, however, serves as a small and re-occurring error in our economic calculations. Many people choose to hold money in savings accounts or bonds that yield 2%

per year, thinking they are getting a growth in purchasing power, while not realizing that price inflation is growing by 2% or more per year.

Imagine that you are a carpenter. You cut various pieces of wood, carefully and in relation to other pieces, to assemble various furniture products that you've designed. Now, imagine that all measuring devices that you use, and that you can buy, are shrinking by a small amount each month. Previously, a 30-centimeter piece should have been connected to a 10-centimeter piece. But now, when you measure your latest batch of 10-centimeter pieces, they are indicated to be 11 centimeters instead, because your ruler is smaller and no longer accurate. Now, you need to make those 30-centimeter pieces 33 centimeters instead to be proportionate, and thus you must change your equipment. If you had already cut a bunch of 30-centimeter pieces for your inventory, you're probably out of luck; there is no use for the combination of new 11-centimeter and legacy 30-centimeter pieces. Those 30-centimeter pieces are now impaired inventory.

That's kind of how price inflation, especially very fast price inflation, impacts an economy and specifically the productivity of people in that economy. Wherever possible, businesses make multi-month or multi-year supply agreements at fixed prices for both the products they sell and the products they buy. They need to factor inflation into their long-term contracts and business plans, including target inflation and any errors the central bank might make in achieving that target. If the products they buy suddenly get repriced higher, while they still have a fixed price contract for what they sell, then the business has a big problem; they may lose money on the work that they do. On the other hand, if they can raise prices for the products they sell, while locking in their suppliers at fixed prices for a while, then they can raise prices for consumers while hurting other suppliers and get a big surge of profit for themselves.

Additionally, salaried employees are often only able to negotiate their salary once per year, and thus must anticipate and account for inflation of the very units they are paid in as part of the process. Persistent inflation by default puts the employee at a disadvantage to the employer because wages tend to be sticky, due to anchoring bias.[227] Merely to keep up with inflation of semi-scarce goods and services, an employee needs at least several percentage points of wage increases each year. To the extent that they gain experience and are worth a higher inflation-adjusted wage, that must be further negotiated. For example, if housing costs are going up by 5% per year, then an employee could reasonably make the case for 6% annual wage increases, which in most contexts will sound unreasonable to the employer. In reality, they're only asking for a 1% "real" wage increase for their increased experience, and the other 5% is just to keep up with housing inflation, but it doesn't feel like that to the employer. Due to this, employees often must change jobs unnecessarily just to reset the anchoring bias of their prior wage agreements — which is counterproductive.

An extreme example of this is Egypt over the past decade. In autumn 2016 Egyptian authorities, practically overnight, devalued the country's currency by half relative to the U.S. dollar to meet IMF requirements for a loan.[228] And then again in 2022 and 2023, they devalued their currency by half once more, in three big stepwise moves to meet conditions for another IMF loan.[229] Each time this happened, it put the onus on wage earners to try to negotiate a doubling of their salary in Egyptian pounds, lest they receive a pay cut in international purchasing power terms. Of course, hardly anyone could even ask for such a pay jump let alone actually get one, and so most workers throughout the country received effective pay cuts, while at the same time seeing their liquid savings devalued.

When the supply and value of currency units are both relatively stable, it is easier to make long-term plans and contracts across the whole economy. Plus, it's easier for employees to keep their wages in line with purchasing power since anchoring bias is no longer working against them. On the other hand, when the supply and value of currency units are both highly variable, it's harder to make those long-term plans. If changes in the supply and value of currency are low enough, it's only a small problem. Much like how a carpenter might not care about the difference between 30 centimeter or 30.1-centimeter pieces of wood, a business might not care about the difference between $5.00 USD and $5.10 pricing for widgets they buy. It's just a small error source that is within the bounds of acceptability. However, if the widgets they buy start hitting $6.00 USD or $7.00 USD because the broad money supply is growing more quickly than usual, then that really messes up their profit margins and their planning, or that of their suppliers, or that of their employees.

In addition, for efficiency purposes a lot of contracts for sales, purchases, and labor wages tend to occur on 12-month or other long periods. It is inefficient to re-determine contract details every month, but that starts to become more important to do if prices are changing rapidly. Stability in the underlying currency is necessary to form long-term contracts, and long-term contracts help reduce administrative overhead and duplication. Even in shorter intervals, we can imagine the waste of time and resources if a restaurant must change its menu prices daily or weekly or monthly, rather than yearly or less often.[230] And then we can imagine countless other small increases in administrative costs like that.

Almost without exception, if you look around the world for regions with persistent double-digit money supply inflation, those regions are not very economically productive. Instead, they tend to be in disarray. In that type of inflationary environment, it is hard for businesses to plan for the long run while remaining profitable, and it's hard for workers to maintain wages that keep up with the cost of living. All negotiations become harder and more frequent, especially if they involve a lot of people, such as unions and large contracts. Investors want to get their capital out to easier jurisdictions, which increases the cost of capital for local businesses, which makes them even less organized, less profitable, and less competitive. In this context, the public ledger is broken, and by extension everything becomes broken. It risks becoming a vicious cycle, because disorganization leads to inflation, and inflation leads to disorganization.

Sound money is like a measuring stick that never changes, or that changes extremely slowly and predictably. These types of environments for the most part tend to develop when nobody can change the measuring sticks. For example, if gold is money that both buyers and sellers accept, it's hard for centralized entities to come in and disrupt that arrangement and change prices. On the other hand, if centralized fiat currency ledgers are money, it's easy for the centralized issuer to change the supply and value of units on that ledger, which can disrupt price signals and business activities.

THE "NEED" FOR CONSTANT PRICE INFLATION

In 2013, James Bullard (president of the Federal Reserve Bank of St. Louis, one of the twelve regional Federal Reserve banks) expressed his concern about inflation being too low. The Federal Reserve has a 2% annual price inflation target, and in 2013 they were undershooting it with inflation levels closer to 1.5%. Bullard supported ongoing expansion of the monetary base (printing new bank reserves to buy U.S. Treasury bonds), citing the lack of sufficient price inflation, and citing the need to defend the Federal Reserve's credibility in hitting its 2% inflation target rather than allowing prices to grow more slowly than that target.

This line is from *CNBC*:

> "If inflation continues to go down, I would be willing to increase the pace of purchases," Bullard told reporters after a speech at the annual Hyman P. Minsky Conference in New York.[231]

And this line is from *Bloomberg*:

> Federal Reserve Bank of St. Louis President James Bullard, who has backed continued bond purchases by the Fed, said it is important for the central bank to defend its 2 percent inflation target to ensure its credibility as price gains moderate.
>
> "I have been concerned about low inflation," Bullard, who votes on monetary policy this year, said in a speech today in Paducah, Kentucky. "There hasn't been much indication so far it is moving back toward target."[232]

When Janet Yellen, Chair of the Board of Governors of the Federal Reserve System from 2014 to 2018, was preparing to leave the position in late 2017 she looked back on her tenure and lamented allowing price inflation to remain too low:

> Janet Yellen looked back on her year at the Federal Reserve and figured most of the boxes are checked: Accelerating economic growth, a solid employment picture and a stable financial system.
>
> The one job left undone? Inflation.
>
> At her final news conference as Fed chair Wednesday, Yellen said the Fed's failure to bring inflation up to the central bank's 2 percent mandate is her single disappointment.
>
> "We have a 2 percent symmetric inflation objective. For a number of years now, inflation has been running under 2 percent, and I consider it an important priority to make sure that inflation doesn't chronically undershoot our 2 percent objective," she said.[233]

For years throughout the 2010s, Christine Lagarde (who at the time was head of the International Monetary Fund) argued that Europe was experiencing too low inflation and needed to perform more accommodative and unconventional monetary policy to try to get inflation higher. These were her words from 2014:

> The head of the International Monetary Fund on Wednesday called on the European Central Bank to ease monetary policy to move prices higher, saying "low-flation" in advanced economies risked undercutting an already sluggish global recovery.[234]

In 2019, when Lagarde was being considered to become the President of the European Central Bank (which she indeed became by the end of the year), she continued this theme of identifying too-low inflation as a problem in a speech to the European Parliament:

> The challenges that warrant the ECB's current policy stance have not disappeared. The euro area economy faces some near-term risks, mainly related to external factors, and inflation remains persistently below the ECB's objective. I therefore agree with the view of the Governing Council that a highly accommodative policy stance is warranted for a prolonged period of time in order to bring inflation back to "below but close to 2%".[235]

Similarly, throughout the 2010s decade, Haruhiko Kuroda in his long-serving position as Governor of the Bank of Japan, kept interest rates at negative levels for a prolonged period in an attempt to raise inflation up to 2%. This line was from *Reuters* in 2018:

> Bank of Japan Governor Haruhiko Kuroda on Tuesday ruled out the chance of abandoning negative interest rates in the near-term, saying they are necessary to accelerate inflation to his 2 percent inflation target.[236]

If we replace the description of an inflation target with a debasement target, which is ultimately what it is, it shows how silly some of these comments are. Using that terminology, rather than heads of central banks lamenting that inflation is below their target, they would be lamenting that the currency that people earn their wages in and keep their savings in is not being debased as quickly as their target debasement rate says they should.

In modern times, most developed country central banks maintain a 2% annual price inflation target and become concerned if inflation is significantly below the target or above the target. A 2% inflation target means that prices on average will double every 35 years. This is interesting, because ongoing productivity gains should make prices *lower* over time, not higher. Central bankers do everything in their power to make sure prices keep going up. To put this another way, central bankers do everything in their power to ensure that deflationary productivity gains are continually offset by a greater amount of currency debasement, so that nominal prices of goods and services keep marching higher at a slow and steady pace despite becoming more efficient to produce.[237]

Price deflation is inherently a good thing. Throughout the 19th century, at the dawn of the age of oil and electrification and long-distance railroads, prices tended to be structurally deflationary. It became much easier to make things with so much extra energy, and there was an explosion of technological growth, productivity growth, human population, and human life expectancy. Similarly, the past several decades have seen a rapid reduction in the prices of electronics. Televisions, computers, phones, and other devices keep getting cheaper, usually on a nominal basis and especially on a quality-adjusted basis. The cost per gigabyte of computer memory, for example, has fallen exponentially for decades, and most people in the world have benefited immensely from this fact. Meanwhile, an 80-inch television today is clearer and cheaper than a 40-inch television was two decades ago.

And yet, deflation is often painted as a terrible thing by central bankers, and by mainstream economists more broadly.[238] In their worldview, prices must continually go up rather than down. In fact, many of them argue that if prices go down, people will delay purchases indefinitely to wait for lower prices (even though we obviously don't do that with electronics). In their policy framework, prices must constantly go up, excess saving needs to be constantly discouraged, and people need to be kept on a constant treadmill of consumption and borrowing to support continual and smooth economic growth.

A key reason why policymakers and economists fear deflation is because deflation is bad for highly leveraged financial systems, and yet leverage is exactly what they encourage to exist through their policies. When everything is built on massive amounts of debt, and policymakers keep intervening to make sure debt levels go ever higher, then deflation can collapse the system if it's allowed to occur. Persistent deflation is not compatible with high debt levels, and thus not compatible with the modern financial system.

In a more equity-based and low-debt financial system, it's desirable for prices to go down. That much is obvious. Technology companies usually have low debt levels, and if they improve their products immensely (offering greater capability for a lower price), they get rewarded for it via large numbers of buyers, even as the per-unit cost decreases. For example, by lowering the cost of a gigabyte of storage by a thousandfold, they can sell a thousand times as many gigabytes of storage (e.g., full terabyte drives). The buyers, of course, also benefit from these technological improvements and price cuts.

However, in a highly indebted financial system where the money supply usually grows substantially over time, deflation is often caused by liquidity crises and recessions, and therefore gets assigned a bad reputation.[239] As companies mature and grow more slowly, in an environment of persistent currency debasement and recurring liquidity support from central banks, they are encouraged to maintain permanent corporate debt in their capital structure, and this type of practice requires constant currency debasement to make sense.

Much like how bloodletting used to be an overused medical procedure that we now know only helps in certain specific contexts, I don't think future historians will look favorably on the current view among mainstream economists that we need constant price inflation and currency debasement for the economy to run well. A framework of constant inflation is primarily meant for 1) constantly promoting the use of credit rather than savings, 2) gradually but persistently devaluing debts, 3) constantly dulling the price signals that our volatile world gives to us to act upon, and 4) allowing governments to run persistent fiscal deficits as a form of non-transparent taxation. These goals primarily benefit those near the core of the system, such as the governments, corporations, and financiers.

This is further complicated by the fact that we can't even measure inflation precisely. The official government measure of inflation is a basket of goods and services that is weighted in such a way that it tries to replicate what the average person buys each year. It also assumes substitution, so for example if a ribeye steak goes up in price, it factors that out from the basket of goods and switches to cheaper ground beef, since that's the consumption pattern that the consumer, now facing higher ribeye prices, opts for. Therefore, the inflation measurement is programmed to avoid high-price items and keep resetting toward cheaper items, which ends up systematically understating inflation.[240]

In 1913 when the Federal Reserve was created, there was $19.31 billion in broad money. At the end of 2022, there was $21.4 trillion ($21,400 billion) in broad money, which is an increase of 1,118 times over, or an average of 6.6% per year when compounded for 109 years.

The population of the United States was 97 million in 1913 and about 333 million in 2022. This means that in 1913, there were 199 dollars per person in the system, and in 2022 there were over 64,800 dollars per person in the system. This is a per-capita broad money supply increase of 325 times over, or 5.5% compounded annually.

The scarcest things, such as luxury waterfront property and fine art from famous deceased artists, tend to go up in price as fast as the money supply does. That's because these things are truly finite, and we don't get more efficient at making them. As a result, as more money is created it pushes up the prices of those goods by nearly the same rate. As an example, one particularly well-documented Miami Beach waterfront property was originally sold for $100,000 in 1930 and by 2022 was worth around $30 million, which was a 6.4% compounded annual growth rate, and that was closely in line with the growth rate of the money supply over that long period.[241]

Semi-scarce things such as gold, oil, beef, and median homes tend to go up in price at a 4-5% annual rate if money supply growth is 6-7%, because we get moderately better at producing them over time, due to better technology. A barrel of oil, for example, went from an average of $0.95 in 1913 to an average of $94 in 2022, which was only a 100-fold increase, or 4.3% compounded annually.[242] The price of beef similarly increased at a 4.1% compounded annual rate from the 1930s through 2022.[243]

Non-scarce things such as certain types of grains, seed oils, electronics, software, apparel, plastic toys, and similar items have a very low or even negative inflation rate. We have become exponentially better at making electronics and software and jeans and toys, and our mechanized agricultural and refinement practices have kept grain prices and seed oil prices very inexpensive.

Between 1913 and 2022, the consumer price index increased at a 3.2% compounded rate, and this index mostly represents a mix of semi-scarce and non-scarce things.[244] Interest on bank accounts and Treasury bills failed to keep up with the consumer price index during that long period, let alone keep up with a basket of semi-scarce things like beef or oil or houses, and certainly did not keep up with truly scarce things like fine art or waterfront property.

Even just between the beginning of the year 2000 and the end of the year 2022, there was significant divergence. The broad money supply per capita grew at an annual compounded rate of 6.8% per year during that timeframe, while the official consumer price index grew at a 2.6% compounded rate.[245] The gold price increased by 8.3% per year.[246] The price of hospital services grew by 5.3% per year.[247] The oil price grew at 4.7% per year. The median house price grew by 4.7% per year. Childcare prices grew by 4.2% per year.[248] Average hourly earnings for non-supervisory workers went up by 3.2% per year.[249] The average bank account had a yield of less than 2% per year.[250] Apparel was flat in price. Electronics, plastic toys, and software of all sorts dropped in price.[251]

The cheaper non-scarce categories of goods, which benefit from exponential technology gains or benefit from shifting manufacturing overseas toward cheaper sources of labor, help to lower the average official inflation number compared to the growth of the money supply and compared to the price growth of truly scarce and semi-scarce good and services. In the real world, however, exponential price declines in a few categories of discretionary goods don’t offset the continually higher prices in necessities and desirables that have a real resource constraint, and that are continually driven up in price by the expansion of the money supply.

There was a heated exchange on this topic in 2011 when William Dudley, then president of the Federal Reserve Bank of New York, spoke to a partially working-class audience in Queens. When asked questions about recent food inflation (commodities had been in a significant bull market during recent years), Dudley pointed out that while energy and food prices may indeed be higher, that this was offset by other things. He pointed out, for example, that the iPad 2 helped bring down the average, which didn't go over well. As Kristina Cooke reported for *Reuters*,

> Dudley tried to explain how the Fed sees things: Yes, food and energy prices may be rising, but at the same time, other prices are declining.
>
> He then stretched for a real world example. The only problem was he chose the Apple's latest tablet computer that hit stores on Friday, which may be more popular at the New York Fed's headquarters near Wall Street than it is on the gritty streets of Queens.
>
> "Today you can buy an iPad 2 that costs the same as an iPad 1 that is twice as powerful," he said." You have to look at the prices of all things."
>
> This prompted guffaws and widespread murmuring from the audience, with one audience member calling the comment "tone deaf."
>
> "I can't eat an iPad," another said.[252]

To sum this up, central bankers generally have a positive inflation target — which isn't necessary and is hard to even define. The default inflation rate in a functioning society is negative, because better technology makes us more efficient at making most things over time. If policymakers reach a goal of 2% average inflation per year, it probably means money supply and truly scarce things went up by 5-7% per year, semi-scarce things went up by 3-5% per year and were offset by some declining prices of non-scarce things due to productivity gains and globalized labor arbitrage. It's important to monitor the broad money supply because that's usually a better representation of the price increases for things that require significant resources to produce and that are sought after.

If the assets that you are saving in are not going up in price at the growth rate of broad money supply per capita over a long stretch of time, then your purchasing power is being diluted. This is hard to keep track of even for a quantitative person who actively grinds the numbers, let alone a typical person who is just trying to earn income and save money. Since the growth rate of the money supply greatly exceeds interest rates most of the time, it's easy for savers to be diluted. Persistent inflation of the money supply allows policymakers and various middlemen to siphon off the purchasing power of peoples' savings without them being able to easily keep track of it. And as bad as it is for savers in developed countries, it's far worse for savers in developing countries.

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CHAPTER 17

THE FINANCIALIZATION OF EVERYTHING

When money in a society maintains its value well over time, there is an incentive to hold wealth in it. Savers will likely be prudent when deciding how much money to place into investments, since investments represent a higher-reward and higher-risk option compared to the default situation of holding reliable sound money.

On the other hand, when money in a society keeps degrading in value, there is a strong incentive to hold other things that have greater scarcity, and thus to add a monetary premium to those other things above and beyond the utility value of those things.

If something like gold is money, then the common form of money is rather sound and there is less reason for investors to have second and third homes, large stock portfolios, and an assortment of collectibles. Of course, some people will have those things, but they will be more discretionarily and thoughtfully collected, and are likely to represent a smaller share of an investor's net worth. However, in weak money environments where supply of money keeps growing and interest rates are below the prevailing inflation rate, then there is a strong incentive to avoid cash and instead to hold second or third homes, to buy stocks, and to own a large assortment of collectibles at inflated valuations. In the absence of good money, everything else that has some degree of scarcity gets monetized instead.[253] There's also a big incentive to borrow (i.e., to "short") money and use it to buy these scarcer things, which drives up leverage in the system.

This can be a particular problem when things of utility get monetized to problematic levels. For the most part, it's fine if something like gold has a huge monetary premium above its utility value. This is because most of its demand is for jewelry and savings, and its industrial use-cases can often be substituted with other materials when necessary. If gold were to double in price next year, most people in society wouldn't have any noticeable negative impact on their life. But if houses get monetized and left empty for most of the year due to wealthy investors and upper-middle-class investors buying extra ones with cheap credit, then it can crowd out the middle class and working class from having access to affordable shelter. This problem shows up in the ratio of home prices to incomes, and has become especially problematic in desirable cities and tourist destinations. Such high prices make it virtually impossible to afford the housing without very high usage of debt financing.

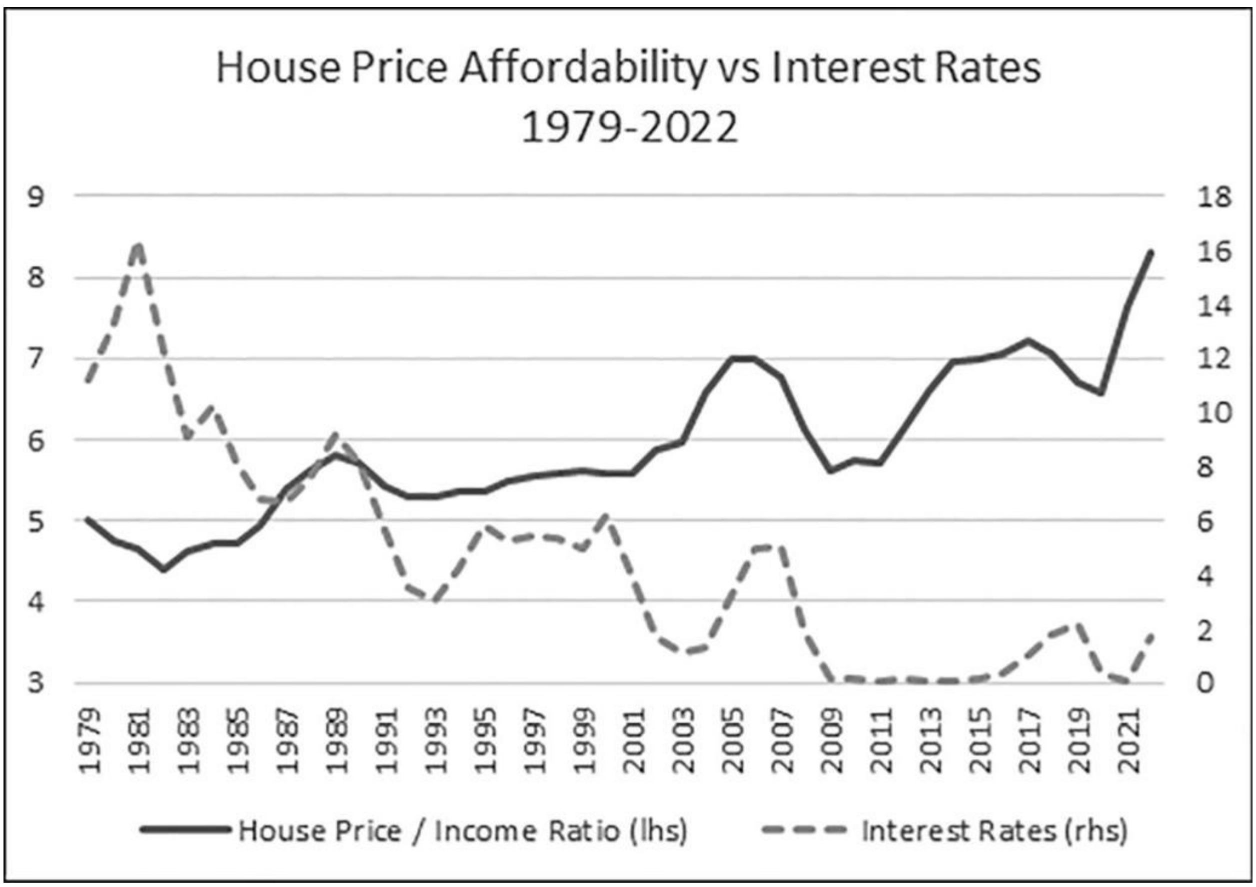

Figure 17-A[254]

This problem is further amplified by global capital flight. Many wealthy Chinese citizens, for example, don't want to hold all their money in China, because there it's easy to confiscate and control. Over the past couple decades, wealthy Chinese citizens have had a strong tendency to buy real estate in Australia, Canada, and southeast Asia, and thus contribute to extraordinarily high housing prices in those regions. Not only were property values inflated from artificially low interest rates and debt accumulation by domestic buyers, but it was made even worse by this extra foreign demand.

The monetization of utility assets can also be seen when comparing equity valuations or household net worth ratios to interest rates. Normally, business equity is valued based on an assessment of its likely future cash flows. When interest rates are high, and well above the inflation rate, then equity valuations tend to be low and more closely aligned with their future expected cash flows, with most of their monetary premium removed. When interest rates are below the inflation rate, and low in general, people would rather hold almost anything else than cash, whether it be equities, real estate, or collectibles even at inflated valuations. These things acquire a monetary premium, in other words.

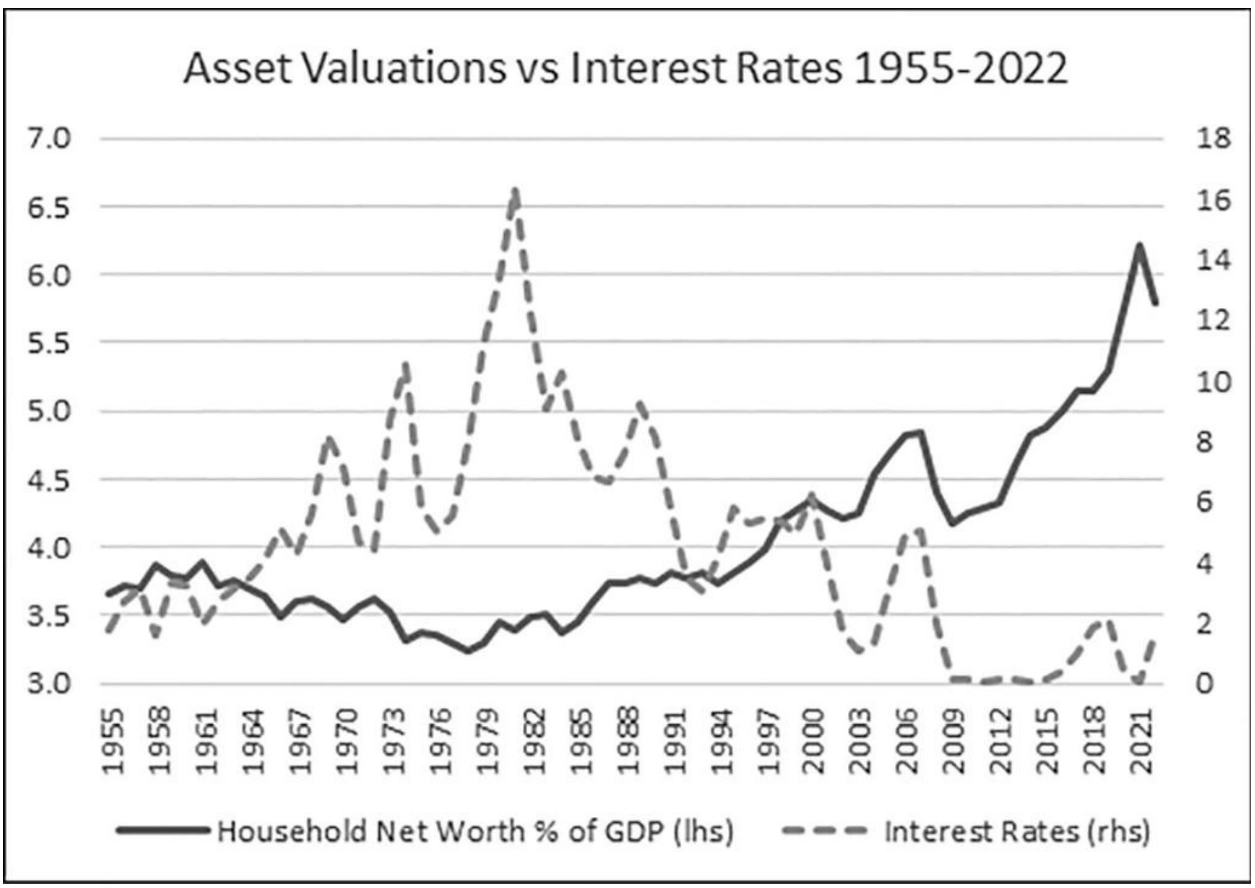

Figure 17-B[255]

People generally build their retirement savings accounts out of equities, rather than money. Therefore, equities of large publicly traded companies acquire a monetary premium compared to most private businesses. This gives large corporations a lower cost of equity capital, and thus gives them a structural advantage (among many other advantages) over smaller, private businesses.

Unusually high equity valuations can further distort capital formation and resource usage. Perpetually unprofitable, growth-oriented companies can exist for longer periods of time in their state of unprofitability, as people prefer to hold their equity, rather than to hold cash that fails to maintain its purchasing power. These companies can underprice their products and services, operate at a perpetual loss, and finance themselves by continually issuing new shares to employees as compensation and continually issuing new shares for investors to buy. The company then grows faster than normal market pricing would allow, due to these high-valuation monetized shares and persistently unprofitable prices for its goods and services. When this goes on for many years or even decades, it becomes challenging to determine what the true market values of their products and services are, since they are priced below their cost of production. This type of company, in an era of soft money, sucks in capital from investors that could otherwise be going to things with clearer pricing mechanisms, and thus can eventually lead to a period of supply shortages and price inflation elsewhere in the economy.

If, or *when*, a harder money environment returns — such as due to higher interest rates from the central bank trying to reduce price inflation — then investors realize that these perpetually unprofitable companies have been partial malinvestments all along. When money gets harder, fewer people are willing to pay up for the stock at such high valuations, and so the stock valuation falls. This makes it impossible for the company to keep raising capital to operate in its structurally unprofitable way. It then must raise prices and cut expenses to become profitable, but by doing so they slow down their growth rate, because part of their growth only existed in the first place by having underpriced their products or services relative to what it cost to produce them. And with that slower and more honest growth rate comes an even lower equity valuation, and thus the vicious cycle continues until most of the malinvestments are wiped out. It’s not necessarily that the product or service shouldn’t exist, but that it was priced incorrectly by users and investors for a prolonged period, and its real supply-demand balance at sustainable levels is only relevant to a smaller addressable market than it seemed to be for a while. It’s natural for early-stage companies to operate at a loss as they build their initial foundation, but it’s unnatural for a company that has been around for well over a decade to be persistently unprofitable as a matter of normal operation. Yet, weak money tends to lead to those types of companies increasing in prevalence.[256]

Weak money encourages people to constantly borrow and invest rather than to save, whether that borrowing and investing make sense or not. Hard money encourages people to save, and to only borrow or invest when it seems like it really makes sense. Monetizing things of utility, such as corporate equity and real estate due to a lack of good monetary alternatives, has tangible negative effects and contributes to unnecessary bubbles. It can increase the cost of things that should otherwise just be for utility (such as single-family homes); it gives large and liquid companies an extra edge over smaller companies; and it slows down the process by which business pricing serves as a method of communicating to consumers and investors what is scarce and what is not, which can lead to a misallocation of resources for prolonged periods of time.

NON-TRANSPARENT SUPPLY DILUTION

Anyone who owns units of something with a flexible supply must be constantly vigilant against being diluted.

The World Gold Council estimates that there is a little over 200,000 tonnes in total above-ground refined gold in the world, which translates into about 7 billion ounces.[257] Meanwhile, annual gold production is a little over 3,000 tonnes per year, and very little gold is destroyed or discarded every year. A holder of gold, therefore, must put up with the total gold supply increasing by about 1.5% per year. If they hold 10 one-ounce gold coins, then each year their amount of gold will represent a smaller and smaller percentage of all refined gold in the world. This rate of dilution has historically been fine because population growth and productivity growth have generally equaled or exceeded that 1.5% rate, and so each gold coin has maintained (or even mildly increased) its purchasing power for goods and services over centuries.

Any real estate investor knows that a big construction boom of new apartment complexes or new houses can have negative implications for existing house prices in an area. After a rapid period of new home construction, each previously existing house now represents a smaller piece of this expanded city, with plenty of new supply relative to demand, and so prices may stagnate or go down. This is good for new buyers but bad for existing owners. A way for property investors to defend against this over time has been to own very scarce property such as waterfront property, because no matter how big the surrounding area gets, builders can't really make more waterfront property — unless they're willing to do something very expensive such as build entirely new islands to do so.

Fiat currency tends to have a much faster dilution rate than gold or real estate. As recently as 2010, U.S. broad money supply was under $8.5 trillion. At the end of 2022, it was approximately $21.4 trillion.[258] This represents a 7.3% annualized growth rate. Meanwhile, most bank accounts paid next to zero interest on savings accounts and certificates of deposit for most of that time. Even if we round up the average savings account interest rate to 1% and exclude taxes on that interest, it means that the average cash deposit holder was diluted by 6.3% per year after interest. Each dollar they held represented a smaller and smaller percentage of all dollars, and at a much faster rate than what happened with gold or real estate. Of course, people can work and earn new dollars, but a lot of those new dollars that they earn would just be replacing the declining purchasing power of their existing dollars. It's like holding a bag of melting ice cubes and working to earn more melting ice cubes.

If commodities and/or foreign labor are abundant and low priced, and productivity keeps improving, then this rapid money supply growth might not translate to high consumer price inflation right away. Price inflation will be more industry-specific, such as prices of healthcare and childcare and attractive housing increasing at a much quicker pace than the price of shoes, grains, or foreign-made electronics. However, this rapid money supply growth environment does readily translate into an increase in asset prices for most things that are growing in supply more slowly than dollars. Is it any wonder, then, that throughout the 2010s, stocks basically went straight up, real estate basically went straight up, and fine art and other collectibles basically went straight up? Holding scarce or semi-scarce assets makes a lot of sense when money supply is growing at a pace that greatly exceeds the interest rate that holders get on cash and cash-equivalents.[259]

This becomes even more problematic for the saver when interest taxes and capital gains taxes are considered. Cash and bonds are bad enough when their interest rate is at or below the rate of consumer price inflation and the rate of money supply growth, but then to make the situation even less favorable, people must pay taxes on the interest they make. So, the tax-adjusted and dilution-adjusted interest rate on their cash and bonds is even more negative. And taxes on capital gains, being unadjusted for inflation or money supply dilution, represent a wealth tax upon sale even if actual purchasing power didn't increase.

Suppose, for example, that you buy a $300,000 house as an investment property. If, over the next decade, money supply growth goes up by 2% per year, and the average house price in the area goes up by 2% per year, then your house (if in line with the average) will be worth around $365,000 by the end of the decade. If you decide to sell the house, you'll need to pay perhaps a 20% capital gains tax on that $65,000 increase, which is $13,000 in taxes or about 4.3% of the original house price, or about 3.6% of the current house price. The purchasing power of the house didn't really go up; it just kept pace with monetary dilution, and you were taxed on that increase anyway.

Now, suppose instead you buy the same $300,000 house, but over the next decade, money supply growth goes up by 10% per year, and the average house price in the area goes up by 10% per year. At the end of this period, your house will be worth $778,000 and if you sell it, you'll owe a 20% capital gains tax on the $478,000 gain (totaling $96,000 in taxes) even though the house price just kept pace with monetary dilution. This $96,000 tax represents 32% of the original house price and 12.3% of the current house price, even though your purchasing power relative to other assets didn't really change. This shows that governments have an incentive to let inflation run hot, because thanks to capital gains taxes that are not adjusted for inflation or money supply dilution, they get a bigger share of transacted wealth if the dollar numbers are inflated.[260]

This example shows that when the rate of money supply growth is elevated, not only do cash and bondholders lose purchasing power, but even holders of hard assets could lose purchasing power if their hard asset merely kept pace with monetary dilution and then they were taxed on that monetary dilution. The same would be true for holders of equities, gold, and similar assets if they are mainly just keeping up with monetary dilution.

The hard way to avoid this problem of monetary dilution is to be a superior investor. If someone selects assets that generate considerably above-average returns, then they can outperform monetary dilution.

The easier way for an investor to avoid that problem of losing purchasing power due to the taxation of monetary dilution is to make use of artificially low interest rates when they exist by taking out long-duration debt. If the above-mentioned house was purchased with a fixed-rate mortgage at a low interest rate at the start of the decade, then in such a rapid 10%-per-year monetary dilution environment, the home equity would have grown at a much faster percentage than the price of the house. This is because the mortgage liability is fixed while the house asset price is expanding rapidly, resulting in major equity growth. This type of borrower is basically shorting all the cash savers in the market and pocketing the difference.

In general, the modern inflationary financial system rewards people who have access to low interest rate debt and then use quite a bit of it judiciously. If they run into problems and are big enough, making mistakes might even get them a bailout. The key to success, in other words, has been to borrow money, but not so much that you're among the first entities to fail during a recession. Savers regularly get diluted, overleveraged entities regularly default, and the sweet spot has been to be permanently leveraged without being overleveraged.

Notably, when looking across the world today and when looking back historically, there is somewhat of a bell curve regarding the relationship between debt levels and monetary hardness.

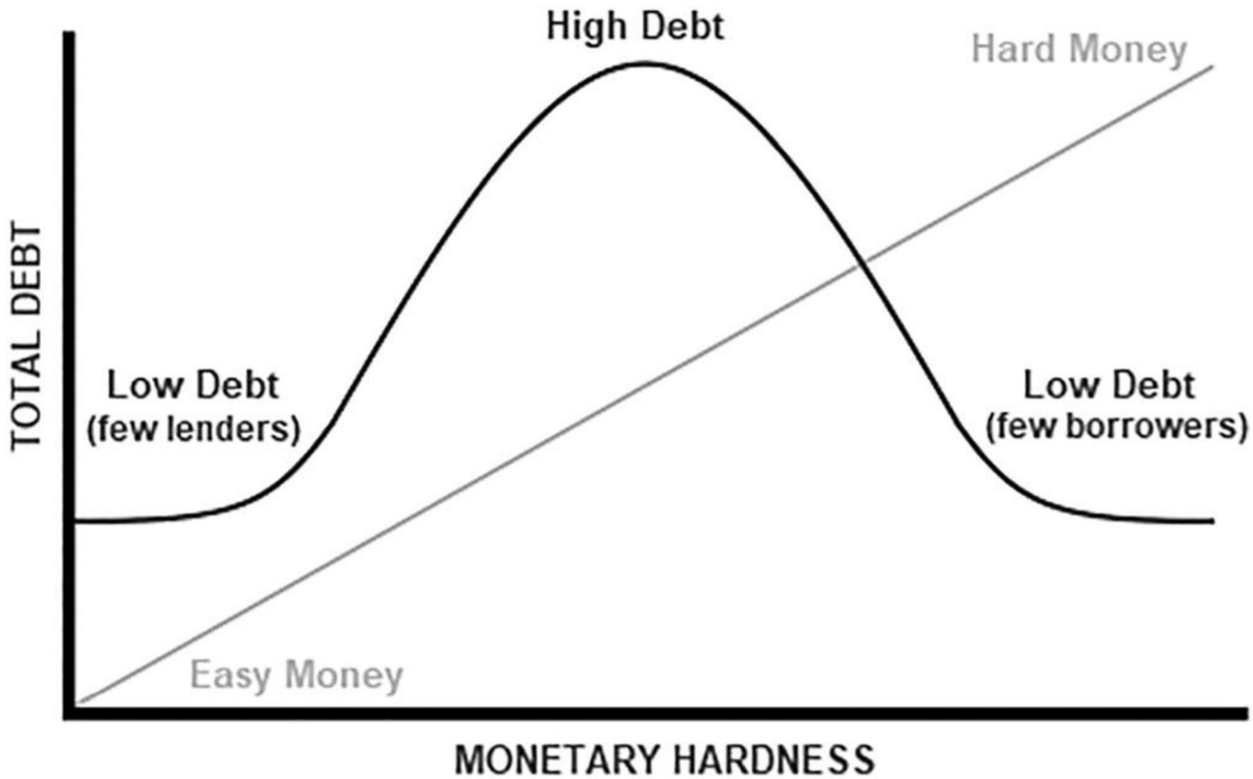

Figure 17-C

In very weak money environments, such as many developing countries with frequent periods of double-digit inflation and/or rapid currency devaluations, you won't find much long-term debt. Few lenders would be foolish enough to issue a 30-year fixed rate mortgage or a 30-year corporate bond in these types of monetary environments, because there's little reason to trust that the unit of account won't be rapidly debased during that time.

Hard money environments, on the right tail of the bell curve, tend not to encounter too much total leverage either, because borrowers are less willing to borrow money in an appreciating unit of account unless they have high conviction that they can put it to very productive use (such as the build-out of the railroads in the 19th century[261]). In those hard money environments, credit is still useful for activities with a high expected rate of return, but debt is used more judiciously.

Moderate money environments where fiat currencies devalue at a slow and steady rate hit the sweet spot for both lenders and borrowers. Borrowers happily take on moderate-term and long-term debt which devalues slowly over time and use it to acquire scarcer assets. Lenders happily lend at low rates as long as those rates are a bit higher than the cost of short-term financing, so that they can earn a spread on the difference, which they then lever up. Consumers, corporations, and governments all casually have 30-year debt on their balance sheets as a normal course of financing. Debt as a share of the economy tends to become maximally high in this scenario, which feels nice when it is all going up but becomes a severe problem when currency volatility one day finally returns against such a highly indebted system. In other words, due to the amount of debt accumulation that tends to occur within gradually devaluing currency systems, the carefully managed stability of this type of system is what eventually leads to its dramatic instability, and its inability to withstand periods of deflation.

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CHAPTER 18

BENEFICIARIES OF THE CANTILLON EFFECT

Whether arguing for or against them, many people focus on top-down wealth distribution mechanisms (such as progressive income taxes) because those are the most transparent. On the other hand, monetary dilution and access to very different interest rates can often be a less transparent, bottom-up wealth distribution mechanism, and in my view, it doesn't get enough coverage.

Someone who is financially struggling tends to have poor access to credit. It will be hard for them to get a low-rate mortgage, a business loan, or a personal loan. Instead, if they need credit, they'll often turn to credit cards and payday loans, which come with very high interest rates. Meanwhile, a wealthy investor often has access to very inexpensive forms of credit, especially because they also tend to have a lot of assets that they can use for collateral. This differentiation applies on the business scale as well. A small family-run hardware store will typically have a much higher cost of credit than a nationwide hardware retail chain that systematically grows across the country and displaces those various family-run hardware stores. Meanwhile, an entity with a lot of assets can use those assets as collateral for relatively low-rate debt, and they are big enough to have access to public capital markets (i.e., they can issue bonds to a very broad set of market participants rather than rely only on local banks).

To some extent this is to be expected; different interest rates should of course reflect the risk of lending money to different entities. However, in a financial system that is built entirely around very high levels of credit and a consistently devaluing unit of account, the difference between having access to cheap credit and not having access to cheap credit becomes far more important. The ability to effectively short fiat currency with long-term debt at low interest rates has historically been a *key mechanism* of wealth creation in this inflationary system, and the inability to do so represents being shut out of that key mechanism of wealth creation.

In contrast, in a more equity-focused system centered around hard money, there would be less of a built-in advantage for large and well-connected entities that have access to cheap credit. Access to credit is still useful in the right contexts in a hard money environment, but it’s a smaller part of the typical capital structure, and the systematic practice of borrowing money for decades for the primary purpose of shorting fiat currency would not be a part of it, and thus the performance gap between large and well-connected entities and smaller entities would not be as wide.

The primacy of credit access and the associated widening performance divide between large and small entities that occurs in a debt-based, weak money system is an interesting dilemma in its own right. Where it really goes off the rails is when governments perform selective bailouts during crises with printed money, at a time when governments are themselves heavily financially influenced by the largest corporate donors.

During the 2008 subprime mortgage crisis, the U.S. federal government authorized hundreds of billions of dollars of low interest loans to large banks amid the crisis to keep them liquid and solvent. Asset prices had crashed and hardly anybody had access to cheap credit at that time, but these banks were given artificially cheap credit by the government and could use it to swoop in and buy up assets and distressed competitors (who weren’t given such credit) at fire sale prices. In total, banks and their executives received a lot of support from the government while the middle-class homeowners received little or none. Being given massive amounts of below-market-rate credit by the U.S. federal government with printed money at a time of distressed asset prices and distressed competitors is an absolute goldmine of value. The U.S. Treasury secretary at the time of this disbursement was himself the former CEO of Goldman Sachs, and Goldman Sachs was one of the recipients of this selective credit. Employees of bailed-out Wall Street firms went right back to receiving huge bonuses, and executives of would-be bankrupt banks who made all sorts of bad loans in the years prior walked away with eight-figure retirement packages.[262] Meanwhile, many homeowners on the other side of that ended up losing their homes, as they were given minimal fiscal support or credit support. Plenty of people made mistakes, but the rich and well-connected people were far more likely to be bailed out than the average person.

During the March 2020 COVID-19 lockdown crisis, financial markets completely seized up. Even the U.S. Treasury market went almost completely illiquid, and so the Federal Reserve printed over $1 trillion in new bank reserves within a three-week period to buy U.S. Treasuries and re-liquefy the market, and then kept buying more from there.[263] This allowed the U.S. federal government to keep financing itself despite seized-up and illiquid Treasury markets. Businesses everywhere suddenly faced the risk that people would choose to remain at home as much as possible for the next several months for safety, and therefore spend less at many types of businesses temporarily. Some areas also had forced lockdowns. Normally, the Federal Reserve is not authorized to print money to buy corporate bonds, but the U.S. federal government gave them authorization to do so during this crisis with a special purpose vehicle and specific financing. When the U.S. corporate bond market froze, the Federal Reserve therefore stepped in to buy them with printed money and re-liquify that market too, allowing large publicly traded corporations to continue issuing new debt and refinancing existing debt at low interest rates without a problem.[264] It only took a small sum of money by the Federal Reserve to send the signal to the market that the corporate bond market would be protected at all costs, and so private sector market makers stepped back in and kept the corporate bond market functioning.

However, there was no such immediate response to help small local businesses, nor were there the financial logistics in place to even do so. The Federal Reserve could buy corporate bond ETFs in giant baskets and help re-liquefy corporate bond markets quickly and easily, but the complexities of providing credit assistance to millions of small family-run restaurants and other businesses took a lot more time. Therefore, many of them went out of business early in the pandemic, while their large publicly traded corporate competitors were more easily bailed out by these centralized liquidity programs.

And then, to try to address that imbalance, Congress introduced the Paycheck Protection Program as part of the CARES Act. The Paycheck Protection

Program provided hundreds of billions of dollars of loans to support small businesses (up to 500 employees), and those loans were later forgiven, which turned them into outright grants, paid for with printed money. At first glance, this made sense: Small restaurants and businesses like that could receive a few months of support during a temporary pandemic crisis, and indeed, many businesses were saved by it. Deploying resources into hard-hit areas during a time of crisis makes sense. However, it took longer to get this money to the small businesses than it took to get financing for corporations, and this program did not effectively filter out the types of businesses that didn't need the aid. An owner of a high-margin law firm or a high-margin investment research firm, for example, could receive a $500,000 or $1,000,000 grant even if their business wasn't really in trouble and they were able to pay employees as normal. In that case, this money dropped right to the bottom line of the already wealthy owners.[265]

A 2022 study by the American Economic Association called, "The $800 Billion Paycheck Protection Program: Where Did the Money Go and Why Did It Go There?" found that three-quarters of the funds went to the top 20% wealthiest households, and very little went to actually keeping workers in their jobs:

> The Paycheck Protection Program (PPP) provided small businesses with roughly $800 billion dollars in uncollateralized, low-interest loans during the pandemic, almost all of which will be forgiven. With 94 percent of small businesses ultimately receiving one or more loans, the PPP nearly saturated its market in just two months. We estimate that the program cumulatively preserved between 2 and 3 million job-years of employment over 14 months at a cost of $169K to $258K per job-year retained. These numbers imply that only 23 to 34 percent of PPP dollars went directly to workers who would otherwise have lost jobs; the balance flowed to business owners and shareholders, including creditors and suppliers of PPP-receiving firms. Program incidence was ultimately highly regressive, with about three-quarters of PPP funds accruing to the top quintile of households. PPP's breakneck scale-up, its high cost per job saved, and its regressive incidence have a common origin: PPP was essentially untargeted because the United States lacked the administrative infrastructure to do otherwise. Harnessing modern administrative systems, other high-income countries were able to better target pandemic business aid to firms in financial distress. Building similar capacity in the U.S. would enable improved targeting when the next pandemic or other large-scale economic emergency inevitably arises.[266]

During the 2020 and 2021 crisis stimulus response overall, the typical person received several thousand dollars in stimulus checks and extra childcare tax credits, but there were wealthy lawyers, investment managers, and business owners that received hundreds of thousands of dollars per person in unneeded fiscal aid, and certain corporations that received billions of dollars and laid off employees anyway. All of this was with printed money, which devalued the savings of anyone holding cash or bonds. As the dust settled over the following years, the combination of fiscal stimulus and the recovery of asset prices led to very uneven results. The bottom 50% of the population collectively saw their net worth increase by $1.5 trillion from the beginning of 2020 to the beginning of 2022. The top 1% of the population collectively saw their net worth increase by $11.8 trillion over the same period[267]. There were trillions of new dollars in the system, and prices went up as a result. Some people in the upper-middle class, like working physicians, received little or no aid and had to deal with prices going up from all of this monetary dilution, and so they were basically left out between wealthy business owners that received aid and lower-income people that received aid. Similarly, some businesses didn't apply for the Paycheck Protection Program, and thus were at a competitive disadvantage to businesses that applied for it and received it despite not really needing it.

During the economic expansion of the 2010s decade, many airline companies (large, publicly traded corporations) decided not to build any significant cash reserves and instead to spend most of their profits on dividends and share buybacks for investors. When the 2020 COVID-19 crisis hit and air travel volumes collapsed, many airlines faced the prospect of bankruptcy. If airlines were to go bankrupt, it's not as though they would cease to exist. Instead, their debtholders would face a partial loss and become the new equity holders in the bankruptcy proceedings, and the former equity holders would be wiped out. If this were to occur, airlines with more conservative financial situations (who had purposely grown more slowly with less debt, paid fewer dividends and buybacks to shareholders, and maintained larger cash reserves) would have had a better prospect of surviving through the crisis than their more aggressively leveraged competitors.[268] Prudence would have been rewarded.

Instead, the U.S. federal government spent tens of billions of dollars bailing out the airline industry, and beyond that also offered subsidized loans (access to credit at below-market rates) to them. This rewarded airlines that aggressively expanded with cheap debt throughout the 2010s decade, that didn't save any profits, and who had instead borrowed money, maintained a weak balance sheet, and sent as much cash as possible to shareholders when times were good. Anyone prudent enough to run an airline corporation more conservatively at the cost of slower growth and/or less dividends for shareholders so that they could weather potential recessions more safely, was punished in hindsight for all of those years of prudence.

This uneven and scattershot fiscal aid to people and businesses didn't come from any stockpile or reserve. The U.S. federal government did not save money during good times to have a reserve from which to bail out failing firms during bad times. Instead, the U.S. federal government issued trillions of dollars in new bonds, which were promptly purchased by the Federal Reserve with brand new bank reserves that were printed out of thin air. Therefore, both the amount of base money and broad money grew rapidly during 2020 and 2021. Over a 2-year period from the start of 2020 to the start of 2022, the broad money supply increased by approximately 40%.[269] Printing money in this way devalued savers, bondholders, and in general people who didn't receive much aid, and rewarded debtors and those who received large amounts of aid (keeping in mind that the biggest recipients of aid were corporations and business owners). Large institutions with low fixed-rate debt or other cheap sources of credit were able to basically short fiat currency throughout this process by maintaining debt with interest rates that were below the inflation rate and way below the rate of new money creation, and the government and central bank directly stepped into the corporate bond market with injections of new liquidity to make sure they could keep doing that.

If the monetary environment had been such that it encouraged savings and more careful use of credit in the first place, then the economy would be better positioned to handle an external shock such as a pandemic. But because it instead encourages and rewards large usage of credit, the system is highly leveraged and incredibly vulnerable to any sort of external shock that could disrupt cash flows. And then the selectivity and the logistics limitations of providing bailouts during a crisis naturally favors those that are larger and closer to the source of money creation.

The Cantillon effect, identified in the 18th century by Richard Cantillon, describes the uneven effects of new money supply on price inflation. Suppose, for example, that someone discovers a huge new gold mine in an economy where gold is widely used as money. As they mine and sell that new gold supply onto the market, the original seller will get a pretty good exchange rate for it and will be able to buy all manner of goods and services with it at current prices. Secondary recipients of the new gold (the merchants who sold goods and services directly to the original gold miner) may also get a pretty good price for the products and services they buy with it. However, over the next few years as the gold money supply noticeably increases throughout the economy, and people have more gold to spend in general, it'll likely result in price inflation, since more money is in circulation chasing a similar amount of goods and services. The closer and earlier someone was to the original injection of new gold into the economy, the better off they were. It was best to be the original gold miner, and second best to be among the earliest merchants to receive that new gold. The worst place to be in this situation was to be a common worker who, after prices have *already* gone up by quite a bit due to so much new gold circulating around the economy, is barely able to convince her boss to get a small wage increase just to partially keep up.[270]

In a fiat currency system, this Cantillon effect is heightened. Selective bailouts and government-subsidized credit given out with newly created money at a time of acute liquidity crises benefit entities that are large and well-connected. In general, big entities (especially large banks and corporations) benefit from this system over small entities because they can reliably get access to cheap debt, which represents a short on the diluting currency and a method to buy more scarce assets with it. These entities, being close to the sources of money creation, have the benefit of access to capital markets and easy loans (during the good times) and bailouts (during the bad times). It's a system with inherently centralizing aspects that tends to help existing winners continue to win more. And then winners can go on to become the biggest political donors and maintain their all-important access to the money printer when needed.

From the perspective of large financial entities, in addition to outcompeting smaller competitors directly, it makes a lot of sense to buy smaller competitors, refinance them, and/or leverage them up with cheap debt. For decades, large corporations and private equity firms did exactly this, making use of the fact that they had access to cheaper credit than smaller entities to buy those smaller entities and consolidate them, and it has been incredibly lucrative. When money is persistently weak, the smart strategy is to grow big and to get better and better access to cheap financing.

Over the past several decades, especially in the United States, small stores have gradually been displaced by large national chains, and small banks have gradually been acquired into larger banks. In 1972, according to FDIC, there were 13,733 banks in the country with 24,829 branches. Fifty years later in 2022, there were only 4,135 banks with 71,190 branches.[271] Although the population increased and the number of branches increased (not to mention all the online banking that the industry shifted toward), the number of separate banks dropped dramatically and consolidated into fewer, larger ones. And even those statistics understate the level of concentration; in 2022 the top ten banks alone had 55% of all bank assets, with the other 4,000+ combined banks holding the remaining 45%.[272] Due to a rapid tightening of monetary policy in 2022, cash was sucked out of community and regional banks more quickly than large nationwide banks, and by 2023 this contributed to a series of bank runs.[273] The number of banks is likely going to keep consolidating toward smaller numbers.

Overall, an environment of persistent currency debasement and selective access to cheap credit naturally favors larger entities over smaller entities and tends to centralize wealth and influence over time toward those that control those larger entities. Within this system, the biggest debtor that always gets access to cheap credit and plenty of liquidity is the U.S. federal government, whose debt will readily be purchased by the Federal Reserve with new base money whenever needed. Below that, the major U.S. banks and corporations have been constantly enabled — by both Federal Reserve activity and fiscal stimulus by Congress — to get access to cheap and liquid debt markets even during crises when liquidity naturally dries up for less well-connected entities. In the middle of the list in terms of credit access are small businesses and normal homeowners who have more selective access to cheap credit only when times are good, and at the bottom of the list are those in the working class or in poverty who rarely have access to cheap credit.

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CHAPTER 19

THE LONG-TERM DEBT CYCLE

There’s a cycle as old as civilization, at the heart of both politics and economics: It’s about the exponential accumulation of debt and the inevitable financial resets that occur whenever debt reaches a societal breaking point. The reason the cycle is so old and repetitive is that the exponential nature of financial debt conflicts to some extent with human nature, while also touching on the deep societal questions of what we ultimately owe to each other.

Wealth and debt both tend to concentrate over time within a society. Someone making a low income must spend practically all their income on shelter and sustenance. Once someone can make some surplus income for one reason or another, either due to natural gifts or external good luck and has the temperament and knowledge to compound it, then they can do so exponentially. At that point, wealth begets more wealth. And at a high enough level, wealth can beget more political influence, to shift public finances more toward them, which begets even more wealth. They can also give their children more nutritious food and a top-tier education, along with any investment capital and high-end connections they might need, to start them with an accelerated boost and maintain what is akin to a dynasty that can compound on itself.

In older times, when most people worked in agriculture, failed harvests or other natural catastrophes would often result in them and their family members becoming debt slaves. People stuck in debt slavery often had limited means to ever get a surplus income and get out of their situation. After several failed harvests or other accumulating problems, a greater and greater share of a society would be in debt slavery, either literally or nearly so, while a vanishingly small percentage of people near the top held almost all the assets and credit. After a certain point, this situation risks manifesting itself in societal breakdown because many of those debt slaves can look around, realize how great their numbers are, and initiate a violent revolution. Credit is a human construct and begins to look especially arbitrary to people when it was primarily accumulated by past circumstances and ancestors.[274] So, if enough people become angry and feel that things are unfairly stacked against them, they can show the handful of owners of that credit how fragile their claims to such credit really are.

In the modern context, now that most people don’t work in agriculture anymore, we can identify various new ways people get stuck in debt traps. It could be as basic as a medical debt that compounds over time. It could be that they took out too much student debt as a teenager, couldn’t get an income large enough to offset it, and thus are stuck with it for decades (and in some jurisdictions, student debt is not dischargeable even in bankruptcy, unlike most other forms of debt).[275]

For a poor person, banking ironically gets more expensive too; they run into overdraft fees as well as fees for having a low account balance, while the wealthy are rewarded with waived fees and extensive rewards[276]. Any loans that a poor person may take out to make ends meet, such as payday loans or credit card loans, come at incredibly high interest rates, while the wealthy can borrow at cheaper rates. Furthermore, people who are poor in wealth often become poor in time as well; they have more frictions and time sinks throughout their day to achieve the same tasks (no car, no childcare, no in-home laundry machines or dishwashers, and so forth). Even basic things like tickets for various violations, being at a flat rate in most jurisdictions, are irrelevant for the wealthy while being financially damaging for the poor. If impoverished people can’t pay tickets, some jurisdictions put them in jail, and then charge them for their jail stay, which further disrupts their finances both in terms of time and money and the ability to earn an income. In developing countries, a considerable percentage of people don’t even have access to a bank account, since bank accounts have substantial overhead costs and aren’t economical for tiny balances. So, many of these people stash what little savings they have in physical currency under their mattress, which keeps getting debased without being offset by interest payments that bank account holders receive.

Debt and poverty have an exponentially compounding aspect to them, sending people ever lower, while credit and wealth have an exponentially compounding aspect in the other direction, sending people ever higher. Peoples' instincts and ways of interpreting the world are generally linear while compounding is exponential, and this mismatch tends to break all our societal models over time.

However, if violent revolution occurs, it is more often the case that poverty is redistributed upwards rather than wealth being redistributed downwards. Rather than the poor becoming wealthy, the wealthy become newly poor alongside the existing poor. The wealthy are overthrown, but along with them the whole system risks being plunged into chaos, and the fragile set of economic incentives risks being destroyed. For the most part, only the people who become wealthier from this process are the handful of leaders of the new regime.

For this reason, kings have been performing periodic partial debt jubilees on a regular basis stretching back to Hammurabi of Babylon and before, as well as other periods and places throughout antiquity. The goal is to partially reset the playing field occasionally before the playing field completely breaks.[277] A technical analogy is that if you leave a computer on long enough, "memory leaks" gradually build up until there is no unencumbered memory left, and the computer crashes. Restarting the computer frees up the unencumbered memory and starts the system anew. If the computer is left on long enough with no response by the user as it starts to slow down and become buggy, it can eventually crash while the user is in the middle of work and lose unsaved data, which can be quite damaging. On the other hand, performing a more proactive reset occasionally or when early signs of the problem begin to arise, can minimize the disruption that a computer crash would cause.

In their book *Lessons of History*, Will and Ariel Durant ended their chapter on economics and history as follows:

> We conclude that the concentration of wealth is natural and inevitable, and is periodically alleviated by violent or peaceable partial redistribution. In this view all economic history is the slow heartbeat of the social organism, a vast systole and diastole of concentrating wealth and compulsive recirculation.[278]

As a way of opting for peaceable partial redistribution rather than risking violent revolution, some civilizations historically encoded this process into their laws or traditions on a regular basis. The Hammurabi Code, for example set limits on debt-slavery durations:

> If any one fail to meet a claim for debt, and sell himself, his wife, his son, and daughter for money or give them away to forced labor: they shall work for three years in the house of the man who bought them, or the proprietor, and in the fourth year they shall be set free.[279]

Furthermore, Babylonian kings would often forgive all consumer debts when taking power after the death or abdication of a predecessor. Certain business debts and so forth would remain in effect, but consumer loans to everyday people would be wiped clean, and debt slaves set free, often with a celebration and a literal breaking of the clay ledgers.

Recurring debt cancellation shows up in Deuteronomy 15 as well:

> At the end of every seven years you must cancel debts. This is how it is to be done: Every creditor shall cancel any loan they have made to a fellow Israelite. They shall not require payment from anyone among their own people, because the Lord's time for canceling debts has been proclaimed. You may require payment from a foreigner, but you must cancel any debt your fellow Israelite owes you. [...] If any of your people — Hebrew men or women — sell themselves to you and serve you six years, in the seventh year you must let them go free. And when you release them, do not send them away empty-handed. Supply them liberally from your flock, your threshing floor and your winepress. Give to them as the Lord your God has blessed you.[280]

In *Lessons of History*, Will and Ariel Durant identified an example of a partial reset from Ancient Greece:

> In the Athens of 594 B.C., according to Plutarch, 'the disparity of fortune between the rich and the poor had reached its height, so that the city seemed to be in a dangerous condition, and no other means for freeing it from disturbances seemed possible but despotic power.' The poor, finding their status worsened with each year- the government in the hands of their masters, and the corrupt courts deciding every issue against them- began to talk of violent revolt. The rich, angry at the challenge to their property, prepared to defend themselves by force. Good sense prevailed; moderate elements secured the election of Solon, a businessman of aristocratic lineage, to the supreme archonship. He devalued the currency, thereby easing the burden of all debtors (although he himself was a creditor); he reduced all personal debts, and ended imprisonment for debt; he cancelled arrears for taxes and mortgage interest, he established a graduated income tax that made the rich pay at a rate twelve times that required of the poor; he reorganized the courts on a more popular basis; he arranged that the sons of those who had died in war for Athens should be brought up and educated at the government's expense. The rich protested that his measures were outright confiscation; the radicals complained that he had not redivided the land; but within a generation almost all agreed that his reforms had saved Athens from revolution.[281]

I've always found that Greek description interesting, because if the names are replaced, we can imagine modern-day politicians taking both sides in that debate. Those who hold the credit (or represent those who do) generally want to preserve the sanctity of credit and the idea of paying one's debts through personal responsibility, strong property rights and hard money policies. Those who owe the debts (or represent those who do) generally point to the structural injustices in the system and the self-reinforcing corruption of those at the top, thanks to the combination of business and political power coming together. Both sides have a point but often talk past each other, because they have a linear perspective on the world in face of the cold hard math of exponential compounding. And to the extent that they can't resolve the situation due to unworkable differences, they eventually risk getting violent revolution instead, where almost nobody wins. The wealthy find out that without broad societal agreement, their fragile claims on a highly interdependent society don't amount to much. The poor find out that merely taking from the wealthy does not make themselves wealthy in their place.

The most productive discussions seem to occur between those who appeal to the other side's rational self-interest. Someone representing debtors, for example, can argue that having broad access to education, healthcare, and some financial breathing room among the public results in more overall productivity and growth for the economy. A small bit of investment or relief from the creditors in the short term, in other words, can pay for itself many times over with a larger economic pie, less crime, and more societal harmony that makes even those creditors wealthier and happier in the long term. Someone representing the creditors, meanwhile, can argue that although such relief can be provided to a certain extent, that core incentive structures of business and profit and property rights must be preserved; naïve thoughts on complete wealth equality or total redistribution are better off discarded, lest they lead to even more widespread poverty and misery for those that are already indebted, by destroying all the necessary economic incentives that lead to the efficient production of goods and services.

In addition to credit compounding exponentially, laws tend to compound as well. Politicians pass more and more laws and regulations over time, and often with an emphasis on favoring those who are in power and are donating to them. Even well-meaning politicians often want to fix things with new laws, but one problem is that old laws are rarely erased; instead, they tend to stack on top of each other, making it more and more burdensome for businesses to understand and work within their boundaries. As a result, administrative overhead expands, tax accounting expands, and productivity decreases. That's not to say that regulations are bad per se, but that layers of regulations that trend toward ever more complexity are unsustainable. Historically, during major credit-clearing cycles, there tend to also be legal-clearing cycles, which further increases the danger of such a point in history because everything is up for being rewritten.

Some societies — whether it's Babylon four thousand years ago, Athens in the sixth century B.C., or the United States in the 1930s and 1940s — manage to navigate these pivotal moments in a way that avoids violent revolution, partially resets the board, and keeps the existing incentive structures intact and functioning well. Other societies don't, and failing to find that type of compromise often leads to much darker outcomes, such as the Russian Revolution of 1917.

SHORT-TERM FIAT CURRENCY BUSINESS CYCLES

Most readers of this book will be familiar with the cyclical ebbs and flows of the modern economy, which have been discussed in earlier chapters. Many people debate their causes, including to what extent they are natural and inevitable and to what extent they are caused by central bank policy mistakes, but either way, we know they exist and that we have experienced many of them.

At the start of an economic expansion, businesses and consumers start to recover from the previous economic contraction, and so they begin to take on more debt and risk. This is often because central banks have cut interest rates and provided extra assurances and liquidity to institutions, to encourage more borrowing and lending. As the expansion progresses, this higher and higher level of debt and eventual over-investment (from businesses) and overconsumption (from households) make them increasingly leveraged and fragile. Asset prices generally move from being cheap to being expensive during this process as well. By the end of the cycle, a lot of investments are not very sober-minded, and are based on unrealistic growth expectations and euphoria, and so resources become utilized less productively. By this point, the economy is likely running very hot, and a central bank is likely to be raising interest rates, which can pop the credit bubble that they themselves contributed to at the start of the cycle.

Eventually, some negative catalyst (such as an external shock or a self-imposed central bank policy error), combined with the elevated debt levels and malinvestments, triggers an economic contraction and period of deleveraging. Businesses, facing weaker revenues, reduce their number of employees, which means fewer people have money to spend on other businesses, which can lead businesses to reduce their employee numbers even more. Policymakers usually respond by offering lower interest rates and liquidity provisions to well-connected borrowers, along with fiscal stimulus to offset this otherwise deflationary period. Some defaults occur, the system cleans out some of the excesses of malinvestment and unproductive leverage, and then the cycle starts anew.

A problem is that in a centralized fiat currency system, where policymakers have a lot of flexibility over the base layer of the system, deleveraging is rarely allowed to reduce debt levels all the way back to where they started in the cycle. As the deleveraging begins to occur, fiscal lawmakers and monetary policymakers respond with stimulus to get the next economic expansion started as quickly as possible. By the time the dust settles on a short-term deleveraging event, businesses will have collectively reduced some of their debt, but still have more debt than when they started the previous short-term cycle. Monetary policymakers at this point have cut interest rates and provided liquidity to try to encourage more credit growth again.[282]

In 1987, stocks crashed unusually sharply. The leaders of the Federal Reserve backstopped it with liquidity arrangements and had various phone calls with commercial banks to give them assurances, with the goal of avoiding a broader credit contagion. In 1998, an extremely large and leveraged hedge fund called Long-Term Capital Management blew up from bad bets, and the Federal Reserve provided liquidity arrangements, cut interest rates, and coordinated a bailout for the hedge fund among 14 banks to avoid a broader credit contagion. This 1998 liquidity backstop contributed to the subsequent two-year parabolic blow-off top in equities during the 2000 dot-com bubble. In the recessionary aftermath of the unwinding of that dot-com bubble, the Federal Reserve cut interest rates down to 1%, which subsequently encouraged massive borrowing and speculation in the housing market over the next several years, which then blew up in 2008 after years of excesses. Throughout this multi-decade process, excess credit was never allowed to clear naturally, and it was repeatedly backstopped and pushed ever higher.

Figure 19-A shows U.S. business cycles over the past five decades up until right before the COVID-19 crisis. Corporate debt as a percentage of GDP decreased during recessions but kept making higher lows and higher highs, and this is in significant part because interest rates reach lower and lower in each cycle and allow for that increased debt accumulation over time. This is driven in part by monetary policymakers.

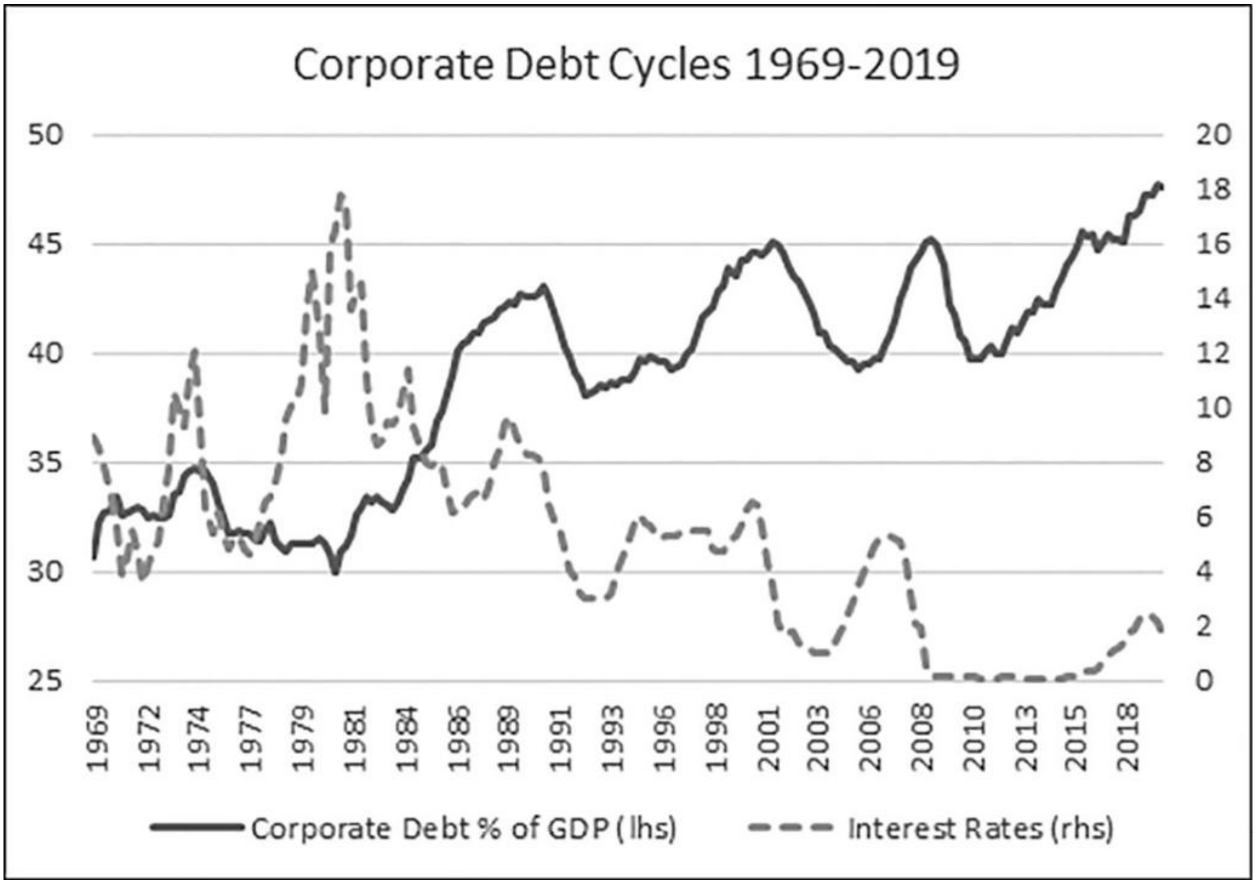


Figure 19-A[283]

Federal debt accumulation, meanwhile, tends to run countercyclically to this trend. Federal debt increases swiftly during recessions, because tax revenues fall due to lower economic output, and federal spending increases to offer extra unemployment benefits and other fiscal stimulus. Meanwhile, the United States engaged in the "War on Terror" which more-so than prior wars was financed by debt.

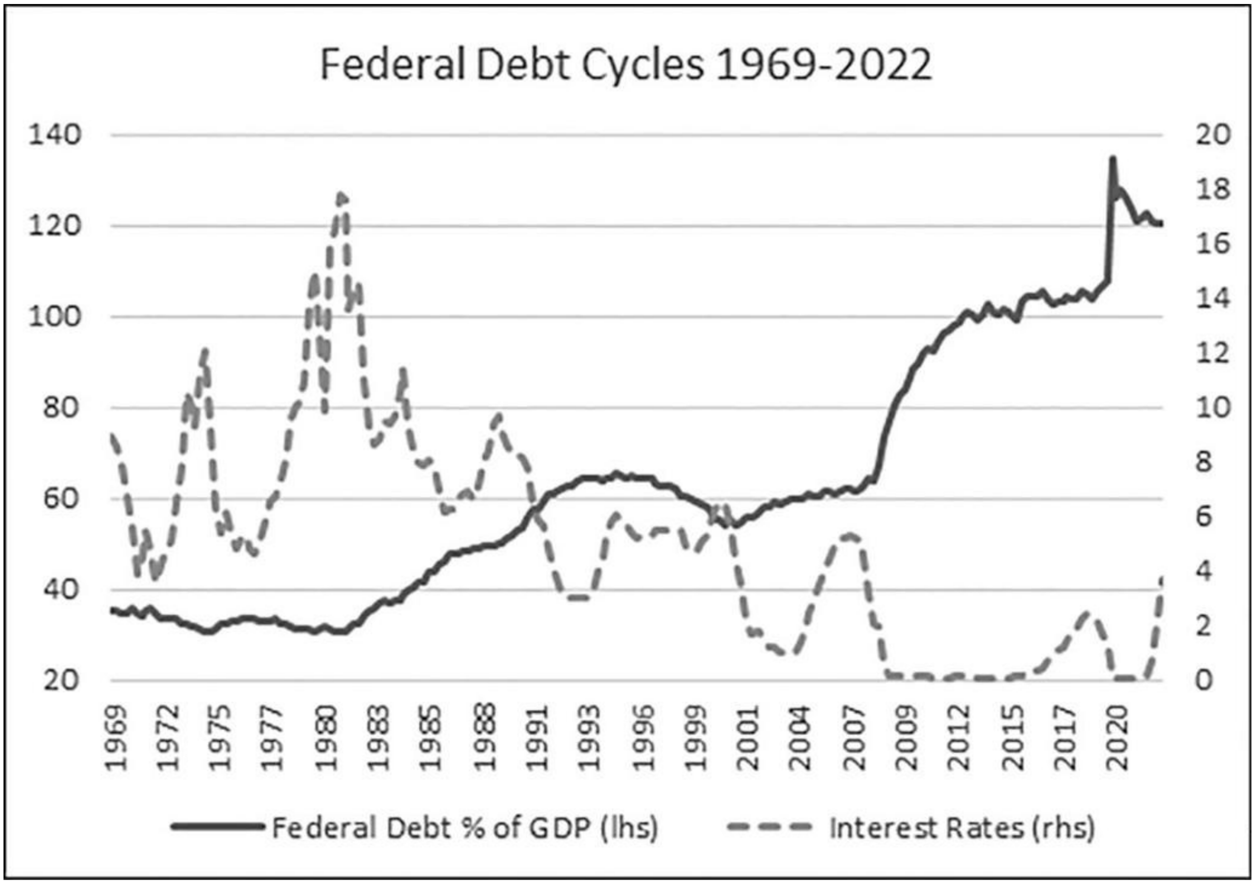


Figure 19-B[284]

If the government is trying to smooth out economic growth via countercyclical policies in a sustainable way, then in that framework the government should run a surplus and build a reserve during an economic expansion and then run a deficit from that reserve during a contraction, so that over the course of a full cycle the budget is balanced but is also flexible. In reality, due to the incentive structure that politicians operate under, they run fiscal deficits almost all the time. There's little or no political incentive to run a surplus in any near term, and so it is rarely ever done. Therefore, public debt relative to the size of the economy normally moves mildly upward even during times of strong economic growth, and then further accelerates upward during recessions. Meanwhile, whenever private sector debt risks contracting even mildly, monetary policymakers step in to stop that from happening too broadly.

Figure 19-C shows total U.S. debt (public and private combined) from the start of 1952 ($461 billion) to the end of 2022 ($93.5 trillion). The reader can see the smooth, tightly curated trend upwards. Throughout this entire seven-decade period, the total amount of debt in the system was never allowed to decrease,

except for a brief period amid the massive 2008 financial crisis where it managed to fall by just 1.3% before continuing its smooth, ever-higher, trend.

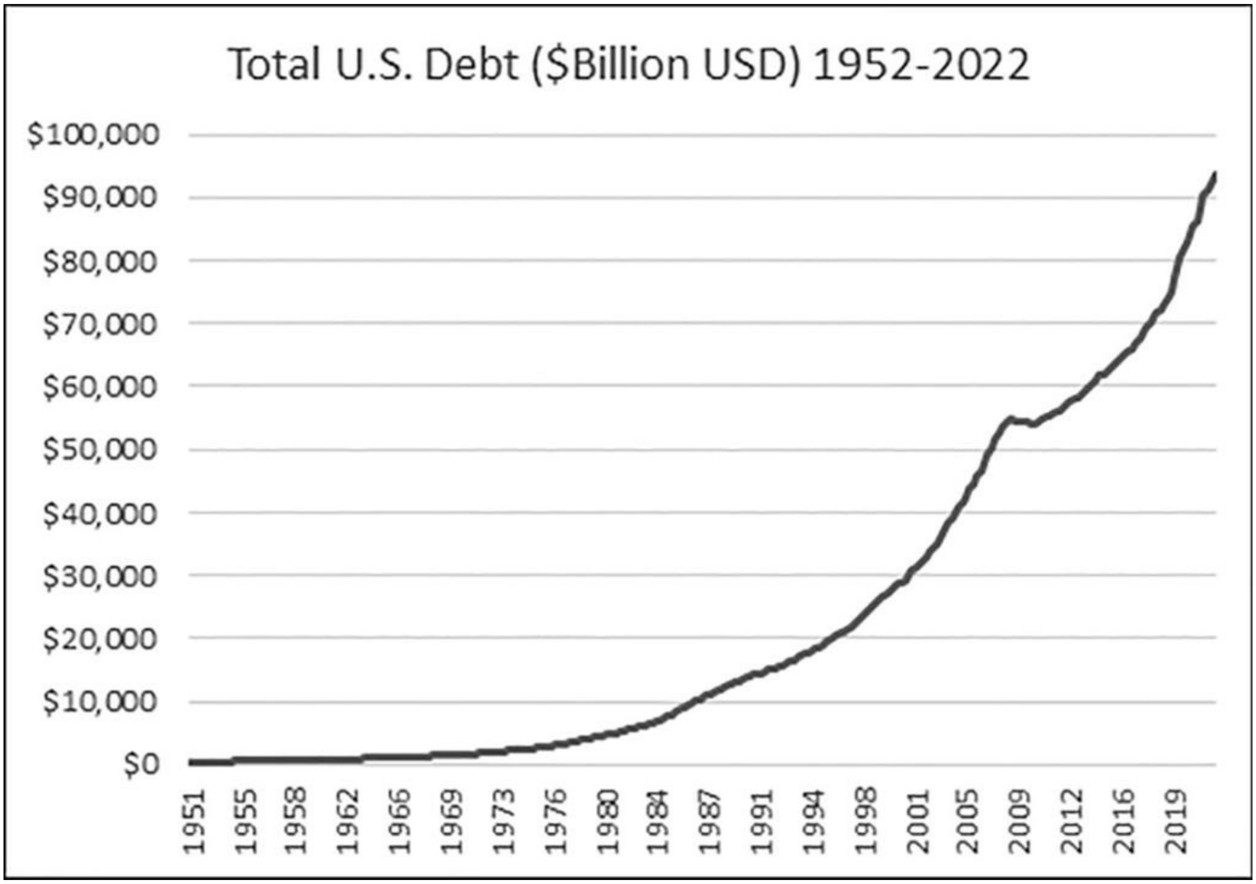


Figure 19-C[285]

This again brings up my theme regarding the gap between the speed of commerce and the speed of settlement that has existed since the second half of the 19th century, starting with the invention of intercontinental telecommunication systems, and continuing through to the present day. Rather than blaming individual politicians for handling the budgets of countries poorly or blaming individual central bankers for handling private sector credit poorly, I instead point mainly toward sound money principals being nearly impossible to implement with the current level of monetary technology that we've had over the past century and a half. With the ability for central banks to print fiat currency as needed, and the speed of hard physical monies (e.g., gold) being too slow to present a realistic alternative payment system compared to fiat currency ledgers, it inevitably shifted political incentives toward constant fiscal deficits, constant credit growth, and constant currency devaluation, with little or no recourse for those who disliked this situation.

As far as the probability of perpetual debt growth is concerned, it hardly matters who is in charge.[286] Even if a politician were to be genuinely concerned about government debts and deficits and campaign on this topic, they wouldn't get very far in politics and wouldn't be well liked by the broad public if they were to implement their preferred policies in office. They usually wouldn't even be able to get broad enough support among fellow politicians or the broad public to begin implementing them. Meanwhile, the same thing happens to central bankers. Alan Greenspan, serving as the chairman of the Federal Reserve System from 1987 to 2006, was a significant gold enthusiast before his long tenure at the Federal Reserve, and yet during his tenure he promoted smooth and ever-rising debt growth even more than other Federal Reserve leaders. While we can of course blame partially corrupt individual politicians, instances of crony capitalism, and selective bailouts to well-connected entities financed by money-printing, the underlying problem is that all the incentives that are currently in place tend to filter this type of behavior to the top of the system, over and over.

Combining this all together, the modern economy is incentivized to build a string of several short-term business cycles over the course of decades that result in higher and higher government, corporate, and household debt levels relative to the size of the economy. This can occur until interest rates reach zero (or even slightly negative) and policymakers run out of fuel to encourage more and more credit growth. At that point, something different and bigger happens.

LONG-TERM FIAT CURRENCY DEBT CYCLES

In 2008, banks across the United States began to collapse, and the entire financial system was beginning to fracture down to its foundation. The Federal Reserve dropped interest rates all the way to zero for the first time in generations, but even that wasn't nearly enough. They subsequently stepped in with an unprecedented number of emergency actions, and quickly doubled the entire monetary base within the course of a year.[287] Meanwhile, Congress stepped in with emergency fiscal bailouts and loans to keep vast portions of the financial system from becoming insolvent at once.[288]

On the surface, this occurred because many banks made risky loans, packaged them together into opaque securities, and had them stamped with perfect credit ratings by badly incentivized credit rating agencies, which allowed those opaque securities filled with bad loans to be levered up even more. But how could a few years of a housing boom and silly lending and securitization processes lead to a financial calamity of this scale? The answer is that there was a lot more going on underneath, which had been building through decades of prior short-term business cycles, and these excessive behaviors were merely coming to the surface.

At the end of 2007, there was $52.7 trillion in total U.S. debt, spread between federal debt, state debt, corporate debt, household debt, and other sorts of debt. This was all on a monetary base of just $837 billion. Each dollar of debt represents a claim to be paid dollars in the future, and in 2007, there was 63 times as much debt in the system as there was base money.

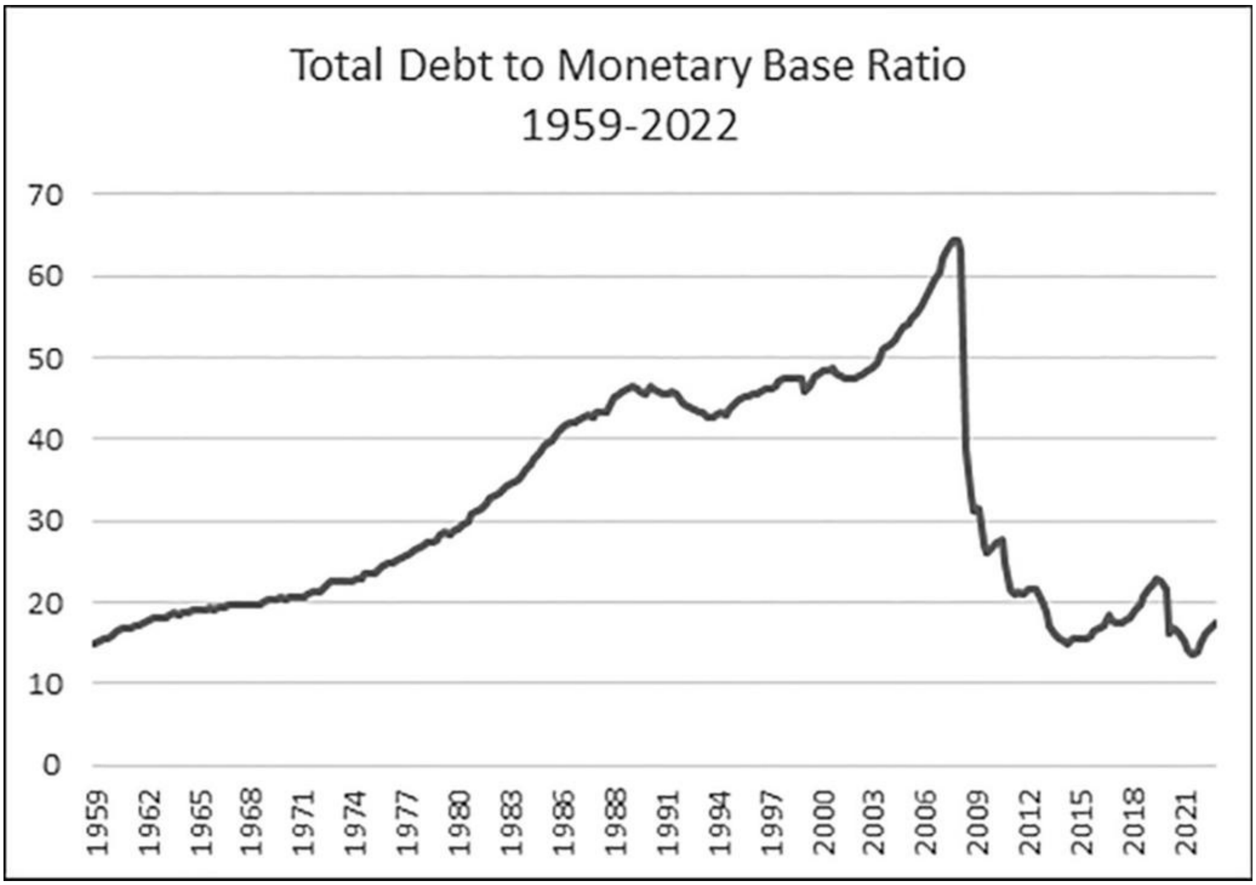


Figure 19-D[289]

When debt is that high relative to the monetary base, the whole financial system is like a game of musical chairs that can never be allowed to stop. All of the IOUs that people have are just that — IOUs (and highly leveraged ones at that). Imagine a game of musical chairs with 63 children for every one chair, and then imagine the calamity that would ensue if it were all allowed to be marked to market at once, by turning the music off and seeing 62 kids become unable to get seats.

When looked at from a narrower angle, even just the banking system had 23 dollars of bank deposit liabilities for every dollar in bank cash. Each of those deposits represented an IOU for a dollar, and yet the banks had very few dollars and instead had a lot of riskier and less liquid loans as their primary assets to back up those IOUs. They relied on their continued ability to borrow money from other banks when needed to meet liquidity requirements, which only works in a smoothly operating environment of banks that trust each other. In other words, as long as the music is playing such a highly leveraged system can function, but as soon as the music stops the inherent fragility is revealed.

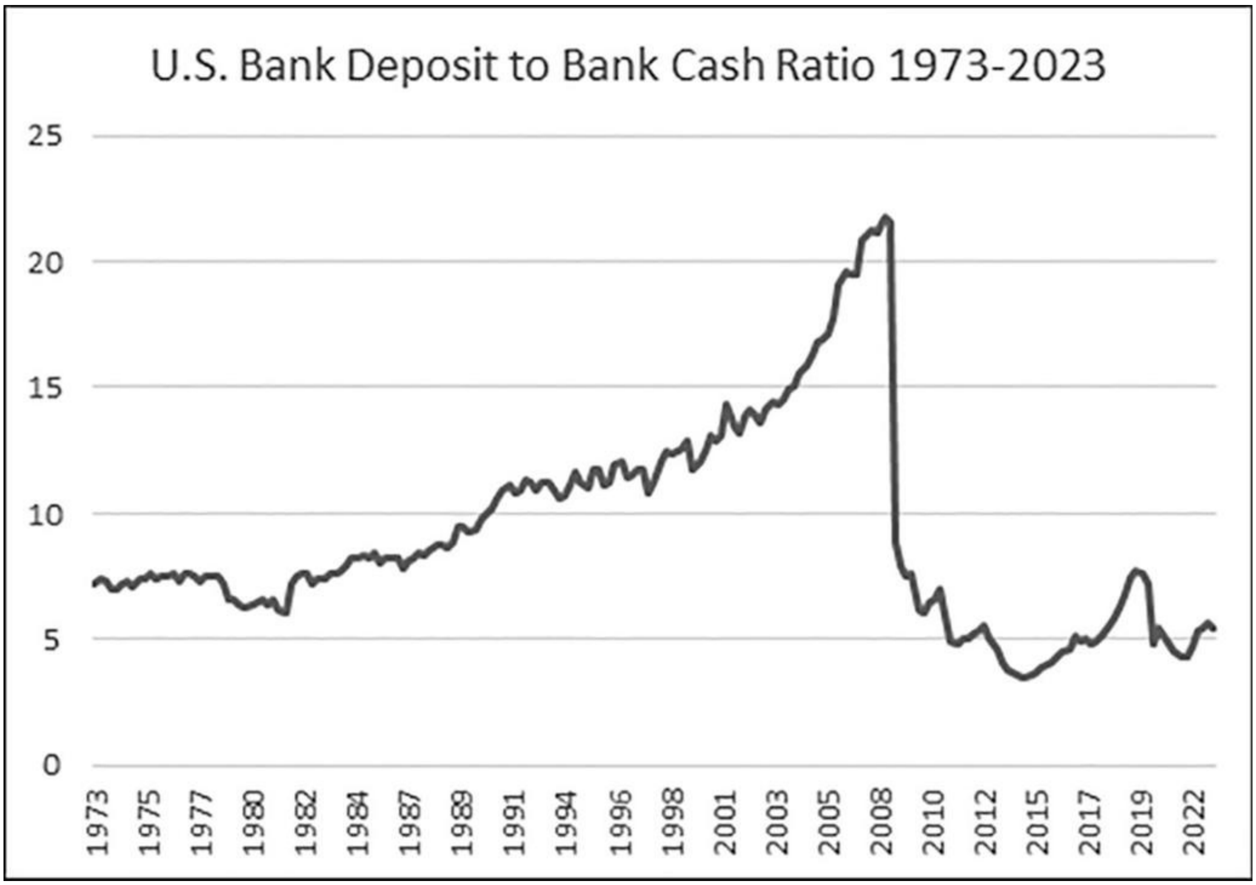


Figure 19-E[290]

We can see by these numbers and charts that the problem wasn't just a series of bad decisions by banks between 2004 and 2007, although that was a part of it. Instead, the problem had been structurally building for decades, through multiple shorter-term business cycles, because the financial system is designed in such a way that it needs to keep growing or it will collapse. Whenever the credit system contracted even briefly during the decades leading up to crisis, policymakers would cut interest rates, provide liquidity, and encourage even more credit creation. The ratio of claims for dollars to *actual* dollars was never allowed to clear out to more reasonable levels. And then, in 2008, everything began to fall apart. There were too many bank deposits for each dollar of actual bank reserves. There was too much debt in all forms relative to how many base dollars were in the financial system. Interest rates were cut to zero and promises of liquidity were assured, but this time, that wasn't enough to deal with the sheer scale of the underlying leverage.

Policymakers then had a big choice to make. Bank failures would lead to more bank failures, which would then lead to even more bank failures. Should they let the system collapse? If so, many depositors would be wiped out like the 1930s, and even FDIC insurance wouldn't be enough since they had an amount of cash equal to less than 1% of total deposits to insure deposits with. If there is 63 times as much total debt in the system (IOUs for dollars) as there is base money (actual dollars), then perhaps most of that debt is unrealistic and needs to all get wiped away? Or should policymakers step in and prevent that collapse from happening? If there is too much debt relative to base money, then perhaps rather than letting all that debt default, policymakers can just... rapidly increase the amount of base money out of thin air, to prevent large portions of broad money from defaulting and going away?

In other words, when the music on this highly leveraged system stopped, either IOUs (bonds and bank deposits) were going to collapse downward toward the size of the monetary base through massive defaults, or the monetary base would need to be expanded upwards to "make good" the large number of dollar IOUs that had been created during prior years and decades.

Of course, policymakers chose the latter option. Figure 19-F shows the total debt in the country (all the IOUs for dollars) and the monetary base of the country (the number of actual base dollars in the system) separately. In 2008, as the music stopped and total debt began to fall due to an uptick in defaults, rather than letting the system collapse in on itself, the Federal Reserve rapidly expanded the monetary base.

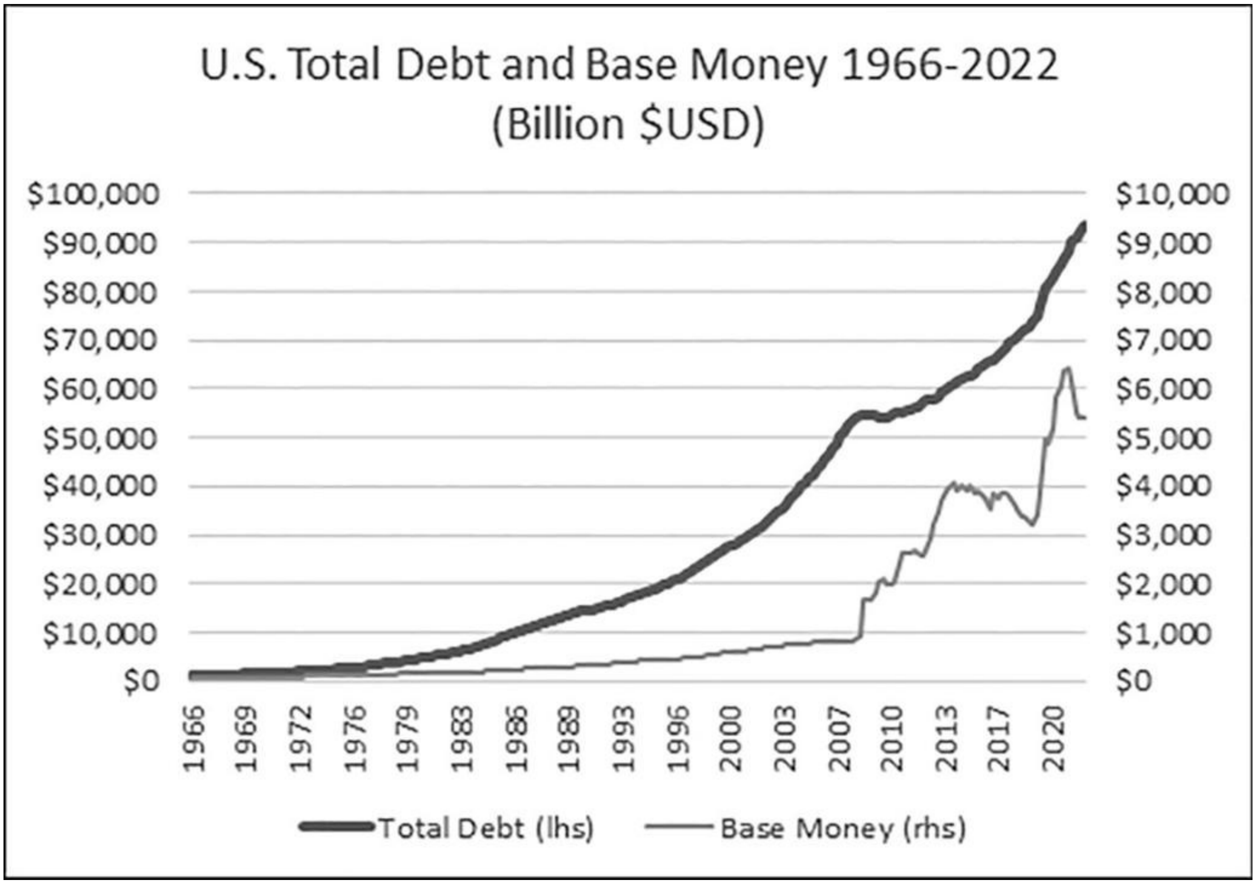


Figure 19-F[291]

Debt never deleveraged in absolute terms after 2008, but private debt did deleverage mildly relative to the size of the broad money supply, mildly relative to GDP, and significantly relative to the base money supply. Private debt began growing more slowly, and base money expanded rapidly. Broad money would normally *decrease* during such a large financial crisis due to multiple bank failures and deposit losses that exceed FDIC insurance capabilities, but due to policy intervention, broad money kept growing at a moderate pace anyway. Defaulted debts and defaulted bank deposits destroy broad money, and those things were mostly prevented. Banks were given more liquidity (newly printed cash reserves) in exchange for some of their less liquid assets, which made them less reliant on other banks to meet their liquidity needs.

This is what makes a long-term debt cycle different than merely a normal business cycle. Debt is allowed and incentivized to accumulate to such massive heights through decades of recurring policy intervention to prevent credit-clearing events from ever happening, and once interest rates can't go much lower and debt is at incredibly high levels, it all risks unraveling. Rather than letting that unraveling happen, policymakers begin rapidly expanding the monetary base and shifting toward a policy of currency debasement to maintain constant broad money growth even as private debt growth slows down. With too much debt in the system relative to base money, the base money supply is increased rather than debt being allowed to nominally default on a massive scale. This is what makes the resolution of a long-term debt cycle different than a short-term debt cycle. The events of a long-term debt cycle are like the climax of a television show's entire season, while the events of a normal business cycle are like individual episodes of that season.

A ONE-TWO PUNCH

Many people thought that the rapid increase in base money during the 2008 crisis would be hyperinflationary, and mark "the end of the dollar as we know it."[292] But they were wrong, and in a big way.[293]

This is because it was mostly just banks that were bailed out in 2008, rather than everyone. Base money increased a lot, but broad money just kept growing at a moderate pace. After massively increasing the monetary base, those existing broad dollars (which are ultimately just fractionally reserved commercial bank deposit IOUs for base dollars) were just more backed by base dollars, and thus the broad dollars didn't vanish with bank failures as they otherwise would have. After all of this intervention, the average person didn't have much additional money in their bank account compared to what they had before the intervention. Since they didn't have much extra money, where would this hyperinflation come from? The answer is that it wouldn't come, or at least not anytime soon. Figure 19-G zooms in a bit and shows both broad money and base money from 1995 through 2022.

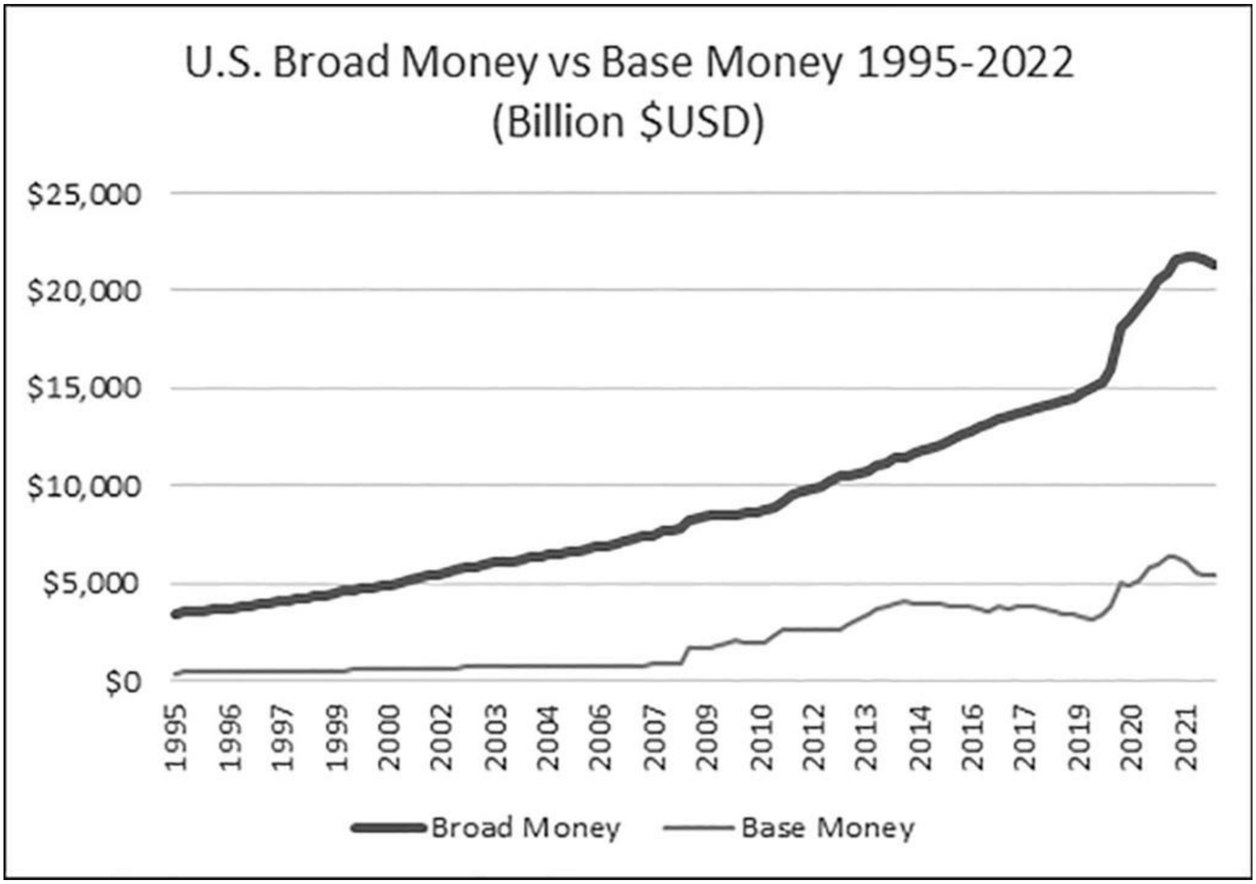
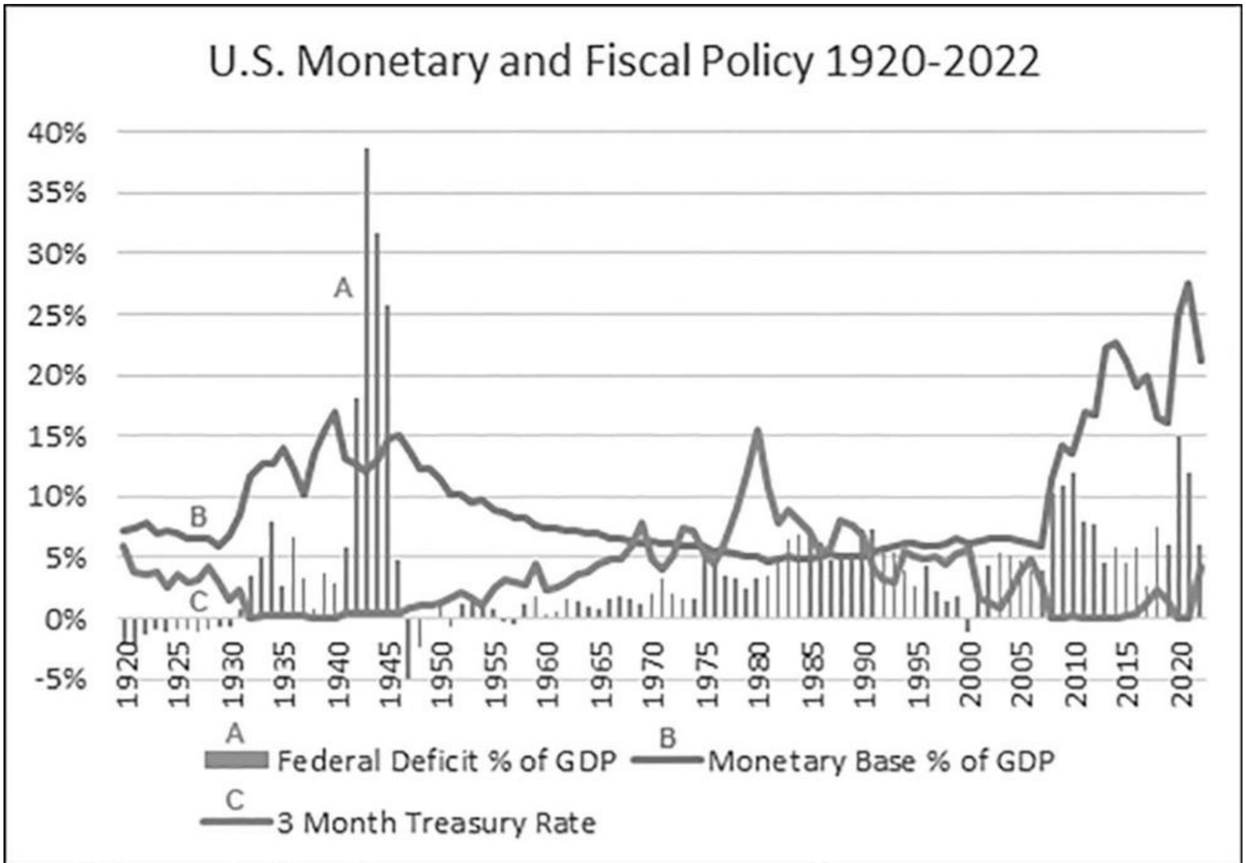


Figure 19-G[294]

If broad money increases dramatically (as it did during 2020-2021 but not 2008-2009), that does tend to be inflationary for consumer prices. In that scenario, people have a lot more money to spend, and approximately the same amount of goods and services available to spend it on, and so prices will adjust upwards because, really, the currency is adjusting downwards. However, if only base money increases rapidly and broad money stays relatively normal (as was the case after 2008), then while this change will have various effects, the average person does not have more dollars to spend on goods and services. For this reason, I tend to describe the events of 2008 as “anti-deflationary” rather than outright inflationary; the rapid expansion of the monetary base, the Troubled Asset Relief Program, and other actions prevented people from *losing* broad dollar IOUs by preventing uninsured bank failures but didn’t give people *more* broad dollar IOUs to spend.

Long-term debt cycles, at least in the modern era, tend to occur with a one-two punch, and to see it we need to separate government debt from non-government debt. The first punch is a big private debt bubble that pops, which is disinflationary. This happened in the 1930s and the 2010s. The second punch is a big public debt bubble that grows in its place, which is inflationary, and is used to offset the damage from the popping of that prior private debt bubble. This happened in the 1940s and the 2020s. In other words, as the long-term debt cycle unfolds, the excess debt starts to shift from the private sector to the government, and the true climax of the event does not occur until the government itself runs into an acute inflationary debt spiral.

Figure 19-H shows U.S. fiscal and monetary policy from 1920 through 2022 and helps shed light on the prospects for future inflation or lack thereof.


U.S. Monetary and Fiscal Policy 1920-2022
40%
35%
30%
25%
20%
15%
10%
5%
0%
-5%
A
B
C
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
A Federal Deficit % of GDP
B Monetary Base % of GDP
C 3 Month Treasury Rate

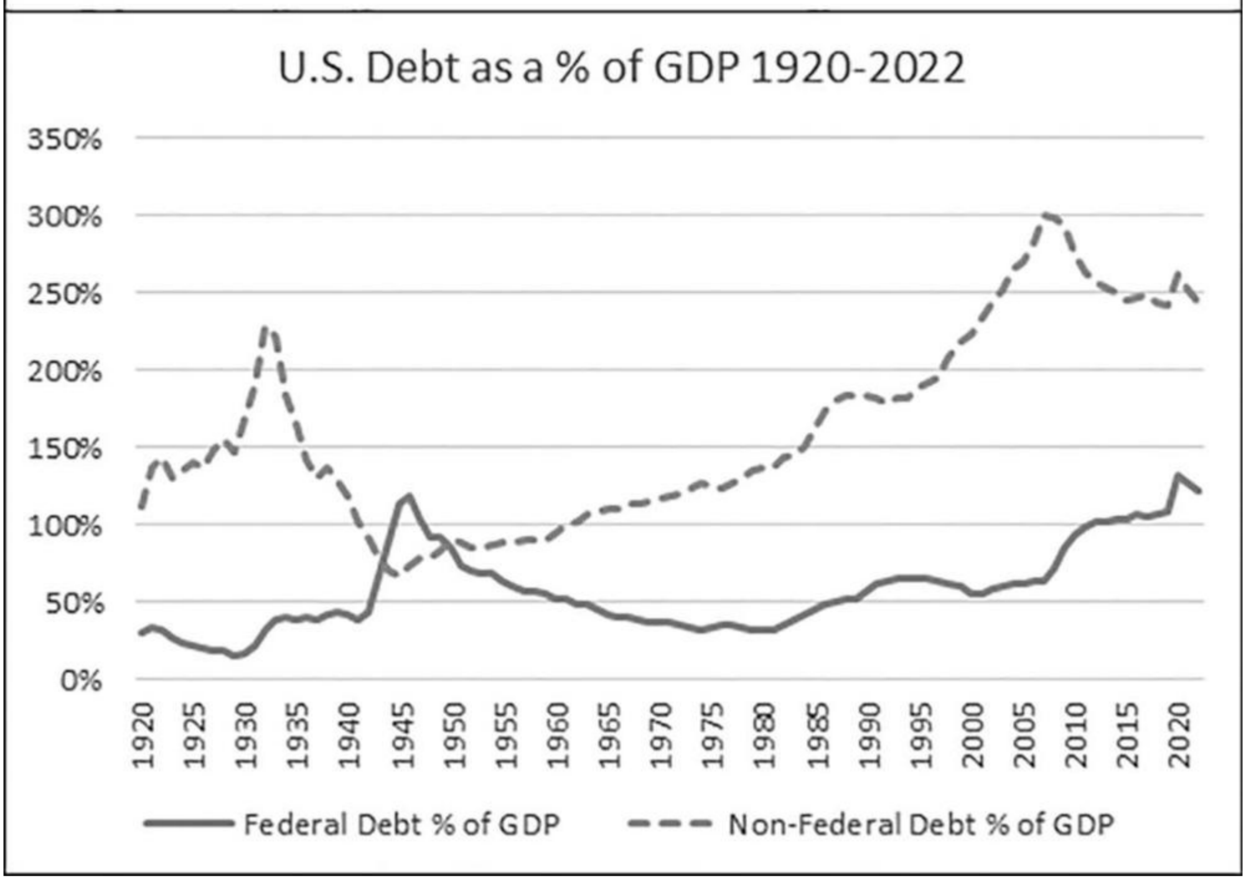

U.S. Debt as a % of GDP 1920-2022
350%
300%
250%
200%
150%
100%
50%
0%
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Federal Debt % of GDP
Non-Federal Debt % of GDP

Figure 19-H[295]

With Figure 19-H in mind along with the rest of the historical knowledge that we have, the 2000s, 2010s, and 2020s have thus far been an echo of what happened in the 1920s, 1930s, and 1940s.

- 1920s and 2000s = booming private credit growth.
- 1929 and 2008 = generational financial crises.
- 1930s and 2010s = economic stagnation and rising populism.
- 1940s and 2020s = geopolitical conflict and populist, deficit-driven inflation.

This is not because cycles magically happen; it's because each part of the process directly feeds into the next part of the process, and it's all enforced by the set of incentives that exist for participants and policymakers involved with the system.

The 1920s and 2000s both had booming private credit growth, with much of that credit being used for speculation. In the 1920s, stocks were speculated on with massive leverage, thanks in part due to so much money having been created relative to the amount of gold in the system during World War I. In the 2000s, real estate was speculated on with massive leverage, thanks in part due to interest rates being cut to 1% after the bursting of the dot-com bubble. These speculative credit booms popped in 1929 and 2008 respectively and resulted in generational financial crises that threatened to collapse the entire banking system.

In the aftermath of the financial crises of both 1929 and 2008, the monetary base was greatly expanded to recapitalize and reliquefy the banking system and prevent further systemic bank failures and loss of customer deposits, with the difference being that it was done more quickly in the aftermath of 2008 (before people lost bank deposits) than in the aftermath of 1929 (after a third of bank deposits were already wiped out from bank failures). In the 1930s, the expansion of the monetary base was done by sharply devaluing the dollar relative to gold, so that the dollar-denominated monetary base could expand even as the amount of gold in the system remained relatively fixed. In 2008 and into the 2010s, the expansion of the monetary base was done by the Federal Reserve creating a lot of new bank reserves out of thin air and using them to buy Treasuries and mortgage-backed securities from banks, which gave banks more cash liquidity and thus made them less reliant on each other for servicing their liquidity needs. The previous Figure 19-H showed the monetary base as a percentage of GDP and how these periods were similar in that regard.

Both the 1930s and the 2010s experienced weak economic growth. Between the two, the 1930s were far worse due to the Dust Bowl and other matters, but the 2010s were still incredibly painful for a lot of people. Deaths by alcohol and drug overdose, for example, dramatically increased in the 2010s, especially for men.[296] In both the 1930s and 2010s, political populism began to rise, with more and more people feeling that the system was structured against them. In the 1930s, there was a rise in communist sympathies and union organization, and a strong shift in favor of President Roosevelt's New Deal policies. In the 2010s, the Tea Party on the political right fought against ever-rising government debt and bank bailouts, while Occupy Wall Street on the political left fought against corporate cronyism and bank bailouts. I contend that these Tea Party and Occupy Wall Street movements were two sides of the same coin — a pushback against the country's flexible ledger and the associated practice of using public debt and money-printing to save the large and well-connected entities at the expense of the everyday person.

The 1930s period of rising populism and economic stagnation was global, and eventually contributed to World War II in the 1940s. When the economic pie is not growing, and people are frustrated, they often turn to strongmen leaders to tell them (incorrectly) who to blame. This growing extremism resulted in massive military spending as multiple countries engaged in global warfare. In the United States, deficits equal to a huge percentage of global economic output were printed and spent on manufacturing facilities, commodities, workers, and soldiers. When soldiers came home from war, they were given financial aid to become educated, and given subsidized loans for a house.[297] Altogether, this was an enormous fiscal stimulus with printed money and represented a financial shift from creditors to debtors. Meanwhile, annual price inflation reached a peak of 19% in the 1940s and averaged about 6% between the early 1940s and the early 1950s, and yet the Federal Reserve kept interest rates low and expanded the monetary base dramatically to keep buying federal debt at low interest rates to fund the war.[298] Anyone holding cash or bonds was sharply devalued throughout the decade.

From 1930 to 1935 U.S. federal debt increased from $16.2 billion to $28.7

billion, which was a 77% increase in five years, as the government dealt with the Great Depression. And then from 1935 to 1940 U.S. federal debt increased from $28.7 billion to $43.0 billion, which was a 50% increase in five years. People thought those periods of federal debt accumulation were big at the time, but then from 1940 to 1945 U.S. federal debt increased from $43.0 billion to $259 billion, which was a 500% increase in five years.[299] That 1940s period was totally different and was inflationary because of it. Existing debts were rapidly devalued due to high levels of deficit-driven inflation.

The 2010s period of rising populism and economic stagnation was also global (aside from Asia) as North America, Latin America, Africa, and Europe all experienced weak or even in some cases negative economic growth. Foreign countries began to gradually buy fewer U.S. Treasuries with their foreign exchange reserves, and to buy more gold instead, while also expanding various alliances and seeking alternative payment rails outside of the dollar-based financial order. In 2020, the COVID-19 pandemic struck our very leveraged global financial system, and high amounts of leverage creates fragility. Highly leveraged households and businesses couldn’t withstand a multi-month shock to their cash flows. Highly leveraged sovereign bond markets couldn’t withstand a sudden drop-off in taxable income. The public in most developed countries would not stand for bailouts of the companies without bailouts for themselves. In the United States, COVID-19 was responded to with fiscal deficits relative to the size of the economy that had not been seen since the 1940s. Trillions of dollars were spent on household stimulus checks, childcare tax credits, small business loans that turned into grants, and corporate bailouts. The Federal Reserve greatly increased the monetary base and bought large portions of the massive U.S. federal debt issuance to fund these payouts, which is a method of monetizing the debt and basically outright money-printing. The broad money supply grew by 40% in just two years, which was very different than what happened in the aftermath of the 2008 crisis. And then in 2022, Russia invaded Ukraine, and a proxy war between NATO countries and Russia ensued, which resulted in further supply disruptions, partial de-globalization, and an uptick in military spending.

A FISCAL SPIRAL

When rapid broad money supply growth and consumer price inflation occur due to unusually rapid bank lending (as was the case in the 1970s due to a demographics bulge), a common central bank policy tool is to aggressively raise interest rates to try to slow down that lending activity and thereby slow down money supply growth.

However, when broad money supply growth and consumer price inflation are occurring due to unusually large fiscal deficits that are being monetized by the central bank or commercial banking system (as was the case in the 1940s and again in the early 2020s), that tool of aggressively raising interest rates is less effective and even counterproductive. This is because higher interest rates on already-high sovereign debt result in even larger deficits due to higher interest expenses, and therefore can result in even more money creation and inflation pouring into the economy. There's no end in sight for how to resolve the problem of high government debts if interest rates on that debt are high.[300]

So, at the end of a long-term debt cycle, how are large sovereign debts dealt with? The answer is that they are partially defaulted on in some way, either nominally or informally through inflation. When this happened in the 20th century what occurred was financial repression, meaning the debts were partially inflated away and capital controls were used to block some of the exits.

During the 1940s, rather than raise interest rates, the Federal Reserve was effectively captured by the U.S. Treasury Department and kept interest rates low despite high inflation.[301] Figure 19-I shows the annual inflation rate alongside 3-month Treasury bill rates during that era.

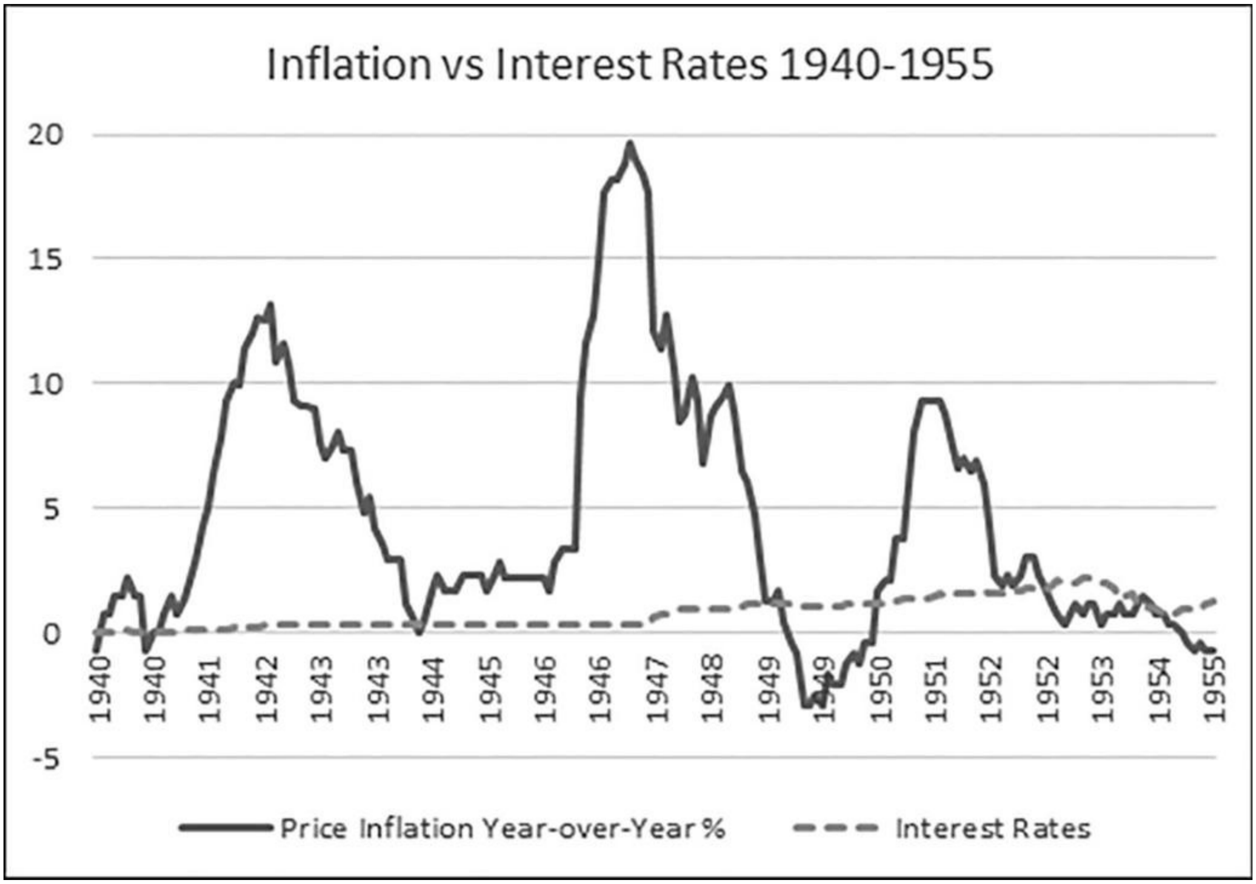


Figure 19-I[302]

A key result of this wide gap between interest rates and inflation was that the purchasing power of bondholders and cash savers was sharply devalued. These holders of credit relied on a social contract to maintain a relatively stable unit of account, and that social contract rapidly shifted. Creditors received the dollars they were owed, but by that time each dollar had lost considerable purchasing power from when the loans were made, due to massive supply dilution. It was basically a debt default and restructuring but occurred by redefining the dollar itself rather than by nominally defaulting on the debt contracts.

A problem, however, is that when interest rates are way below the prevailing inflation rate and fiscal deficits are very large, it encourages speculative borrowing. If you can borrow money at 5% per year due to suppression of interest rates when inflation is 10% per year, and use that loan to buy hard assets, why wouldn't you? The smart thing to do in that environment is to short the currency by taking out a loan or issuing a bond with a low interest rate and a long duration and buy something scarce with it. Central bankers then face a dilemma when the government has large debts and deficits: High interest rates would result in an unrecoverable fiscal spiral by the government toward ever-higher deficit-driven inflation, but low interest rates would encourage excessive borrowing and money creation via the private sector creating loans to buy hard assets.

Therefore, in periods of high public debt and negative inflation-adjusted interest rates, that type of private sector borrowing tends to be discouraged. During periods of financial repression, governments historically turn to capital controls and lending restrictions to ensure that people hold the currency and the bonds while they are devalued. Interest rates are kept low for the government, but restrictions are placed on the private sector from making use of those low interest rates in unapproved ways.

A paper in the journal *Economic Policy* by Carmen Reinhart and Belen Sbrancia from 2015 called “The Liquidation of Government Debt” studied the period from 1945 to 1980 across multiple countries quite thoroughly, as their government debts were reduced relative to the size of their economies. Their abstract reads:

> High public debt often produces the drama of default and restructuring. But debt is also reduced through financial repression, a tax on bondholders and savers via negative or below-market real interest rates. After WWII, capital controls and regulatory restrictions created a captive audience for government debt, limiting tax-base erosion. Financial repression is most successful in liquidating debt when accompanied by inflation. For the advanced economies, real interest rates were negative half of the time during 1945–1980. Average annual interest expense savings for a 12—country sample range from about 1 to 5 percent of GDP for the full 1945–1980 period. We suggest that, once again, financial repression may be part of the toolkit deployed to cope with the most recent surge in public debt in advanced economies.[303]

In the United States, people were banned from owning gold between the 1930s and the 1970s and could be sentenced to 10 years in prison if they didn’t comply. This was an example of what is meant by a “captive audience.” As the public ledger was being rapidly debased, most attempts to flee to another sort of ledger, even just the natural ledger of a benign yellow metal, were stopped and squashed in various direct or indirect ways.

Overall, the 1940s marked the climactic end of decades of geopolitical conflict and a long-term debt cycle. Throughout the 1930s and the 1940s, debt was effectively transferred from the private sector to the public sector, and then inflated away. It was a partial debt jubilee, similar to debt jubilees of antiquity. The centralized monetary unit was rapidly debased, and any attempts to flee from holding it while it was debased were heavily restricted.

The United States and most other developed countries have built up a similar problem in recent decades. Private sector credit growth has been consistently encouraged by policymakers, and whenever it blows up some of it gets transferred to being public sector debt via fiscal bailouts. Additionally, multiple wars were financed purely with public debt. Now, with public sector debt this high, it's at the stage where it is likely to get inflated away over time. There is little else for lawmakers and policymakers to do about it. Figure 19-J is from the Congressional Budget Office and shows their projection of future U.S. federal government debts as a percentage of GDP.

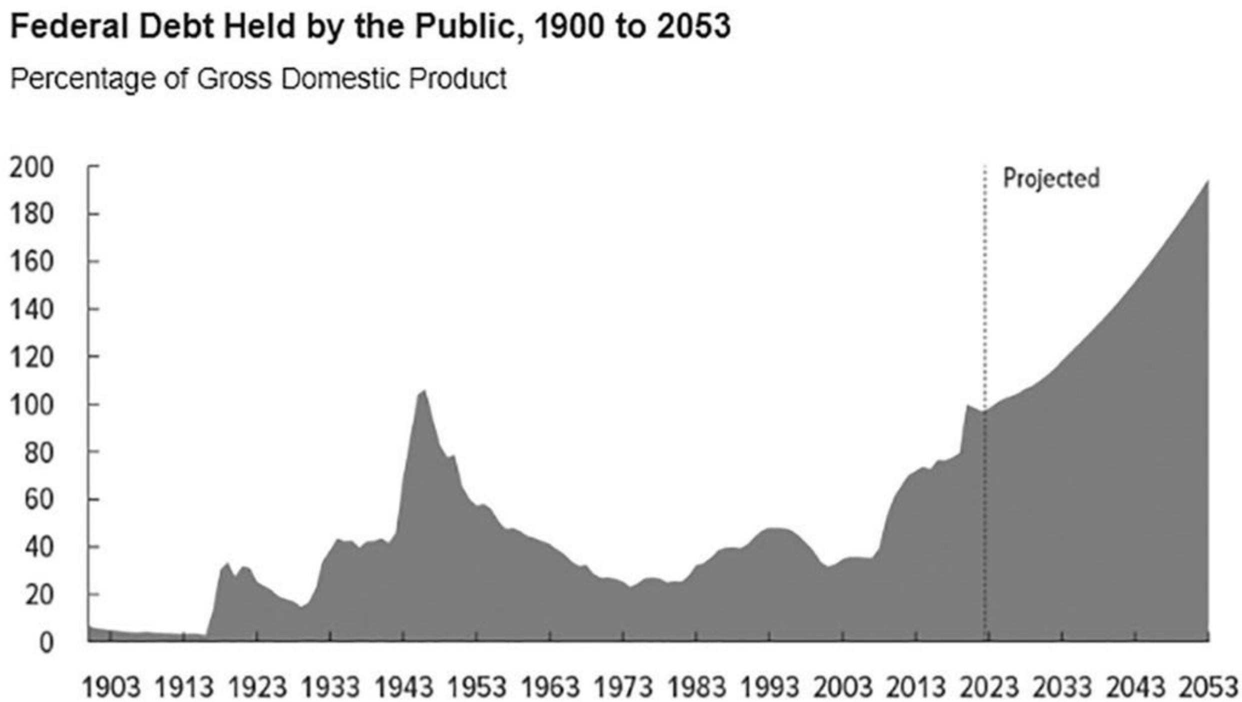


Figure 19-J[304]

However, here in the 2020s with government debt levels across the developed world having reached levels similar to what they were in the 1940s, it may be harder for the government to repeat the same financial repression process this time. Back in the 1940s, the fiscal deficits and inflation that devalued the debt were triggered by war and could be turned off after the war was over. Developed countries still had young populations and low dependency ratios between elders and workers back then. In the United States in 1950 for example, there were 16 workers to support every retiree receiving Social Security benefits. In the 2020s, that number is now under three workers per retired beneficiary, and in the decades ahead it is projected to fall to as low as two.[305] Medicare has a similar top-heavy problem. We as a country have made promises on our centralized flexible ledger that are challenging to back up by real-world resources, and the same is true for most developed countries in the world. Unlike the 1940s, there is no end in sight for the fiscal deficits that need to be run, and which need to be financed at negative inflation-adjusted interest rates. Plus, we exist in a world of social media where people can rapidly share information about what's happening.

Unlike the 1940s, there is no big common cause that we're all willing to sacrifice purchasing power for; instead, our predicament was just caused by a gradual mismanagement of the public ledger over time, with everyone pointing the blame at others. Voters wanted all sorts of things without knowing how to pay for them: They voted politicians into office that promised them tax cuts without spending cuts, or who promised spending increases without tax increases. Politicians were incentivized to promise these things because they would likely lose elections if they did not. And whenever a crisis occurred, it was always put on the public ledger with debt and printed money so that the cost of paying for it could be figured out by the next generation.

It will be very challenging for political parties throughout the developed world (and particularly the United States and Europe) to agree on how to handle this public debt problem in the 2020s and 2030s. Decades of having a flexible ledger combined with short-term incentives to use it have resulted in a very imbalanced situation that is likely to be rather inflationary for the broad money supply to varying degrees for the foreseeable future. Debt must be restructured or inflated away, but who will be left holding the bag?

Could this have turned out differently? Around the margins it could have, but for the destination I don't think it could have. In addition to the historical human tendency to think linearly even as debt compounds exponentially, this time the generational debt accumulation was empowered by the fact that the invention of telecommunication systems allowed commerce to occur at the speed of light while any sort of hard money could still only settle at the speed of matter. Gold, despite being of sounder supply than the fiat dollar, takes considerable time and expense to transport and authenticate, and thus could never really present an alternative in a digital era. Once the fiat dollar came into being, those who manage it were able to discard gold as a supply constraint without much pushback and use the flexibility of their ledger to opaquely finance war, entitlements, and all sorts of things in ways that don't add up in the long run. It was the first time where a weaker money globally won out over a harder money, and it occurred because a new variable was added to the monetary competition: *speed*. This speed gap between commerce and settlements empowered banks and central banks, and created an irresistible arbitrage that the whole world turned to, which led to a greater level of centralization for the public ledger than ever before.

Entropy is the law by which physical systems inevitably become more disordered over time, because the disorder imposed by friction and heat loss only moves in one direction. A similar sort of financial entropy has built up in our system, as fiat credit can only move in one direction (higher) without the whole highly leveraged system collapsing. Meanwhile, the system with its built-in flexibility at the base monetary layer tends to incentivize politicians and their voters to keep making promises that, once the numbers really begin to hit hard, aren't maintainable as originally intended; the difference is just printed. The present has been persistently improved at the cost of the future. Dealing with the public debt has always been the next politician's problem, and yet now, toward the later stages of a long-term debt cycle, we're beginning to reach the point where the problems are materializing in the present.

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PART FIVE

INTERNET-NATIVE MONEY

"A purely peer-to-peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution. Digital signatures provide part of the solution, but the main benefits are lost if a trusted third party is still required to prevent double-spending. We propose a solution to the double-spending problem using a peer-to-peer network."[306]

-Satoshi Nakamoto

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[306] Satoshi Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System," 1.

CHAPTER 20

THE CREATION OF STATELESS MONEY

In 1984, Nobel laureate economist Friedrich Hayek said in an interview:

> I don't believe that we shall ever have a good money again before we take the thing out of the hands of government. Since we can't take them violently out of the hands of government, all we can do is by some sly roundabout way introduce something they can't stop.[307]

That kind of statement sounds extreme at first, but when we remember that there are approximately 160 currencies in the world, and most of those rapidly lose value and have little acceptance outside of their own monopoly jurisdictions, then it may suddenly seem less extreme.

Government and money often go together in modern history, but much like government and religion, they need not be inherently connected. And even if they are connected, it need not mean that there can't be private alternatives. In plenty of developing countries, people repeatedly turn to dollars or gold for some degree of stability rather than rely entirely on their local unstable currencies.

For decades in the 1980s, 1990s, and 2000s, programmers looked for ways to create stateless digital money using cryptography over the internet, with varying degrees of temporary success that ultimately ended in failure or stagnation. They did, however, build the foundation for what would come later.[308]

In 1982, the computer scientist and cryptographer David Chaum published his dissertation at Berkeley called “Computer Systems Established, Maintained, and Trusted by Mutually Suspicious Groups.”[309] It was about how several entities who don’t necessarily trust each other can maintain a shared database together, using cryptographic techniques. In 1983 he invented e-cash, which used a cryptographic technique he developed called “blind signatures” to enable private electronic transactions, where even the parties processing the transaction don’t get to see the details but are able to process them by using mathematical proofs.[310] In 1989, he founded a corporation called DigiCash to commercially pursue this opportunity. However, it was not successful; he achieved limited merchant and user adoption and was unable to bootstrap a self-reinforcing network effect. In 1998 DigiCash went bankrupt, and in 1999 Chaum was quoted in a *Forbes* article saying, “It was hard to get enough merchants to accept it, so that you could get enough consumers to use it, or vice versa.”[311] He also noted that transaction privacy was not in very high demand as more users joined the internet and the average level of user sophistication decreased.

In 1989, the Hypertext Transfer Protocol (HTTP) was developed. Most people reading this are familiar with the various error codes associated with this protocol, with “HTTP 404 Not Found” being the most well-known. We’ve all run into it at some point: It’s the error that someone gets if they try to go to a webpage that doesn’t exist, often due to a typo or a page that has been removed. Fewer people are familiar with the fact that another original error code is “HTTP 402 Payment Required.” The 402 error code was reserved for future use when it was created, for some sort of digital cash in the future. For decades it went mostly unused, even in the era of e-commerce, since online payments were still ultimately run by banks with an internet overlay rather than being digitally native.

In 1996, Gold and Silver Reserve Inc. (G&SR) launched e-gold, which allowed users to open an online account on their website, and these accounts were denominated in grams of gold. Users could instantly transfer value to other accounts, including down to a fraction of a gram. At its peak, it reached over 5 million accounts and $2 billion worth of annual transfer volume. However, by the 2000s they began to face legal challenges. After the September 11 terrorist attacks, the U.S. federal government passed the Patriot Act, which among other measures tightened regulations around being a money transmitter business. The U.S. federal government ended up suing the company, and by 2009 the operation was shut down.[312] This event emphasizes the problem of gold that I described in earlier parts of this book: To move around quickly, gold needs to be abstracted by a centralized custodial entity, and that entity can be corrupted or shut down.

In the late 1990s and early 2000s, several advancements were made around the topic of digital scarcity. In 1997 Adam Back created Hashcash, a proof-of-work system that was meant to limit email spam and denial-of-service attacks. The idea of proof-of-work is to use computation techniques that require significant computational power to produce some sort of digital token or certificate, which is then easy to verify as genuine by any party once the token or certificate is presented. Nick Szabo subsequently proposed Bit Gold, which was the idea of using this type of unforgeable costliness to create an online scarce asset. Hal Finney then incorporated both Hashcash and the idea of Bit Gold into a 2004 invention called Reusable Proof of Work (RPOW). Using a centralized server, Finney turned Hashcash into a reusable token, a type of verifiably scarce digital collectible, which he called RPOW tokens.[313] There were other types of digital currency proposals around this time as well, but this specific Back-Szabo-Finney development path was particularly important.

The limitation that most of these monetary projects all shared was that they were centralized. DigiCash as a centralized company failed to build a network effect. E-gold was quite successful until it was shut down by the government. RPOW tokens relied on a centralized server.

In 2008, an unknown developer or group using the pseudonym Satoshi Nakamoto implemented some of these techniques in a decentralized way. On October 31, 2008, Satoshi introduced a paper called “Bitcoin: A Peer-to-Peer Electronic Cash System” to a cryptographic mailing list that included several of the above-named individuals, among many others.

The abstract was as follows:

> A purely peer-to-peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution. Digital signatures provide part of the solution, but the main benefits are lost if a trusted third party is still required to prevent double-spending. We propose a solution to the double-spending problem using a peer-to-peer network. The network timestamps transactions by hashing them into an ongoing chain of hash-based proof-of-work, forming a record that cannot be changed without redoing the proof-of-work. The longest chain not only serves as proof of the sequence of events witnessed, but proof that it came from the largest pool of CPU power. As long as a majority of CPU power is controlled by nodes that are not cooperating to attack the network, they’ll generate the longest chain and outpace attackers. The network itself requires minimal structure. Messages are broadcast on a best effort basis, and nodes can leave and rejoin the network at will, accepting the longest proof-of-work chain as proof of what happened while they were gone.[314]

The paper, only nine pages long, was written in an academic form, with eight citations for a variety of cryptographic and timestamping techniques, including a citation for Adam Back's Hashcash. Over the next few weeks, various cryptographers on the email list reviewed it and asked questions, mostly critically and skeptically, which were politely replied to by Satoshi.[315] The emails are public record now and reading through them feels like reading a dissertation defense, with articulate questions and articulate answers between professionals.

At no point did Satoshi promise riches or come off like a salesman. He wrote like an academic, although he made it clear that the goal of this work was freedom, in the ethos of the cypherpunk movement.

For example, one person on the mailing list wrote, "You will not find a solution to political problems in cryptography." Satoshi responded with, "Yes, but we can win a major battle in the arms race and gain a new territory of freedom for several years. Governments are good at cutting off the heads of centrally controlled networks like Napster, but pure P2P networks like Gnutella and Tor seem to be holding their own."[316]

Satoshi then released the open-source code on January 9, 2009, and mined the first set of blocks. In the genesis block, he referenced a topical newspaper headline about British bank bailouts during the heart of the global financial crisis:

> The Times 03/Jan/2009 Chancellor on brink of second bailout for banks[317]

Hal Finney publicly announced in a tweet on January 10 that he was running the Bitcoin software, and he subsequently received the first test transaction from Satoshi.[318]

For the first two years of Bitcoin's existence, through 2009 and 2010, Satoshi continued to provide updates for the code and discussed various concepts with early users, keeping with his calmly spoken and matter-of-fact persona. In late 2010, Satoshi disappeared and made no more public posts, leaving the project in the hands of others.[319] As of this writing, nobody has been able to conclusively prove who he was. There has been a rolling participation of developers for the Bitcoin network ever since.

Bitcoin is a distributed public ledger that some people have referred to as "triple entry bookkeeping." It's a protocol that allows all participants around the world to come to a consensus on the state of the ledger every ten minutes on average. Anyone with a basic laptop and an internet connection can participate in the network as a node operator by running a free and open-source software application, and doing so allows them to send and receive transactions without the permission of any centralized entity. Miners receive transaction fees and newly created bitcoin for processing new blocks of transactions on the network (updates to the ledger), using proof-of-work and timestamping, and node operators check to ensure that those new blocks of transactions are following the rules of the network. Since the ledger is highly distributed and relatively small in terms of data, node operators can store a full copy of the ledger and constantly reconcile it with the rest of the network. Users can keep their own private keys, which along with node applications is what allow them to move coins (or fractional coins, typically called "sats," short for "satoshis") from their address to someone else's address on the ledger without using any third-party custodian. Alternatively, people can choose to trust a custodian with their keys if they prefer, and thus interact with bitcoin similarly to how they interact with a bank account. The total number of bitcoin that will eventually exist is 21 million, and they are divisible into a total of 2.1 quadrillion sats.

This is an incredibly powerful concept. A bitcoin holder can memorize twelve words (representing their private key) and bring her savings with her anywhere in the world, without relying on a centralized counterparty. Bitcoin is a decentralized ledger, existing across the world in a decentralized cloud of computers, that is costly to attack and impossible to unilaterally change the rules for. There is no centralized server and no centralized issuer. It's completely transparent, meaning that every line of code is public. Developers can collaborate to create and propose updates for it, but there is no way to push updates to users; updates can only be freely accepted by users and must be backward-compatible if they want to remain part of the existing network.

In addition, Bitcoin closes the speed gap between transactions and settlements that I've described several times in this book. Ever since the invention and deployment of intercontinental telecommunication systems in the second half of the 19th century, transactions have been able to move around the world at the speed of light, while scarce, self-custodial bearer asset money (e.g., gold) could only be transported and verified at the speed of matter. This speed gap opened a massive arbitrage opportunity for banks and governments to use, because it gave them custodial monopolies over fast long-distance payments. Bitcoin represents the first significant way to settle scarce value at the speed of light, since once bitcoin are sent across the network and are settled under a few blocks on the blockchain, they are irreversible — unless over 50% of miners on the network (which are dispersed all around the world) try to reverse it. A bitcoin is a scarce asset that is not someone else's liability, much like a gold bar, and this ability to quickly move a non-liability asset over long distances is something that the world has never had before.

In Chapter 8 I discussed William Stanley Jevons' 1875 description of a centralized world clearing house, allowing all entities to settle with each other quickly. And although his vision increasingly came into being, starting with its center in London and then shifting to New York, the problem was that this centralized world clearing house was based on abstraction and debt and therefore allowed for significant mismanagement of the ledger. Bitcoin can serve as a *de*centralized world clearing house, because rather than relying on abstraction and debt, the bearer assets themselves can be settled directly between entities within minutes.[320]

It's not an accident that it took approximately a century and a half after transactions were enabled to occur at the speed of light for bearer asset settlements to also occur at the speed of light. This process was path dependent, similarly to how the invention of the bicycle in some form would necessarily come before the automobile. Credit-based transactions over telecommunication systems only require simple data like Morse code to occur, and thus could be performed in the 19th century. Settlements of scarce value over telecommunication systems require far more complex computation, data structures, bandwidth, and mathematical proofs. Bitcoin and the broader ideas of digital scarcity and a decentralized digital settlement network were invented nearly as early as they could have been, based on the developmental timing of the underlying technologies that they rely on.

If I were to describe in one paragraph why money has been *broken* around the world for so long while almost everything else has improved substantially (energy abundance, technology abundance, and so forth), it's due to this gap between transaction and settlement speeds that the telecommunication era created. For a century and a half, the world has been stuck in a local maximum that has required and incentivized ever more complex forms of centralized abstraction to bridge that gap. The international gold standard worked for several decades during peacetime but was inherently flawed from the start due to how many claims it enabled to exist on such a small monetary base of actual gold, and it failed its first test as soon as war broke out between major powers in Europe. The Bretton Woods system was even more flawed due to even greater levels of abstraction and managed to fail in less than a decade and a half after full implementation. The modern system of 160 different ever-devaluing fiat currencies loosely tied to one world reserve fiat currency is highly flawed due to having no inherent grounding in scarcity. The invention of Bitcoin as an open-source fast settlement network with its own scarce units provides the first credible way to close that gap between transaction and settlement speeds, and now it's a matter of researching it and testing it to see if it's robust enough to serve that purpose at a large scale for the long run.

BITCOIN TECHNOLOGY OVERVIEW

Satoshi summarized Bitcoin in a forum post in February 2009, approximately one month after its release. There have been thousands of articles and many books written about Bitcoin since then, but I think Satoshi's own description remains useful for its clarity:

> I've developed a new open source P2P e-cash system called Bitcoin. It's completely decentralized, with no central server or trusted parties, because everything is based on crypto proof instead of trust. Give it a try, or take a look at the screenshots and design paper:
>
> Download Bitcoin v0.1 at http://www.bitcoin.org
>
> The root problem with conventional currency is all the trust that's required to make it work. The central bank must be trusted not to debase the currency, but the history of fiat currencies is full of breaches of that trust. Banks must be trusted to hold our money and transfer it electronically, but they lend it out in waves of credit bubbles with barely a fraction in reserve. We have to trust them with our privacy, trust them not to let identity thieves drain our accounts. Their massive overhead costs make micropayments impossible.
>
> A generation ago, multi-user time-sharing computer systems had a similar problem. Before strong encryption, users had to rely on password protection to secure their files, placing trust in the system administrator to keep their information private. Privacy could always be overridden by the admin based on his judgment call weighing the principle of privacy against other concerns, or at the behest of his superiors. Then strong encryption became available to the masses, and trust was no longer required. Data could be secured in a way that was physically impossible for others to access, no matter for what reason, no matter how good the excuse, no matter what.
>
> It's time we had the same thing for money. With e-currency based on cryptographic proof, without the need to trust a third party middleman, money can be secure and transactions effortless.
>
> One of the fundamental building blocks for such a system is digital signatures. A digital coin contains the public key of its owner. To transfer it, the owner signs the coin together with the public key of the

> next owner. Anyone can check the signatures to verify the chain of ownership. It works well to secure ownership, but leaves one big problem unsolved: double-spending. Any owner could try to re-spend an already spent coin by signing it again to another owner. The usual solution is for a trusted company with a central database to check for double-spending, but that just gets back to the trust model. In its central position, the company can override the users, and the fees needed to support the company make micropayments impractical.
>
> Bitcoin's solution is to use a peer-to-peer network to check for double-spending. In a nutshell, the network works like a distributed timestamp server, stamping the first transaction to spend a coin. It takes advantage of the nature of information being easy to spread but hard to stifle. For details on how it works, see the design paper at http://www.bitcoin.org/bitcoin.pdf
>
> The result is a distributed system with no single point of failure. Users hold the crypto keys to their own money and transact directly with each other, with the help of the P2P network to check for double-spending.
>
> Satoshi Nakamoto[321]

With that description in mind, the following paragraphs go into more detail for how the Bitcoin network works. Readers don't necessarily have to understand all of this, and the deeper details are more complex than this, but it's helpful to run through the intermediate-level details; I'll do my best to keep it in plain language. In this book, I capitalize the word "Bitcoin" when referring to it as a network and leave it uncapitalized when referring to "bitcoin" the monetary unit (unless of course it's the first word in a sentence).

Bitcoin began as a genesis block and a downloadable open-source software application, created by Satoshi, that people can use to run their own node on the network. The genesis block and all blocks after it leave a cryptographic puzzle (which is just a giant hidden number) that can only be solved by repeatedly guessing the answer by using processing power (which people typically refer to as "mining" but could perhaps more accurately be referred to as "timestamping"). Any person can contribute processing power from their computer to begin guessing to solve this puzzle, although in practice specialized SHA-256 processors are exclusively used now due to their efficiency. The person that finds the answer to the puzzle can connect a new block (filled with transactions) to the previous block and is rewarded with transaction fees and a certain number of newly generated coins for doing so, which serves as an incentive for people to dedicate processing power for this purpose. This new block also creates a new puzzle to continue the process and create the next block.

The Bitcoin network uses public-key cryptography. A user randomly generates a private key, which is simply an enormous number. You can generate a key by flipping a coin 256 times, for example, but in practice most people use software "wallets" to generate one for them. There are more possible private keys than there are atoms in a million galaxies, so the probability of randomly generating one or guessing one that someone else has already generated is vanishingly small.[322] In more human-readable form, the private key can be stored or memorized as a twelve-word seed phrase. The private key can be used to create a public key and an address, and other users can send bitcoin to that address. The public key and address are derived from the private key, but the process does not go in reverse; nobody can derive the private key from the public key or address. The private key, known only to the user, allows the user to sign a transaction to send bitcoin (including fractions of bitcoin) from their address to someone else's address.

Once initiated and signed by the owner of a private key, a pending transaction (the movement of bitcoin from their own address to someone else's address, or even from multiple of their own addresses to multiple different addresses of other people) is propagated to the network of other user nodes. Each node maintains a queue of pending transactions called a "mempool" (short for "memory pool"). Each node also maintains a full history of all prior blocks and the transactions therein since the genesis block. Therefore, each node contains the full ledger and the full history of the ledger since inception. A miner (or pool of miners) that successfully solves the puzzle left by the prior block can look through their pending transaction queue and pick ones to add to the new block that they create. Each block can hold a few thousand transactions, depending on the complexity of the transactions. Senders of a transaction must include a transaction fee for the miner with their pending transaction. If there are more pending transactions in the queue than there is space in the block they are creating, a miner will typically put the highest-fee transactions into the block in order to maximize the revenue earned from that block. During busy network times, higher transaction fees will generally get a pending transaction into a block more quickly than a pending transaction with a low fee attached to it. Miners that successfully create a block are rewarded by the network with a block subsidy (a certain number of new coins created per block), as well as transaction fees from all the transactions they include in the block.

Once created, the miner sends the newly created block to the node network, and nodes verify that the block follows the rules of the network, such as the maximum amount of data that can be put into each block and the maximum number of new coins (block subsidy) that the miner can create for themselves when creating the block. If a node determines that a block is valid, it stores it and propagates it to other nodes, and within a short period of time, all nodes verify and store this new block. The full history of all blocks and their transactions is commonly known as the "blockchain," and it is stored on each user node. There are tens of thousands of nodes worldwide, each storing the full ledger including all prior transactions from genesis.

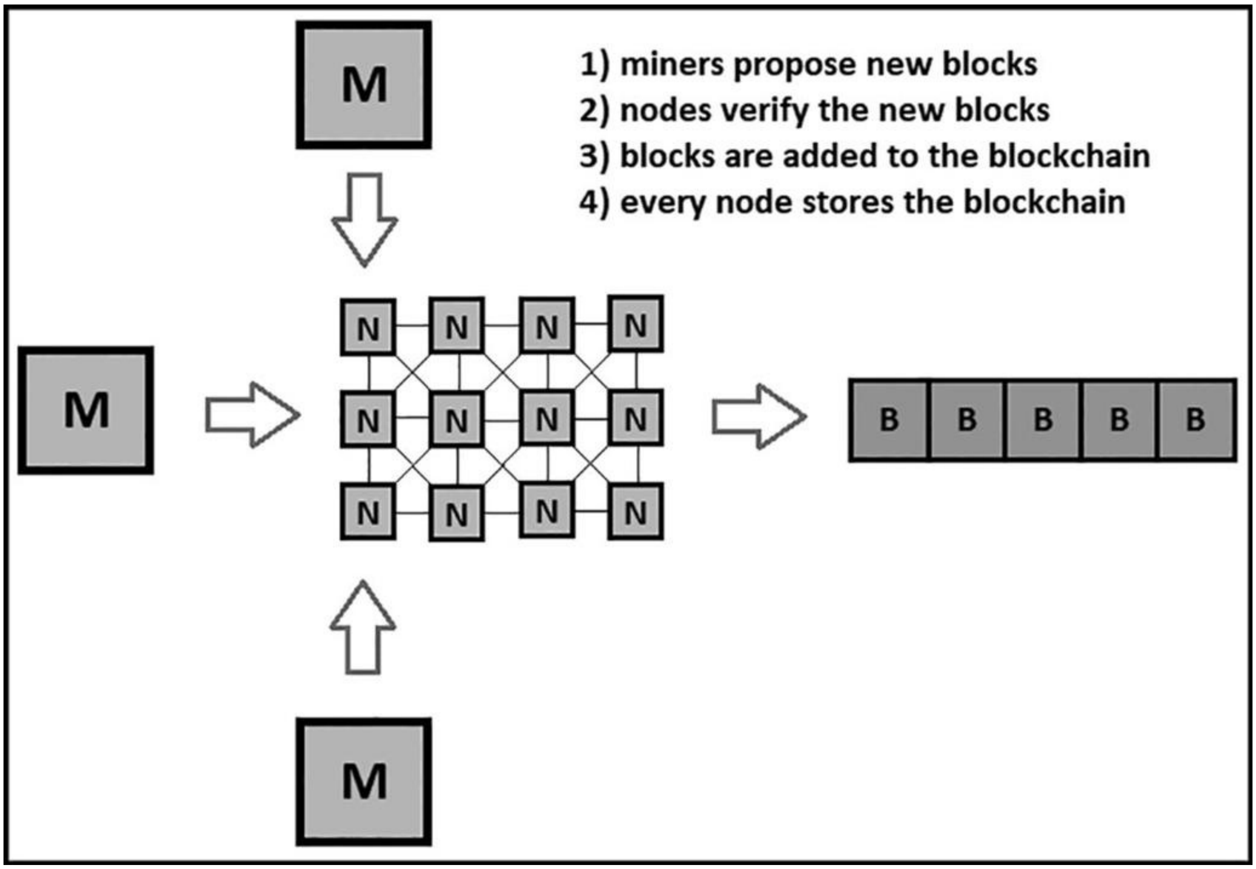

Figure 20-A

If two miners solve the latest puzzle at roughly the same time, it creates a temporary chain split. Some nodes will see Miner A's "block A" first, and other nodes will see Miner B's "block B" first, and these nodes will send these blocks to their peer nodes. Some miners may begin trying to solve the puzzle left by "block A," and others may begin trying to solve the puzzle left by "block B," based on which block happens to be propagated to them first. Eventually, a miner solves one of them, let's say for "block B," and that becomes the bigger blockchain than the "block A" one. As this fact is propagated around the network, that becomes the new dominant blockchain, "block A" gets discarded as an orphaned block, and the chain split is resolved back into one consensus ledger. Nodes are programmed to consider the biggest blockchain that follows the network's rules to be the correct blockchain to continue building upon.

All Bitcoin transaction settlements are probabilistic, but in practice a transaction is considered increasingly "final" as it is buried under many blocks, since it would take an increasingly huge amount of work to create a set of blocks built on some prior block that is larger than this version of the blockchain. A transaction that is in just one block has some chance of being reversed if it turns out there is a near-simultaneous bigger chain out in the network somewhere. A transaction that is two or three blocks deep is much less likely to be reversed. A transaction that is six or more blocks deep is almost certainly never going to be reversed. These numbers may change in the future if there are attempted censorship attacks or double-spending attacks on the network by well-capitalized attackers, resulting in users waiting longer to confirm their transactions. The larger and more important a transaction is, the more important it is to wait for several blocks to be built on top of the block that includes that transaction.

The network monitors the speed at which new blocks are added to the blockchain, with the goal of adding a new block every ten minutes on average. If more computational power joins the network and begins guessing the puzzle and trying to mine bitcoin, then blocks will be added faster. If some of the computational power leaves the network, then block creation will slow down. Every 2,016 blocks (approximately two weeks), the network checks the average speed of new block creation and adjusts the difficulty of the mining puzzle to reset it toward ten-minute average block times. This way, no matter how much computational power joins or leaves the network, the network continues to produce a block on average every ten minutes.

The more nodes there are on the network, the more decentralized the enforcement of the network ruleset is and thus the more resistant it is to undesired changes. The more computational power there is on the network, the more costly it is for an adversarial entity to attack the network by purposely reversing prior transactions, or by censoring new transactions. If some entity or group of entities is able to achieve and maintain over 50% of the computational power on the network (which currently requires billions of dollars' worth of equipment and electricity to do), they have the ability to censor the network in whatever way they like, but they still cannot change the rules of the network as enforced by the node operators that run the network. Users of the network could respond to this attack by bringing more computational power onto the network and try to reclaim a 50% majority of beneficial participants to un-censor it.

Developers from around the world can contribute proposed updates to the Bitcoin node software, which is what users run when they decide to operate nodes. A volunteer revolving team of maintainers organizes, reviews, and publishes updates, which node operators can then review and choose to upgrade to, or not. There is no way for developers to force node operators to make an update. As of this writing, there is one primary implementation of Bitcoin node software, referred to as Bitcoin Core. However, other implementations of Bitcoin node software from different people do exist and are compatible with each other and with Bitcoin Core. Since the code is open source, it's possible to fork away from the existing dominant implementation of Bitcoin Core and go in another direction, if the node operators of the system determine that the developers associated with that existing implementation are no longer serving their interests.

A "client update" involves small changes to Bitcoin Core or other Bitcoin client applications. As operating systems change over time, it's necessary to keep the client software compatible with them. A client update doesn't change the consensus rules of the Bitcoin network, but instead mainly just updates other parts of the software that makes it easier and safer to run a node.

A "soft fork" is a backwards-compatible change to the consensus rules of the network, meaning that nodes that upgrade to this software can continue to interact on the same network as older nodes that haven't updated yet. Specifically, a soft fork narrows the existing consensus ruleset slightly. An example of a soft fork would be to reduce the maximum block size, since any blocks created under this new update would meet the prior maximum block size rules, but now the rules are also a bit stricter. Bitcoin has historically updated using soft forks, which optimized the code and have added some new features. As an analogy, USB 2.0 devices are compatible with existing USB 1.0 ports but offer some new features for those that choose to upgrade to USB 2.0 ports. Similarly, USB 3.0 devices are compatible with existing USB 2.0 (and earlier) ports but offer another level of features from there.

A "hard fork" is a non-backwards-compatible change to the consensus rules of the network, meaning that any node that upgrades to this software is no longer using a ruleset that is compatible with the rest of the network. An example would be to increase the block size limit, since blocks made using this software will not meet the maximum block size that older nodes have in their rulesets and won't be accepted by the network. Other examples of hard forks would be to increase the number of coins in the system, or to increase the future pace of new coin creation per block. Existing nodes would automatically reject blocks with these characteristics. As an analogy, it's like introducing a different and incompatible communications protocol than USB, and that doesn't work with existing USB ports.

A non-compatible update, i.e., a hard fork, creates a separate ledger network, with much fewer nodes, and much less computational power, and won't be recognized as Bitcoin by the existing node network (unless the vast majority of individual nodes and miners together decide to upgrade to that new non-compatible ruleset). When a hard fork happens, the ledger is effectively copied, and so each existing private key holder retains their bitcoin on the existing ledger and in addition has access to an equivalent number of forked coins on the new ledger. From there, the outcome of hard forks is determined by market forces: Each existing holder now has both sets of coins, although it's likely that the minority fork will have considerably less market value. The history of all transactions prior to the fork are the same for the two ledgers, but starting with the point where the fork occurs, the ledgers can begin to diverge due to different new transactions being added to each one. If a user has a high conviction about which fork will win, they could sell the other set of coins and buy more of the coins associated with the fork that they think will win. If a user has no strong opinion, they could hold both sets of coins and wait for the fork to be resolved and wait for the value on the minority fork to be re-absorbed into the main network. There have been many hard forks out of the main Bitcoin network, and as of this writing the biggest one only has around 0.5% of the market capitalization of the main Bitcoin network. The incumbent fork is the one that is already compatible with the existing node network, which gives it an inherent advantage at winning competitions with new hard forks that are not.

Bitcoin was programmed by Satoshi to produce 50 new coins every ten minutes on average to a miner that creates a successful block, and then every 210,000 blocks (approximately every four years) that number of new coins per ten minutes is halved. After four years it became 25 coins every ten minutes, and then four years later it was 12.5, and then four years later it was 6.25, and so on. This declining block subsidy was programmed into the software from inception. The way the math works out is that the network asymptotically approaches 21 million coins, with nearly 19.5 million already having been created as of this writing.

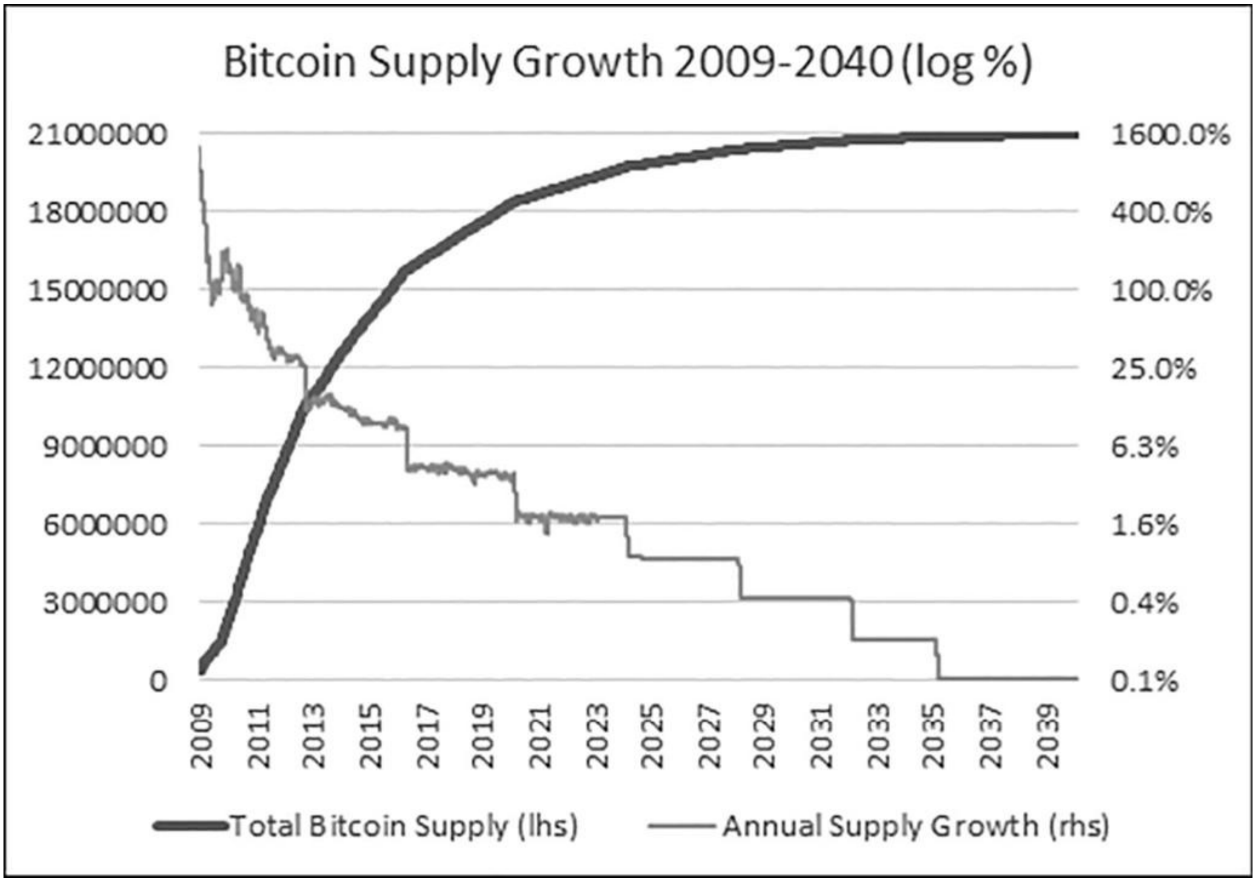

Figure 20-B[323]

While some of this may sound complex at first, it's not nearly as complex as the step-by-step details of how the global banking system works under the surface, including the complex handshaking that goes on between financial entities to process dollar transactions and the overnight credit arrangements between financial institutions via dollar repurchase agreements and similar contracts. The base layer of the Bitcoin network is straightforward in comparison, and most of it is abstracted from users. The fact that a full node can run on an aged laptop speaks to how simple it is at the foundation; the Bitcoin network is just a swarm of these relatively simple nodes, programmed to operate with each other and come to an agreement on the state of the ledger every ten minutes. The details described here, however, are important to potential early adopters as they try to determine whether this network is likely to be successful, or what this type of technology can mean for the concept of money going forward.

These days, there are many types of signing devices and phone wallet apps that allow users to easily manage private keys, addresses, and node functions without having to worry about what's going on under the hood — kind of like how the owner of an automobile doesn't need to be a mechanic. These products are created by various teams and companies around the world; anyone can create new products and services for users if they are compatible with the open-source Bitcoin network.

There is a big spectrum for how technically involved users can choose to be when interacting with the Bitcoin network. If someone runs their own node and holds their own private keys, they can audit the supply of the network, participate in network consensus, initiate peer-to-peer transactions, and retain privacy, with no centralized third-party interactions. Unless someone gains control of over half of the computational power on the whole network (or shows up at their door with force), nobody can stop a node operator from sending or receiving transactions. They can use various privacy and anonymization techniques, and directly run software associated with other layers of the network as well.

A step down from there is that someone can keep their own private keys but use a node that is run by a third party. This sacrifices some privacy and auditability, but at least they can custody their own coins, and at any time they could begin to run a node if they want to. This is a middle ground that gives people a significant amount of optionality to get more involved over time.

Another step down from there is that someone can use a custodial service to hold their private keys for them. There are custodial wallet apps and custodial financial services companies that will hold bitcoin for clients and allow clients to easily send bitcoin around. This is a very convenient method, but it introduces privacy problems and counterparty risk, including potentially not being able to withdraw coins or not being allowed to send coins to an address that the client wants to send them to. There are some new technologies like the Fedimint open-source protocol that allow for automated and private custody arrangements.

There are also hybrid solutions, thanks to multi-signature technology. The digital signature required to send bitcoin from an address can be broken into pieces, where for example two out of three are needed to sign a transaction. This is useful for additional security or estate planning. Someone can keep one key with them, keep a second key somewhere separate and safe (perhaps with a trusted relative or legal representative or kept in an encrypted, password-protected file somewhere), and keep a third key with a bitcoin-native financial services company. This gives some protection against losing one key and gives the user some benefits of a custodial service without giving the custodian the full ability to control their coins. This type of hybrid custody is impossible with cash, gold, and other types of non-encrypted money.

As we finish the chapter we should ask “who controls the ledger?” for Bitcoin.

The primary answer is that the tens of thousands of users that run nodes control the ledger, and anyone with a basic laptop (or similar hardware) and a standard internet connection can join as a node operator. Node operators are the ones that store the full history of the ledger, and collectively maintain the software that runs the network and enforces network rules for new blocks being added to the blockchain by miners.

The secondary answer is that miners play an important role in updating the ledger. Miners use electricity and specialized processors to earn the right to add new transactions onto the ledger. A single miner or group of miners that somehow marshals together over 50% of all active computational power on the network could censor transactions or reverse recent transactions that users previously thought were final. They could censor specific transactions, or they could attack the network by mining empty blocks to censor all transactions going forward. If this happens, it’s not necessarily a permanent problem; more computational power could be brought online by users of the system, incentivized by a spike in transaction fees by censored users, to collectively regain over 50% of the network’s computational power.

Developers are influential but have no direct power over the ledger since they can’t force any node operator to accept a software update. If developers make an update that node operators don’t like, then that update won’t be accepted by them. In that case, node operators will just keep running their existing software, and eventually could support other developers to create different updates. Many node operators wait years after an update is released before using it, to ensure that it is fully stable and without bugs. Developers are, of course, still important for the network; their expertise at crafting backward-compatible updates that the users of the network want to use has helped Bitcoin become more secure and scalable over time. Developers consist of an ever-changing set of volunteers (many of which are financially supported by companies in the ecosystem), and they ensure that the node software continues to be compatible with modern computing environments that evolve over time.

Unlike banks, central banks, and fiat currency financial systems, there is no entity that can unilaterally debase the Bitcoin ledger. There is no central node that can create a million new coins for themselves. Nobody can take a user's coins unless they get their private key (which can be further secured by passwords and/or multi-signature protection) or unless they coerce them to send over their coins. The ledger is transparent, objective, and secured by real-world resources in the form of electricity and specialized processors.

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CHAPTER 21

BITCOIN’S PATH OF MONETIZATION

Prior to the creation of Bitcoin, anyone who wanted to quickly send value across long distances needed to go through a trusted intermediary — such as the banking system and their associated central banks. Bitcoin is a powerful innovation that allows people to quickly transfer value in a peer-to-peer manner over the internet, without relying on any centralized third party.

The question then becomes, “What is this capability worth?”

To try to answer that question, let’s first back up and look at gold again for a moment.

The key reason why paper claims and banking systems were built on top of gold for centuries was to improve gold’s capabilities as a medium of exchange. Gold is good as a savings asset, but due to its limited divisibility, physical nature, and need for authentication whenever it changes hands, it is not great as a medium of exchange in the modern world. Even as a final settlement network, it leaves a lot to be desired. When gold is settled in large amounts using large bars, the only way to truly know that a bar consists of gold down to its core is to melt it down and re-make the bar. If users want to transact with it online or over long distances, they need to abstract it in some way and therefore rely on a centralized custodian and legal chain of custody so that they can trade digital claims for the gold rather than the gold itself.

Bitcoin on the other hand is a bearer asset that is safe to self-custody in large amounts (especially with multi-signature setups) and can be sent peer-to-peer around the world over the internet within minutes. Therefore, it removes the need for custodial abstraction. Some holders will still prefer custodians to hold it for them, but it's not as necessary as it is with large amounts of gold. Thus, the units of the network are less prone to centralization. Bitcoin is a very fast global settlement system; it takes 30-60 minutes to settle a large transaction on Bitcoin whereas most international bank transfers take significantly longer than this. And by writing down or memorizing twelve words, someone can travel anywhere in the world with their bitcoin.

From the start, the Bitcoin network was designed as a peer-to-peer network for the purpose of being a self-custodial medium of exchange. It's not the most efficient way to make small purchases, but it's the most unstoppable way to settle final value online. It has no centralized third parties, no centralized attack surfaces, and sophisticated ways of running it can even get around rather hostile networks. Compared to other cryptocurrencies, Bitcoin is harder to attack due to its bigger network of nodes and total amount of miner computation. In addition, the node software is small and tight so that it can be run on a laptop with normal internet bandwidth, which is not the case for most other cryptocurrencies.

At first, bitcoin were mined and held as digital collectibles by enthusiasts, and there was no quotable price for them.[324] The cost to acquire them was determined by hardware and electricity to run a computer and participate as a miner, and the amount of this input cost per coin varied depending on how many people were using their computers to mine it.

In 2010, the first bitcoin exchanges were created, which allowed a quotable market price to form. This was also the first year of practical use for bitcoin. When Wikileaks was de-platformed by PayPal and other centralized payment methods, it turned to bitcoin donations in their place. Bitcoin's original use-case as censorship-resistant money came to the forefront with this event, and even Satoshi wrote at the time that he was concerned that this would bring negative attention toward them like a swarm of hornets before the network was robust enough to handle it.[325] Days later, he ceased posting in public, and within a few months he vanished from email communications as well. And yet the Bitcoin network has continued to grow and evolve since then, for well over a decade.

Kind of like how a tank is designed to get from point A to point B through resistance but is not well suited for commuting to work every day, the Bitcoin network is designed to make global payments through resistance but is not well suited for buying coffee on the way to work. More broadly, the Bitcoin network is the world's most immutable and decentralized database for storing the history of bitcoin transactions as well as other arbitrary data, and bitcoin are required to pay transaction fees to update that database.

In that sense, the Bitcoin network has utility, for both ethical and unethical participants (just like any powerful technology). And because it is broken up into 21 million units (each with eight decimal places, resulting in 2.1 quadrillion actual sub-units), it is a finite digital commodity.

And that's how Satoshi described it in a forum post in 2010:

> As a thought experiment, imagine there was a base metal as scarce as gold but with the following properties:
> – boring grey in colour
> – not a good conductor of electricity
> – not particularly strong, but not ductile or easily malleable either
> – not useful for any practical or ornamental purpose
>
> and one special, magical property:
> – can be transported over a communications channel
>
> If it somehow acquired any value at all for whatever reason, then anyone wanting to transfer wealth over a long distance could buy some, transmit it, and have the recipient sell it.[326]

In addition to sending them online, bitcoin in the form of private keys can be physically brought with you globally. You can't bring a lot of physical cash or gold through an airport and across borders. Banks can block wire transfers into and out of their country or even within the country. But if you have bitcoin, you can bring an unlimited amount of value globally, on your phone, on a USB stick, or stored in a password-protected file in a cloud drive that you can access from many different countries — or simply by memorizing a twelve-word seed phrase (which is an indirect way of memorizing a private key). It's challenging for governments to prevent that without extremely draconian surveillance and control, especially for technically savvy citizens.

This utility combined with an auditable and finite number of coins eventually attracted attention for its monetary properties, and so bitcoin acquired a monetary premium. When you hold bitcoin, especially in self-custody, what you are holding is the stored-up ability to perform global payments that are hard to block, as well as the stored-up ability to transfer your value globally if you want to or need to. You are holding your slot on a global ledger. It could be an insurance policy for yourself in the future, or you could simply hold it because you recognize that capability to be valuable to others, and therefore recognize that you could sell that capability to someone else in the future. And compared to other cryptocurrencies, Bitcoin is the largest, most liquid, most immutable, and most decentralized one.

Furthermore, thousands of developers are working every day to make the Bitcoin network more useful. Some of them are contributing to base layer improvements. Some of them are working on higher parts of the network stack. Some of them are making hardware devices, software applications, or bitcoin-native financial services companies, and all of this work makes holding, transacting, and otherwise interfacing with the Bitcoin network easier and more efficient.

Bitcoin is becoming a rather salable good, in other words. Meanwhile, it settles faster than dollars and has a lower supply growth rate than gold. Figure 21-A shows the dollar-denominated market capitalization of bitcoin over time.

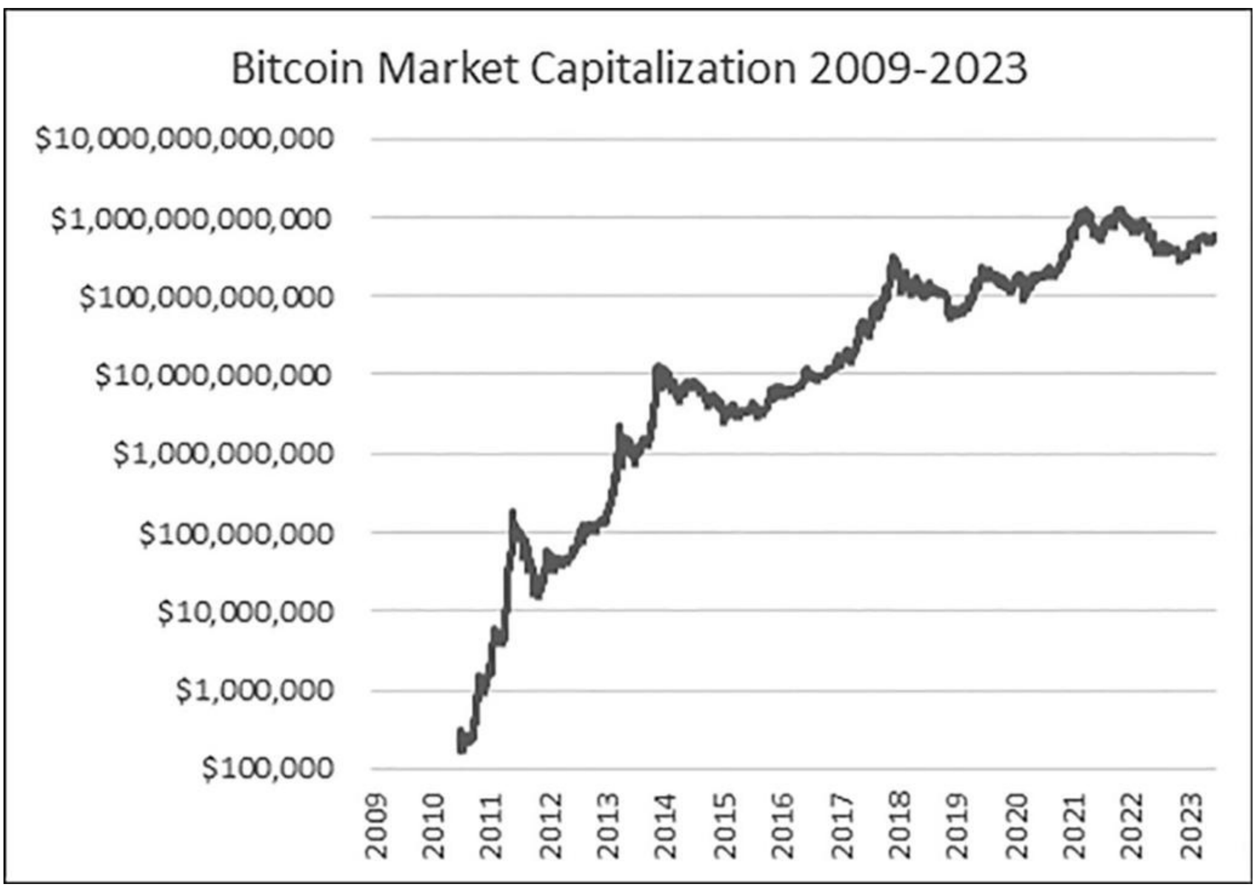

Figure 21-A[327]

If we catalogue the various bearer asset monies of the world and list the top five or ten in terms of global salability, bitcoin already make the list. If you bring physical Egyptian pounds, Norwegian kroner, South Korean won, Thai baht, or 100+ other paper currencies with you to various places of the world outside of their host jurisdictions, you'll most likely find it very difficult to get anyone to take them in exchange for goods or services, or even to exchange them for local currency (aside from a very small number of specialized dealers who charge high fees and are hard to find outside of airports). The best bearer asset monies as of this writing to bring with you are probably physical U.S. dollars and physical gold coins; in most regions of most countries, you could buy something with them, or at least exchange them for local currency at fair market value with little difficulty. Euros are in the top five as well. Bitcoin is already in the top ten globally salable monies, especially within cities. There are tens of thousands of bitcoin ATMs in urban centers around the world, and many niche businesses in many countries directly accept bitcoin for payment. There are Bitcoin communities and meetups in countries around the world as well. Bitcoin is able to move globally through airports and other ports of entry in a way that cash and gold cannot. There are decentralized social media protocols like Nostr where bitcoin is the standard unit of account and people across the world can easily send it to each other by tipping each other's posts. There are platforms like Bitrefill that let people around the world easily convert bitcoin into gift card vouchers for all sorts of everyday purchases, so that even merchants who don't directly accept bitcoin can still transact with people who primarily use the Bitcoin network.

Bitcoin is volatile, but that's in large part because it monetized from zero to more than a trillion-dollar market capitalization at its peak within its first twelve years. The market is exploring this technology and trying to determine its total addressable market as more and more people buy into it over time. It's an asset that is still only held by a small fraction of the global population.

Censorship-resistance is a significant feature when it comes to payments, and the ability to self-custody portable money that cannot be debased is a significant feature when it comes to savings.

To many people in developed countries, those features might not seem important, because we are privileged and take our freedom and comfort for granted. We might even imagine that the only people who would want these features must be up to no good. But for a large portion of the world, being able to bring self-custodied wealth with you if you must leave your country is immeasurably valuable. When Jews fled Nazi-controlled Europe, they had trouble bringing any valuables with them. When people left the failing Soviet Union, they could only bring the equivalent of $100 USD with them.[328] When people today want to leave Venezuela, Syria, Iran, China, Afghanistan, or any number of countries, they often have a rough time bringing most of their savings with them, unless they have self-custodied bitcoin, and I personally know some of them that have done this. Even if they just want to stay where they are, people in developing countries all around the world suffer from repeated currency debasement, which makes saving very hard to do. Billions of people today can appreciate the value of this feature.

Vladimir Putin's political opposition in Russia, Alexei Navalny, began using bitcoin after Putin's establishment cut them off from their banking relationships. Nigerians protesting against police violence turned to bitcoin after they had their bank accounts frozen by the government. Chinese people have used bitcoin to transfer value out of the authoritarian country through capital controls. Venezuelans have used it to escape hyperinflation and transfer value out of their failed state. Lebanese citizens, Argentinian citizens, Turkish citizens, and more have used bitcoin to store value in the face of persistent high inflation. People in various African nations have used bitcoin in places where they don't have banking services; today more people in the world have a smartphone than a bank account. Remote workers in various countries can perform online services such as virtual assistance, graphic design, programming, or other services to foreign clients and receive bitcoin as payment with much less hassle than many other forms of international payment.

Aside from usage on the dark web, one of the earliest practical use-cases for bitcoin, back in 2013, was by Roya Mahboob to pay Afghan women with a type of money that their male relatives could not confiscate and that they could send to others. In his book *Check Your Financial Privilege*, Alex Gladstein wrote about this topic:

> At first, Roya paid her employees and the WomanNX contributors in cash. The problem was that the women wanted to send the money to family and pay vendors in different parts of the country. They used the hawala system, an 8th-century money transfer process that relied on brokers and a web of trusted intermediaries.
>
> This ancient platform seemed dated and slow to Mahboob and the women, many of whom already had

> Nokia cellphones and had started to create and use their own Facebook accounts. Even worse, sometimes the money did not make it through the hawala system, and it was hard to verify that the whole amount reached the recipient.
>
> So, Mahboob researched the idea of mobile money. As it turned out, cellphone-based payment systems like M-PESA, which worked so well in Kenya, never took off in Afghanistan. PayPal was still not available because of U.S. sanctions. And the women did not have bank accounts, so she could not wire them the money. The women had to have their father's or husband's permission to open an account, and this was often not granted.
>
> Mahboob's employees wanted digital control over their time and earnings.
>
> "If I gave them cash," she said, "their fathers or husbands or brothers might find out and take it away."
>
> In early 2013, Mahboob's Italian business partner told her about bitcoin. He said it was a new kind of money that could be sent from phone to phone without a bank account. Unlike the local afghani currency, which was steered by the government, bitcoin floated on the open market. When Mahboob first learned about bitcoin, it was trading at around $13. By the early summer of 2013, it broke $70.
>
> "At first, I did not think the girls would trust Bitcoin," Mahboob said. "It was too hard to understand."
>
> But her business partner encouraged her and said: "Let's try it — what do we have to lose?"[329]

Bitcoin indeed ended up being quite useful for their purposes, where other monies were insufficient. The primary challenge was its volatility, which especially in the early days made it hard to work with as money. And then, in addition to self-custody and decentralized payments, the ability of bitcoin to be brought across borders ended up being critical for some of the women. As Gladstein wrote further in his book:

> A few of the women did keep their bitcoin from 2013. One of them was Laleh Farzan. Mahboob told me that Farzan worked for her as a network manager, and in her time at Citadel Software earned 2.5 BTC. At today's exchange rate, Farzan's earnings would now be worth more than 100 times the average Afghan annual income.
>
> In 2016, Farzan received threats from the Taliban and other conservatives in Afghanistan because of her work with computers. When they attacked her house, she decided to escape, leaving with her family and selling their home and assets to pay brokers to take them on the treacherous road to Europe.
>
> Like thousands of other Afghan refugees, Farzan and her family traveled by foot, car and train thousands of miles through Iran and Turkey, finally making it to Germany in 2017. Along the way, dishonest middlemen and common thieves stole everything they brought with them, including their jewelry and cash. At one point, their boat crashed, and more belongings sank to the bottom of the Mediterranean. It's a tragic story familiar to so many refugees. But in this case, something was different. Through it all, Farzan was able to keep her bitcoin, because she hid the seed to her bitcoin wallet on a piece of tiny, innocuous-looking paper. Thieves could not take what they could not find.[330]

The limited scalability of Bitcoin's base layer has not been an issue so far, because there is only so much public understanding and current demand for tank-like censorship-resistant payments and globally portable money. And as development has continued since Bitcoin's launch, the network has branched into additional layers just like any other financial system or protocol stack.

The Lightning network is a series of channels that run on top of the Bitcoin network base layer. It allows for custodial or non-custodial instant payments online or in person with a mobile phone, to the point where they can easily be used to buy coffee, and with practically no limitation on transactions per second. The Liquid network, as another example, is a sidechain that wraps bitcoin into a federated network for rapid transfers, better privacy, and additional features. The Fedimint open-source protocol now allows anyone to set up a federated and private community bank on top of the Bitcoin and Lightning network stack. RSK and Stacks are smart contract layers built on top of Bitcoin that give developers and users more expressive programmability. Smart contracts can be used to make Bitcoin more programmable, which may be able to reduce the overhead costs of certain financial services and make them more globally accessible — services such as trading, collateralized borrowing, or escrow functionality. There are other proposals such as covenants, drivechains, and zero-knowledge rollups that can scale the Bitcoin network if certain soft forks are enabled as well.

In that sense, bitcoin began as digital collectibles or commodities that had utility value as an internet-native and censorship-resistant medium of exchange for people who need that capability. Bitcoin eventually acquired a monetary premium as an emergent and volatile store of value (an increasingly salable good) and began to be held more and more for their scarcity than for their medium-of-exchange capabilities. And then over time, the network developed additional ways to enhance the network's medium-of-exchange capabilities beyond their initial limitations, and the depth of liquidity has increased over time.

Bitcoin as a network and surrounding ecosystem went through multiple boom and bust cycles so far, and in each one, larger pools of capital became interested in it. In the first era, the user experience was challenging and required technical understanding, so Bitcoin was mainly used by computer scientists and enthusiasts exploring the technology. In the second era, the Bitcoin network became a bit easier to use and bitcoin reached enough liquidity to have a quoted price in dollars and other fiat currencies, and so it became noticed by early speculators as well as dark web buyers/sellers for the purposes of buying drugs and other things, which continued until some key centralized dark web marketplaces were shut down. In the third era, Bitcoin reached early mainstream adoption, in the sense that exchanges with proper security protocols could operate with bank connections, provide more liquidity to the market, and improve the user experience so that everyday people could more easily buy some. In the fourth era, institutional-grade custodians entered the market, which allowed pensions, insurance companies, hedge funds, family offices, small businesses, and sovereign wealth funds to safely allocate capital to bitcoin.

In each era of adoption so far, too much enthusiasm and leverage eventually built up, causing a local bubble to form and to pop, washing out a lot of traders, and setting the stage for the next foundation of growth. Unlike other technologies such as electricity, washing machines, televisions, computers, and phones, a new type of emerging money most likely cannot be widely adopted quickly. This is because if too many people adopt it at once, it drives up the price and incentivizes leveraged buyers to enter it. This leverage eventually causes a bubble to form and to pop, which sets the price back and disillusions people for a while until it builds the next base and grows from there. Due to the attachment of leverage, Bitcoin cannot realistically have a fast and smooth adoption curve like non-monetary technologies can.

There’s no guarantee that Bitcoin will be successful in the long run, but to whatever extent that it will be, it’s almost guaranteed to be very cyclical along the way, with higher-highs and higher-lows as it repeatedly washes out speculative traders that try to attach leverage to it. Only once it is closer to its total addressable market, with extremely high levels of liquidity and user adoption, can its notorious price volatility realistically diminish.

THE APPLICABILITY OF GRESHAM’S LAW[331]

According to Gresham’s law, if people have a good money and a bad money with a fixed exchange rate between them (or other frictions such as capital gains taxes placed on the good money), they will usually want to spend the bad money and keep the good money. Ironically then, the bad money is what tends to circulate with high velocity while the good money is hoarded with low velocity.[332]

This trend emerged multiple times under bimetallic standards. Whenever gold and silver have been fixed relative to each other by government decree, and this fixed exchange rate was not in line with the global supply/demand exchange rate (which can change over time), then the undervalued metal tends to disappear from circulation while the overvalued one circulates.

In a 2011 report for the Congressional Research Service titled “Brief History of the Gold Standard in the United States,” Craig Elwell wrote:

> The United States began with a bimetallic standard in which the dollar was defined in terms of both gold or silver at weights and fineness such that gold and silver were set in value to each other at a ratio of 15 to 1. Because world markets valued them at a 15½ to 1 ratio, much of the gold left the country and silver was the de facto standard.
>
> In 1834, the gold content of the dollar was reduced to make the ratio 16 to 1. As a result, silver left the country and gold became the de facto standard.[333]

There are a couple processes for how that happens.

The first process is simply that the better (undervalued) money gets hoarded, and so it stays in the country but gets removed from everyday circulation. Instead, it is treated as a form of savings. People will not usually part with what they perceive as being undervalued.[334]

The second process is that international entities can observe this and arbitrage it. For example, if the global ratio of gold-to-silver is 15.5 to 1, but Americans have it fixed by government decree at 15 to 1 (slightly undervaluing gold vs silver relative to the global exchange rate), then a European entity can keep selling silver to Americans and buying gold from Americans to arbitrage that difference. As years or decades pass, there will be a lot less gold in the United States, and a significant surplus of silver instead.

The same thing has tended to happen during historical periods of physical coin debasement. If gold coins are initially issued with 90% gold content, but newer coins are issued with only 80% gold content, but the government treats both as having the same legal tender face value and expects their citizenry to do the same, then it will lead to some obvious outcomes. The 90% gold coins will tend to be hoarded domestically or traded to external merchants at their proper metallic value wherever possible, while the 80% gold coins will be spent on domestic commerce, and therefore circulate with high velocity where they are treated at an above-market rate. Eventually, most of the coinage in domestic circulation will be the 80% gold variety.[335]

The U.S. broad money supply has grown at a 7% annualized rate since 1960. Most developed countries have a similar rate to that, and emerging markets tend to have a much higher rate on average.

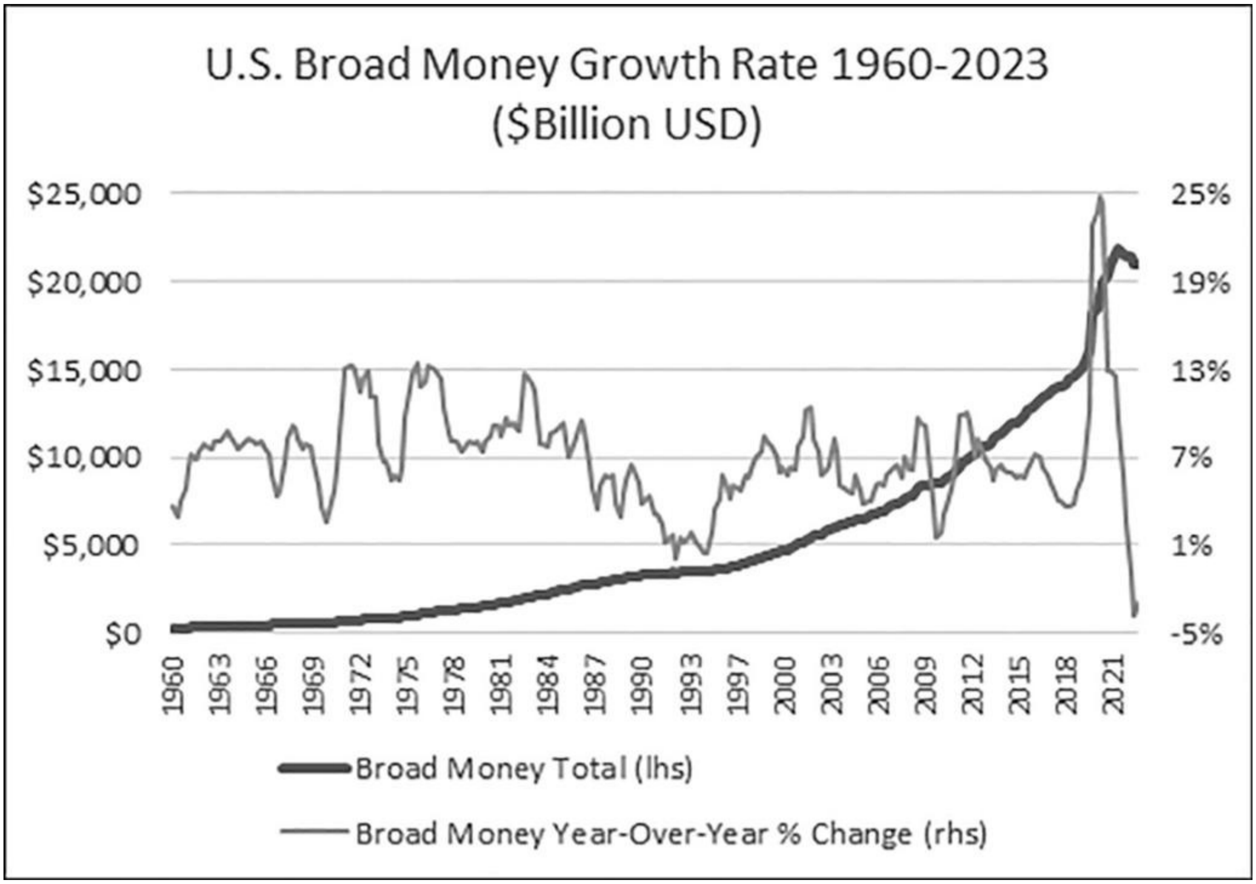

Figure 21-B[336]

Meanwhile, total supply of bitcoin is growing at less than 1.8% per year, which will fall to below 0.9% in 2024, and to around 0.4% in 2028. The Bitcoin network is programmed to asymptotically approach 21 million bitcoin in total by halving its rate of new bitcoin creation every four years until it has 0% supply inflation. And unlike most other blockchain monies, the wide node network helps ensure that no centralizing force can change this distribution pattern. Plus, it has the dominant network effect among proof-of-work blockchain monies, which makes it rather protected against censorship or transaction-reversal attacks.

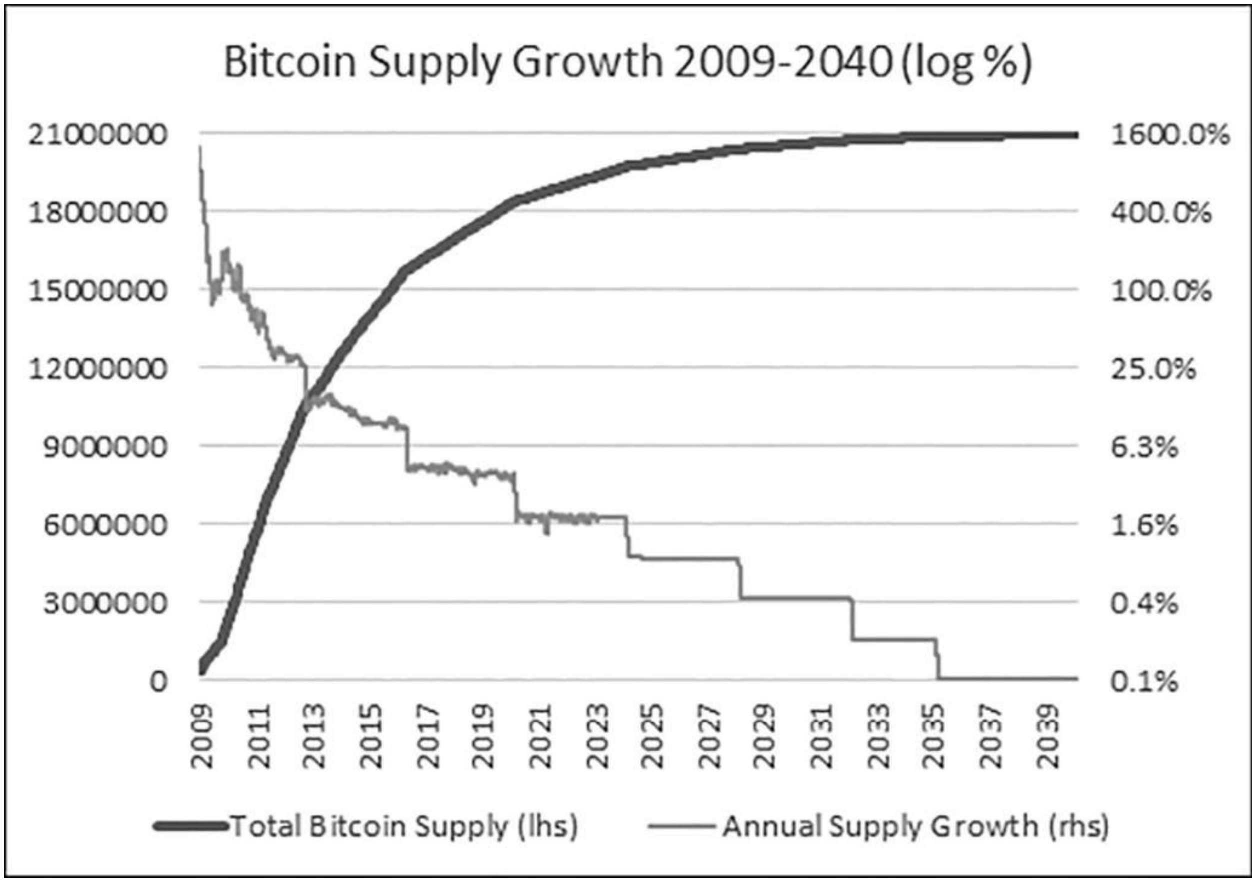

Figure 21-C[337]

It's natural for people to want to save something like gold or bitcoin, and spend their fiat dollars, pounds, yen, euros, yuan, pesos, naira, and rupees. Assuming both are widely accepted by merchants, money that depreciates in purchasing power tends to circulate, while scarce money that tends to appreciate in purchasing power gets kept as savings, with much lower spending velocity.

This becomes especially true if a jurisdiction treats the harder money like property and taxes each transaction, while enforcing legal tender for the weaker money, which most jurisdictions do. If you try to use things like gold or bitcoin as media of exchange, each transaction is a taxable event compared to your initial cost basis (when you originally bought that asset). The incentive therefore is to hoard the taxable gold or the taxable bitcoin, with their lower levels of supply inflation, and spend the non-taxable fiat currency on consumption, unless someone has a strong need for Bitcoin's censorship-resistant payments properties.

In this sense, although Gresham's law originally applied between monies with fixed exchange rates, I think it can be said to apply more broadly any time there is transactional friction mismatch of some sort, including a tax. The depreciating and/or lower-friction currency will be spent while the appreciating and/or higher-friction currency will be saved, unless there is a strong practical reason to do otherwise, meaning a use-case that specifically needs the unique properties of the appreciating and/or higher-friction currency, such as for example if someone needs to use Bitcoin's censorship-resistant properties or if someone is operating in an environment of limited banking access.

People that don't have banking access but are tech-savvy, people that are facing financial resistance or censorship, or people that have become de-platformed in various ways, are more likely to use bitcoin for their medium-of-exchange capabilities early on in their adoption. Some others use it as a medium of exchange because they want to remove themselves from banks as much as possible or enjoy the ease of making international peer-to-peer payments with it. If a region makes it legal tender or removes capital gains taxes from bitcoin, this makes it more convenient to use in these ways.

On the other hand, people who hold bitcoin but don't actively use it as a medium of exchange yet, are still using it as money. They are holding it for its monetary premium and the future optionality and insurance that this portable, self-custodial, supply-capped, censorship-resistant global money provides to them. Even if they have all sorts of traditional assets and banking relationships, on the side they also are their own bank, thanks to their allocation to bitcoin.

The future remains uncertain, and in chapter 26 I analyze risks for the Bitcoin network and various ways that the network's failure or stagnation could occur. So far, however, Bitcoin continues to gain users, developers, and a flourishing ecosystem of companies built around it, with structurally increasing (albeit very volatile) network value.

APPROACHES TO BITCOIN VALUATION

The exact numbers change every year, but the value of global assets has been estimated by both Credit Suisse and McKinsey to be worth over $500 trillion in recent years.[338] Real estate, equities, bonds, and cash represent most of the assets.

As of the end of 2022, the largest broad money supply in the world was China at approximately $38 trillion (when translated into U.S. dollars). The United States was the second biggest at $22 trillion, the euro area was the third biggest at $16 trillion, and Japan was the fourth biggest at $12 trillion.

The World Gold Council estimates that there are 208,000 metric tons of refined gold in the world, with two-thirds of it having been mined since 1950.[339] With gold prices where they were at the end of 2022, that translated into a total gold market capitalization of approximately $10 trillion.

There are many estimates regarding what the Bitcoin network (and by extension, individual bitcoin) could be worth one day. Chapter 26 covers risks associated with the network and covers scenarios where the network could stagnate and die over time. If none of the failure scenarios occur, it's not unreasonable to expect the network to continue to take more market share, as understanding of it grows and as its user experience improves with new ecosystem developments.

In its nascent state, it's very volatile and prone to leverage and liquidation cycles. The more widely held it is and the more liquid it becomes, the less volatile it is likely to be, which would make it similar to gold in that regard. Unlike most assets that tend to be partially siloed based on jurisdiction, the Bitcoin network has no specific connection with any country or corporation and is available to anyone in the world with internet access.

The total addressable market for the Bitcoin network, therefore, includes everyone that might want to hold some percentage of their net worth in a scarce, liquid, and immutable form that can be self-custodied and that is globally portable. With over $500 trillion in global assets, every 1% of global assets that the Bitcoin network manages to capture would translate into over $5 trillion in market capitalization in today's dollars — which at 21 million coins translates into a fully diluted value of $238,000 per coin. As a bullish scenario, it's not hard to imagine that at a mature stage for the network, people around the world might on average want several percentage points of their assets in that form of money.

Monies tend to have network effects based on salability. The more liquid, widely held, and widely accepted a certain type of money is, the more useful that money becomes to each user, and thus more people want to hold it and accept it. All else being equal, the more conversion points between bitcoin and goods, bitcoin and services, and bitcoin and currencies there are globally, the healthier the Bitcoin network is. Even if a user doesn't want to use bitcoin as a medium of exchange currently, the more assurances that a user has that they *could* find a buyer anywhere around the world, the more useful bitcoin is to hold as part of their long-term savings. Furthermore, there are some pools of capital that realistically can only use bitcoin once it grows more expensive. When the whole network only had a few million dollars' worth of exchange trading volume per day, billionaires couldn't enter and exit it in size without moving the price. Now that there are billions of dollars of exchange trading volume per day, it's still too small for some of the largest trillion-dollar pools of capital to comfortably enter or exit in size. The network must partially saturate certain types of markets and grow larger from doing so, in order to reach each higher level of adoption.

WHAT WOULD A "BITCOIN WORLD" LOOK LIKE?

If the Bitcoin network in some form (a fast money with a fixed supply, based on a decentralized open-source global ledger that is backed up by energy and user-operated nodes, with many software layers and financial institutions built on top of it) reaches critical mass and becomes very widespread in use — like the dollar is today and like gold used to be — then this would lead to multiple aspects of commerce and governance working differently than they do within the current monetary system. We can't necessarily know all of those implications, but we can infer some directional outcomes. I view most of the likely outcomes as positive, but as with any new technology, these types of changes can also lead to some outcomes that we might consider to be negative as well.

- Unlike the bimetallic and gold standard banknote era, the underlying asset of bitcoin itself can settle nearly as quickly as transactions can and is inherently divisible into well-defined amounts, and therefore there is no need for unit abstraction. Coinage and banknotes historically served the purpose of providing an abstracted unit denomination for physical metal, which had inherent shortcomings for divisibility and authentication. This fact gave rulers the option to change the abstraction over time. During the latter half of the 19th century, when gold standard advocates (mostly creditors) debated with bimetallic standard advocates (mostly debtors) about the definition of the dollar, it was because the unit of account (the dollar) was abstract from the underlying metal, and therefore by its very nature the dollar could have its definition changed. Choosing what precisely to peg the dollar to has always been a political decision, which could affect the dollar's scarcity and disproportionally benefit either creditors or debtors.[340] Similarly, in the modern era where central banks can rapidly change the supply of fiat currencies, this can favor creditors or debtors at various times. To the extent that bitcoin is accepted as money, and credit contracts are denominated in bitcoin, then bitcoin is just bitcoin, which is self-defined, highly divisible, and has an intrinsically stable supply. Individuals and businesses can send bitcoin to each other, and while certain layers may use custodial trade-offs to improve efficiency when so desired, the underlying unit of account can function without abstraction.

- Financial middlemen would likely be diminished in terms of wealth and power. Sending and storing money would be more automated and less expensive than they are now. Financial services companies would exist on the periphery of the system rather than the center of the system. With hard money, individuals can focus more on working and saving, and less on complex investment schemes. During the telecommunication era where the speed gap between transactions and settlements existed, the financial system required ever-more complex layers of abstraction and the economy became more financialized over time. As that gap closes due to the proliferation of hard money and fast settlements, both financial abstraction and economic financialization can decrease. Investing would still be a significant activity, especially if securities are tokenized and accessible to anyone with a smartphone, but the need for it would be lessened because the benchmark of outperforming money itself would be much harder.[341]

- Various custodial and noncustodial payment ecosystems would more seamlessly connect to each other using the Bitcoin/Lightning open-source protocol stack and be able to settle each with other nearly instantly, much like how people can currently send emails between different webmail providers (e.g., Gmail and Yahoo) due to those providers using the same shared open-source email protocols. Today, methods of connection between different domestic financial ecosystems such as PayPal and Cash App leave a lot to be desired, and to send a sizable international payment often requires going through an expensive and opaque series of transfers and currency conversions between correspondent banks. These siloed, piecemeal financial ecosystems can be connected to each other with fast and efficient open-source protocols, much like how various parts of the internet function today. As of this writing, Cash App is already integrated into the Bitcoin and Lightning protocol stack.

- With the ease of accessing a bitcoin wallet and even running a network node for normal people, peer-to-peer transactions can occur more globally. Anyone can pay anyone else if they have internet access. Borders become less relevant. Value can flow faster and more easily between nations, which would likely reduce the frictions that small countries face when transacting with the rest of the world. This could unlock economic value in Africa (which has over 40 different currencies) and Latin America (which has over 30 different currencies) compared to the current and historical baseline, since their citizens would more easily be able to save money and participate in global commerce. Globally, the average size for government structures might shrink and become more local, since there may be less advantages to being a large country than there are today. There would likely still be large regional power structures and alliances of various forms.

- Credit denominated in bitcoin would exist for highly productive financing and short-term liquidity, but most long-duration loans denominated in a unit of account with a fixed supply would not make productive sense. The idea of households carrying 30-year mortgages, giant corporations carrying debt as a permanent part of their capital structure, and governments carrying permanent rolling debt balances, would make less sense than they do within the current system if the underlying unit has a finite supply. Overall debt-to-equity ratios would likely diminish, and the world would be more based around equity.

- Due to both high speed and finite supply, it would entail significant risk to hold demand deposits in fractional reserve bitcoin banks. Interest rates above the rate of money supply growth are inherently risky or illiquid, and in the long run, the supply growth for bitcoin is zero. Providing time deposits or otherwise engaging in investment contracts to earn yield from Lightning liquidity or productive credit would still make sense for investors that want yield and are willing to take on credit risk and/or illiquidity risk to earn it.

- Income taxes within the current system rely on ubiquitous financial surveillance to be enforceable. If it becomes commonplace for people to send money peer-to-peer, including globally, and there are a large variety of privacy tools to make transactions hard to track, then it may become untenable for governments to tax incomes as their primary source of revenue. Taxes might have to revert more to how they were in the 19th century — when transactions were inherently more private — meaning that wealth taxes on real estate, excise taxes on select goods or ports of entry, sales taxes on physical establishments, income taxes on large and well-audited businesses, and fees for government services, would likely need to become the primary sources of revenue. Administrative and tax overhead costs would likely be reduced, especially for individuals and businesses that don't have a big physical footprint.

- People have historically been willing to deal with weak money if it's faster than gold, but if weak money doesn't even have a speed advantage relative to harder money alternatives, then in a world of widely accepted bitcoin it would likely become harder for governments to convince their people to accept fiat currencies for payment and hold large amounts of value in them. Gresham's law dominates until the weaker money is basically useless. At that point, Thiers' law takes over, which observes that good money drives out bad money. A payee generally wants to pay for goods with weaker money, and a merchant generally wants to sell their goods for stronger money. If a weaker money gets bad enough that merchants won't even accept it, that is when Gresham's law gives over to Thiers' law.[342] The prospect for government seigniorage would likely diminish, and so governments would need to rely on more transparent methods to fund their activities rather than diluting the savings of their citizenry in opaque ways.

- Savings would be more globally portable. This would make it easier for refugees to bring their savings with them if they need to flee a problematic region to a better region, but it could also give wealthy oligarchs with shady business practices more geographic discretion on where to operate. Jurisdictions would likely need to compete more directly to draw in and retain highly portable capital.

- Stranded energy sources would be universally monetizable. Variable sources of power could become more economically useful if they have bitcoin miners attached to soak up periods of excess supply. It may become more commonplace for human settlements to form around naturally occurring energy sources, rather than energy needing to be brought to human settlements, especially since certain types of remote work can be done from anywhere.

[324] William Luther, “Is Bitcoin Intrinsically Worthless?” 38–39.

[325] Nakamoto, “Re: PC World Article on Bitcoin”; Peter Chawaga, “Free Assange: Inside a Cypherpunk’s Fight to Publish the Secrets of Superpowers,” *Bitcoin Magazine*, Gatekeeper’s issue, May 2023.

[326] Nakamoto, “Re: Bitcoin Does NOT Violate Mises’ Regression Theorem.”

[327] Blockchain.com, “Market Capitalization.”

[328] Yan Pritzker, “Bitcoin Mass Adoption,” *What Bitcoin Did*, September 6, 2021 (9:40-10:00).

[329] Gladstein, *Financial Privilege*, 165–66.

[330] Gladstein, *Financial Privilege*, 168.

[331] This section draws on Lyn Alden, “A Look at the Lightning Network.”

[332] Robert Mundell, “Uses and Abuses of Gresham’s Law in the History of Money”; George Selgin, “Salvaging Gresham’s Law: The Good, the Bad, and the Illegal.”

[333] Craig Elwell, “Brief History of the Gold Standard in the United States.”

[334] Mundell, “Uses and Abuses,” 4.

[335] Guido Hülsmann, *The Ethics of Money Production*, 125–36.

[336] Federal Reserve Economic Data, “M2.”

[337] Blockchain.com, “Total Circulating Bitcoin.”

[338] Anthony Shorrocks et al., “Global Wealth Report 2022: Leading Perspectives to Navigate the Future,” 7–10; Jonathan Woetzel et al., “The Rise and Rise of the Global Balance Sheet,” vi, 3.

[339] World Gold Council, “Above-Ground Stock.”

[340] Marmefelt, *Money and Monetary Arrangements*, ch. 4 and ch. 7.

[341] Parker Lewis, “Bitcoin is the Great Definancialization.”

[342] Peter Bernholz, *Monetary Regimes and Inflation*, 131–34.

CHAPTER 22

CRYPTOCURRENCIES AND TRADE-OFFS

Once Satoshi Nakamoto showed the way with the invention of Bitcoin as the first persistently functioning and decentralized cryptocurrency network, thousands of other cryptocurrency developers followed in his wake. They all wanted to modify the concept in some way, to explore new rulesets and features for different purposes or optimization goals. And although Satoshi never spent any of his coins as far as anyone can tell (the coins that are believed to have been mined by Satoshi to bootstrap the network in its infancy have been sitting transparently dormant on-chain since he mined them in 2009 and 2010, through multiple cycles of massive appreciation and massive price crashes), many later cryptocurrency founders do want to personally get rich from their own creations.

It's often said that a blockchain is just an inefficient database, and that's basically correct. Users in this context are willing to accept inefficiency relative to other types of software applications to ensure decentralization. Nodes must broadcast every change to the network and keep track of broadcasts from elsewhere in the network.

A blockchain, especially the truly decentralized variety, is a database that is small and tight enough that thousands of entities around the world can store it on their local devices and constantly update it peer-to-peer using an established set of rules. Each node provides validation to ensure that a new block is following the rules of the protocol, and they will only accept and propagate a new block to other nodes if the new block follows the rules. A very large number of user-run nodes helps ensure that the ruleset is immutable, whereas if there are only a handful of nodes, then it only takes a small quorum of people to rewrite the rules of the network.

Plus, the easier a node is to run, the more private, auditable, and permissionless the network is for a regular user. More specifically, the act of running a node gives each user the financial self-sovereignty to privately send and verify their own transactions, and audit the details of the network, rather than rely on any trusted third party. Not everyone will do it, but the barrier of entry for those that choose to do it is low.

A fully centralized database has fewer limitations because it doesn't need to be small and tight. A large service provider can have an utterly massive database contained in a server farm. That can make things run very efficiently, but unlike a blockchain, outside entities can't directly audit it for content and changes; they have no way of stopping the owners of that centralized database from doing whatever they want with it.

So, every blockchain network that claims to improve something compared to Bitcoin on its base layer makes multiple trade-offs to do so. I think it's natural for the market to explore multiple wrong answers to see in practice what the right answers are, and part of what allows me to analyze these concepts is the historical track record of why and how various cryptocurrency projects failed to accrue value. The following sections represent a list of some of the major trade-offs that cryptocurrencies tend to make compared to the Bitcoin network.

Trade-Off 1: Transaction Throughput

To increase the number of transactions that can be processed per unit of time on the base layer, either the block size or the block speed needs to be increased. However, increasing either the block size or the block speed increases the bandwidth, processing, and storage requirements of running a node, and if those variables are pushed too far, it puts running a node out of the reach of a normal person. And, if the requirements to run a node grow faster than the rate of technological growth in terms of bandwidth, processing, and storage, then it leads to a shrinking node set over time, which centralizes the network.[343]

Trade-Off 2: Privacy

To increase privacy, some degree of auditability needs to be sacrificed. One of the key things about Bitcoin is that any node can tell you the exact bitcoin supply and maintains the entire history of transactions and the full state of the ledger. That's not possible to the same degree in a privacy-based blockchain. Cryptocurrencies that are private at their base layer make it easier for undetected inflation bugs to occur. In addition, if a privacy-based system doesn't have a serious network effect, its privacy likely isn't as good as advertised because the anonymity set is very small and is therefore somewhat trackable. Privacy is in large part a function of liquidity, and if liquidity is lacking in various privacy-focused ecosystems, then their privacy potential is limited. Various privacy techniques have been built into layers on top of the Bitcoin base layer, which allow for private usage of the network.

Trade-Off 3: Code Expressivity

To increase code expressivity (e.g., to execute complex smart contracts right on the base layer), a network must also increase the bandwidth, processing, and storage requirements of full nodes, which makes running a full node harder and thus risks centralizing the network over time, as previously described. In addition, base layer computational capabilities increase the complexity and number of possible attack surfaces on the network. It also opens more opportunities for miners or validators to front-run others and play games with transaction ordering, in a process known as "maximal extracted value," and this tends to lead to centralized block constructors dominating the market.

Trade-Off 4: Energy Usage

In a proof-of-stake system, transactions are verified, and new coins are generated, by those who "stake" their coins, rather than by energy-intensive miners. Replacing the proof-of-work consensus with a lighter proof-of-stake consensus requires accepting a circular validation process. In other words, the existing coin holders are determined by the state of the ledger, and the state of the ledger is determined by the existing coin holders — a perpetual motion machine based on circular logic that doesn't have high fault tolerance. Since there is no unforgeable costliness associated with the history of a proof-of-stake ledger, it is nearly costless to make an infinite number of copies of the blockchain with different transaction histories. If the network temporarily goes offline for any reason, there is no way other than governance decisions and/or centralized checkpoints to determine which ledger is the "real" one to restart from. A proof-of-work system uses energy as that external arbiter of truth, which creates a history with unforgeable costliness, and is what makes the system robust.

Adam Back, the CEO of Blockstream and whose development of Hashcash in the 1990s was cited by Satoshi Nakamoto in the Bitcoin white paper, had this to say about Bitcoin trade-offs in a 2021 interview:

> There's something unusual about Bitcoin.
>
> So, in 2013 I spent about 4 months of my spare time trying to find any way to appreciably improve Bitcoin, you know, across scalability, decentralization, privacy, fungibility, making it easier for people to mine on small devices… a bunch of metrics that I considered to be metrics of improvement. And so I looked at lots of different changing parameters, changing design, changing network, changing cryptography, and, you know, I came up with lots of different ideas — some of which have been proposed by other people since.
>
> But, basically to my surprise, it seemed that almost anything you did that arguably improved it in one way, made it worse in multiple other ways. It made it more complicated, used more bandwidth, made some other aspect of the system objectively worse.
>
> And so I came to think about it that Bitcoin kind of exists in a narrow pocket of design space. You know, the design space of all possible designs is an enormous search space, right, and counterintuitively it seems you can't significantly improve it.
>
> And bear in mind I come from a background where I have a PhD in distributed systems, and spent most of my career working on large scale internet systems for startups and big companies and security protocols, and that sort of thing, so I feel like I have a reasonable chance — if anybody does — of incrementally improving something of this nature. And basically I gave it a shot and concluded, 'Wow there is literally, basically nothing. Literally everything you do makes it worse.' Which was not what I was expecting.[344]

Bitcoin has been successful in large part due to its widely distributed node network, simplicity, robustness, and the associated concept of "monetary self-sovereignty." Anyone with an old laptop and basic internet connection can run a node, use the system relatively privately, initiate transactions themselves, and verify the whole system from genesis. Node requirements increase more slowly than computer processing, data storage, and internet bandwidth do, which means even decades from now, it will still be possible for individual users to run a node. The requirements to run a node increase more slowly than the technological increases in bandwidth and storage, which means that a node gets easier and more accessible to run over time. As a result, Bitcoin is designed to likely get more decentralized over time, in contrast to most other cryptocurrencies that are likely to get more centralized over time.

If developers want to change something about Bitcoin, their changes cannot be forced onto users' nodes. Bitcoin's ruleset is determined by the network of existing nodes. Any changes to Bitcoin in practice must be backwards-compatible upgrades, which node-users can voluntarily upgrade into if they want to, while still being compatible with older nodes. Unless they can gain overwhelming agreement from the users, any attempted upgrades by developers that are not backwards-compatible with the existing node network are merely hard forks — they create separate new coins that lack a network effect and lack serious security.

Trying to do a hard fork from Bitcoin is conceptually like copying all the data from Wikipedia (it's not that much) and hosting it on your own website, but then getting very little web traffic because you don't have the millions of backlinks that point to the real Wikipedia or the volunteer army of people that constantly update the real Wikipedia. Your split version of Wikipedia would be inherently worse than the real one from the moment you copy it. Similarly, any minority hard fork of Bitcoin inherently has far fewer nodes and far less miner computation, making it less decentralized and less censorship-resistant from the start.[345]

If nodes had much higher requirements to run, then only large entities could run a node, and the set of nodes would be much smaller. A consortium of miners, exchanges, custodians, and other large entities could agree to make changes to the network. And if that's the case, then the properties of immutability and decentralization are lost for the network. In particular, the 21-million finite supply of coins could be changed, and the censorship-resistant properties would be threatened.

What gives bitcoin its "hardness" as money is the immutability of its network ruleset, enforced by the vast node network of individual users. There's basically no way to make backward-incompatible changes unless there is an extraordinarily strong consensus among users to do so. Some soft-fork upgrades like SegWit and Taproot make incremental improvements and are backwards-compatible. Node operators can voluntarily upgrade over time if they want to use those new features.

Proponents of newer cryptocurrencies often criticize Bitcoin for being old technology, when in reality it's just strict about the trade-offs that it was designed with, and was built to maximize security and decentralization over other attributes. Protocol-level technologies, once established, tend to last a very long time. Internet Protocol was invented in the 1970s; Ethernet was invented in the early 1980s; Universal Serial Bus was invented in the 1990s. All of these protocols are still going strong, and will likely remain strong for decades to come, because they are foundational, and they upgrade over time. They have entrenched advantages from network effects and can upgrade in a way that preserves their backwards compatibility.

Bitcoin, in many respects, looks like these types of long-lasting protocol technologies with dominant market share. It's foundational. It's elegantly simple and robust. Its entrenchment comes from backward compatibility — any attempt to make a non-consensus hard fork inherently creates a weaker, less decentralized, less secure, and less liquid rival that is unlikely to be able to compete.

But that still leaves us with a potential dilemma. If only minor updates are realistically possible, and most major types of improvements would lead to unacceptable trade-offs, how can the Bitcoin network scale? With only a few tens of millions of payments possible per month due to limited block space and deliberately slow block times, how can the network potentially scale to a billion users, if there is indeed such a time that so many people want to use the network?

The answer is layers. Most successful financial systems and network designs use a layered approach, with each layer being optimal for a certain purpose.

A LAYERED DESIGN

If one blockchain network layer is attempting to be used for all purposes, it makes too many sacrifices to be useful for almost anything in the long run. This can be described as scaling horizontally.

However, if each layer of the system is optimized according to certain variables to serve a specific purpose (throughput, security, speed, privacy, expressivity, and so forth) then the full network stack can optimize for multiple use-cases simultaneously without making unacceptable trade-offs. This can be described as scaling vertically.

The Internet Protocol, to take one obvious example, stacks functions in four layers. The top layer is the Application Layer, which includes a variety of different protocols for formatting information. Below that is the Transport Layer, which typically is either TCP or UPD. Below that is the Internet Layer, with IPv4 being the historical protocol and IPv6 being what the world is aiming to upgrade to. Below that is the Link layer, which consists of Ethernet and other physical networking details. The top layers tend to have more options depending on the task at hand, while the bottom layers are the foundational things that everyone uses.

For a financial example, in the United States we have Fedwire as a gross settlement system between banks. It currently performs fewer than 20 million transfers per month (approximately 200 million per year) but settles over $80 trillion in value per month (approximately $1 quadrillion per year) because the average transfer size is massive, and each of these settlements represents a batch of many smaller payment transactions.[346]

Annual Fedwire Transfers

Year	Number of transfers	Total value of transfers	Average transfer size
2022	196,052,238	$1,060 trillion	$5.41 million
2021	204,490,893	$992 trillion	$4.85 million
2020	184,010,202	$840 trillion	$4.57 million
2019	167,650,062	$696 trillion	$4.15 million
2018	158,430,742	$716 trillion	$4.52 million

Figure 22-A

Individuals don't directly use the Fedwire base layer. Instead, we use payment methods like credit cards, debit cards, PayPal, Cash App, and so forth, and our banks record those transactions on their ledgers and then settle with each other later. Each Fedwire transfer represents a batch of many smaller transactions from these higher layers.

In other words, there is the underlying core settlement system, and then layers on top of it to offer more throughput, capable of performing billions of transactions per month.

Bitcoin's ecosystem has evolved in a similar way, except in an open and peer-to-peer manner. Fedwire is a centralized and closed domestic settlement layer. Bitcoin is a decentralized and open global settlement layer, and with its own underlying finite unit of account. Bitcoin is in many aspects like gold and Fedwire wrapped into one system, but decentralized and open source.

Bitcoin's base layer has the capacity to process up to approximately 400,000 transactions per day, although each transaction can have multiple outputs, resulting in over one million individual payments per day. That's a few tens of millions of payments per month, or a few hundred million payments per year, which is a bit more than what Fedwire currently handles.

From there, layers can be (and have been) built on top of it to give it more throughput or more capabilities.

As the most important example currently, the Lightning network is a series of 2-of-2 multi-signature smart contracts that run on top of the Bitcoin base layer. These channels are peer-to-peer and can support many transactions over time for each base layer transaction. The trade-off is that the channel must be kept online to protect the funds and receive payments.

For a second example, the Liquid network is a federation of dozens of entities that wraps bitcoin in tokens called L-BTC, and from that point, L-BTC is faster to move around, has better privacy, and can support smart contracts including various other types of security tokens that run on top of it. Many L-BTC transactions can therefore be contained within two BTC transactions (one to peg in, and one to peg out). The trade-off is that the user must trust the federation, which is more decentralized than trusting a single entity but less decentralized than trusting Bitcoin's raw base layer. Most of Liquid's functionary federation entities would need to collude against the system in order to steal user funds. Along similar lines, there is also an open-source protocol called Fedimint that allows people to deploy their own smaller and more private community federations, which are like customizable community banks.

As a third example, RSK is a merge-mined layer that wraps bitcoin into tokens called RBTC, and from that point, RBTC serves as the basis of a smart contract ecosystem.

As a fourth example, Stacks is another layer for smart contracts on top of Bitcoin. Its design has changed over time, with the current goal of implementing collateralized peg-ins and peg-outs with a separate equity token, which has caused some controversy but represents a different incentive structure compared to federations of known and trusted entities.

As a fifth example, there are proposals for covenants that allow certain bitcoin to be assigned with temporary programmable restrictions. Covenants, which would require a soft fork if they are to become active on the Bitcoin network, allow for some programmable lock-ups and layered designs.

As a sixth example, there are various current and prospective roll-up methods. These are data compression techniques that can allow for more transaction throughput and/or better privacy. Some of them exist now, and other ones would require a soft fork to become active on the Bitcoin network.

As a seventh and more detached example, any proof-of-stake system that regularly inserts its checkpoints into the Bitcoin blockchain is in some sense a sidechain of Bitcoin.

From there, custodians can operate in layers above that for people that want them. Exchanges, payment applications, banks, and so forth can all provide services to users that are willing to trust them with a portion of their funds. This can scale Bitcoin usage to any arbitrary level. Each node on the Lightning network doesn’t necessarily need to be one person; it could be a custodian or federation with thousands or millions of users.

For example, Cash App is a mobile payment service with tens of millions of users operated by Block, Inc. that allows users to transfer money to one another using dollars or bitcoin. It connects to both the Bitcoin base layer and the Lightning layer, and thus gives users many options. Cash App users can send dollars or bitcoin to other Cash App users for free, since it just consists of Cash App updating their centralized internal ledger. Users can also send or receive bitcoin outside of the Cash App ecosystem by making use of the fact that Cash App is connected to the Bitcoin/Lightning network stack. External transactions by Cash App users can include exchanging value with other people that don’t use Cash App or those who are taking self-custody of their bitcoin.

In the current fiat financial system, users of the system cannot really choose which layer they interact with. They can’t directly use Fedwire, for example. They can choose which brand of payment service that they use, and all their options consist of centralized, higher-layer payment services that settle on deeper, centralized layers such as Fedwire.

When interacting with the Bitcoin network, however, users can choose to use whichever layer or layers makes the most sense for their specific needs. The Bitcoin base layer is ideal for large, censorship-resistant, irreversible settlement transactions that nobody can control, and for significant, long-term savings. It provides the most security and reliability but comes with limitations regarding transaction speed and transaction throughput. The Lightning layer is ideal for smaller and faster transactions, with greater privacy, and can also be used in a censorship-resistant way. Various sidechains may be used for multiple different reasons, including preferences toward trusting a federation (rather than a single centralized entity) in return for several optimizations related to speed, privacy, and programmability. And on top of all that, custodians, federations, and other centralized or semi-centralized financial services companies may be used for convenience and optimization. For example, someone could use a Fedimint wallet for sending or receiving Lightning payments like a checking account while keeping most of their bitcoin in cold storage on the Bitcoin base layer like a savings account, with occasional transfers between the two.

What makes open protocols powerful is that they allow applications to interface with each other without even knowing that they do. For example, each email provider doesn't need to ensure that their software works with every other specific email provider; they just need to make sure they use the common email protocols. Similarly, each Bitcoin-related application can interact in various ways with other Bitcoin-related applications even if they aren't aware of each other, simply because they are using the same underlying protocol stack. This contrasts with current payment networks that mostly function as closed, non-interoperable systems. Bitcoin and Lightning as a layered network can serve as the open-source connective tissue between any payment ecosystem that elects to connect itself with it.

An open protocol with a network effect, therefore, has immense scaling potential because so many different companies and individuals can build on it. Bitcoin is the first instance in history of a major monetary protocol that can be openly built upon, and that therefore can be exponentially enhanced by developers with new ideas, and that can be connected to by all sorts of different payment ecosystems to make them interoperable with each other.

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[343] Jonathan Bier, *The Blocksize Wars*, 1–3.

[344] Adam Back, "Early Days of Bitcoin & Future Outlook," Blockstream Talk #1 (17:02-19:11).

[345] Lyn Alden, "Analyzing Bitcoin's Network Effect."

[346] The Federal Reserve, "Fedwire Funds Service: Annual Statistics."

CHAPTER 23

THE LIGHTNING NETWORK

As of this writing, the most relevant layer on top of the Bitcoin base layer is called the Lightning network. The Lightning network consists of a series of smart contract channels that run on top of the Bitcoin base layer.

Individual consumer payments make a lot more sense with channels rather than being broadcast out to everyone. If you and I do an in-person physical cash transaction, it's directly peer-to-peer; we don't shout our transaction to the whole world. Lightning replicates that cash concept on top of Bitcoin's base layer and was enabled by the 2017 soft fork called SegWit.

The result is a much faster, more scalable, cheaper, and more private global payment system, albeit with some trade-offs and limitations compared to directly using Bitcoin base layer transactions.

Channel-based payments for Bitcoin have been conceptualized since the early innings of the network. From there, the original white paper on the Lightning network was written in 2015, and the first implementations of it for use with real bitcoin came out by early 2018, months after the SegWit update was activated.[347] Developers purposely restricted their software's channel size early on, to grow cautiously and test things out safely in those early years.

The network has been functioning and growing ever since, and by late 2020 the network reached a level of liquidity, usability, and critical mass that became quite interesting to me from a macroeconomic perspective. I began to cover it in my research at that time, and over the few years since then it has continued to grow rapidly.[348]

THE LIMITATION OF BROADCAST NETWORKS

Using a broadcast network to buy coffee on your way to work each day is a concept that doesn't scale well. A blockchain is meant to be an immutable public ledger. Do you really need to broadcast your coffee transactions to tens of thousands of nodes around the world, to be held in a distributed database for the rest of humanity?

Imagine, for example, if every email that was sent on the internet had to be copied to everybody's server and stored there, rather than just to the recipient. Even if we could anonymize them and thus factor out the privacy issues with that, it would be grossly inefficient. And yet, that's how various high-throughput, big-node blockchains try to work regarding money.

Instead, what if I can open a channel on top of the broadcast network, pay for things that only me and the merchant know about, and then close the channel, with no immutable public record of those individual payments having occurred?

A network that tries to scale transaction throughput on the broadcast-oriented base layer by radically increasing the block size and/or block speed makes no sense in terms of decentralization. The node requirements become absurdly high, which turns the network into a centralized, enterprise-scale database with just a handful of massive nodes. Changes can be made to the fundamental rules of the system at any time with the agreement of a handful of major node-running enterprises, and therefore all network rules including the supply of coins becomes changeable, and it becomes easier to censor transactions. Privacy becomes very hard; various entities could track your net worth and payment history, which is bad enough in a benign environment but outright terrible in an authoritarian environment, which is where half the world lives.

Additionally, a channel transaction will almost always be faster than a broadcast transaction, since it inherently requires propagation time to go through a broadcast network, even among the blockchains with the fastest block times.

That's why every blockchain that attempts to scale transaction throughput too much on a base layer with a shared global state is inherently flawed. Bitcoin

Cash, Bitcoin Satoshi Vision, Litecoin, Dogecoin, and other coins like this all sacrifice too much and become too centralized, to do something that doesn't make technical sense in terms of scalability or privacy.

The only way scaling makes sense, and avoids sacrificing decentralization, is to use a layered approach. As described in the prior section, users can then pick their own solution, meaning the layer or layers that make sense for them, depending on their specific needs.

LIGHTNING NETWORK 101 EXPLANATION

Suppose you and your friends are spending a long evening at an expensive restaurant. Rather than pay for every plate or drink, most restaurants give you whatever you order throughout the experience and charge you at the end in one big transaction. However, that relies on the restaurant trusting you to some degree.

Suppose instead that the restaurant collects your credit card information at the start of the meal, and then anything you order gets added to your tab. At the end of the night, the waiter gives you the receipt, you sign it, and then they charge the credit card that you already provided.

By doing this, you and the restaurant have opened a payment channel with each other. There is a moment of friction when setting up the tab and a second moment of friction when closing the tab, but between those moments, there is no payment friction for individual plates or drinks because you just need to tell the waiter what you want, and it comes.

That's how the Lightning network works conceptually, but without using credit. I can open a channel with you, using a base layer Bitcoin transaction. This channel is a 2-of-2 multi-signature time-locked channel, meaning that we both must agree to open it, but thanks to the time lock it's designed so that either one of us can unilaterally close the channel if we need or want to (although it's faster and easier if we do a cooperative close). While the channel is open, we can transact back and forth any number of times instantly — as long as we have sufficient liquidity in the channel — until one or both of us decides to close the channel with another base layer Bitcoin transaction.

Unlike a restaurant tab, a Lightning channel is not based on credit. The money is locked into the channel when the channel is created, and the rules are enforced by the decentralized global software. Payments within the channel are updated within seconds, and the ongoing tab can be enforced by either party closing the channel to reconcile with the base layer, with each side receiving their current balance. There is no debt, no promise to pay later, from one person to another. It's like instantly transmitting money to the restaurant's account through the channel every time you order something. The only indirect form of credit is the limitation in how many channels can be closed per unit of time due to Bitcoin's finite block space, meaning that not every Lightning channel can close within a short period of time. There's also an on-chain transaction fee associated with closing a Lightning channel.

Now, suppose that we take this a step further. Alice has a tab with the restaurant, and another person at another table, Bob, also has a tab open with the same restaurant. If Bob has spent all his money but realizes he has to pay an Uber to get home, Alice can tell the restaurant to deduct funds from her tab and give some money to Bob. Alice can pay Bob through the restaurant, or Bob can pay Alice through the restaurant, despite the fact that Alice and Bob know nothing about each other and have no direct payment channel open with each other. What they share is that they both have a payment channel open with the restaurant.

The Lightning network does that too, on a bigger scale, and without credit. Figure 23-A is an example diagram. If user A wants to send a payment to user P, she can do it by routing the payment from A to C to E to J to L to P. Each node in the middle might charge a tiny routing fee, perhaps a fraction of a penny, since it's easy to automate. She doesn't need to set up a channel directly with user P.

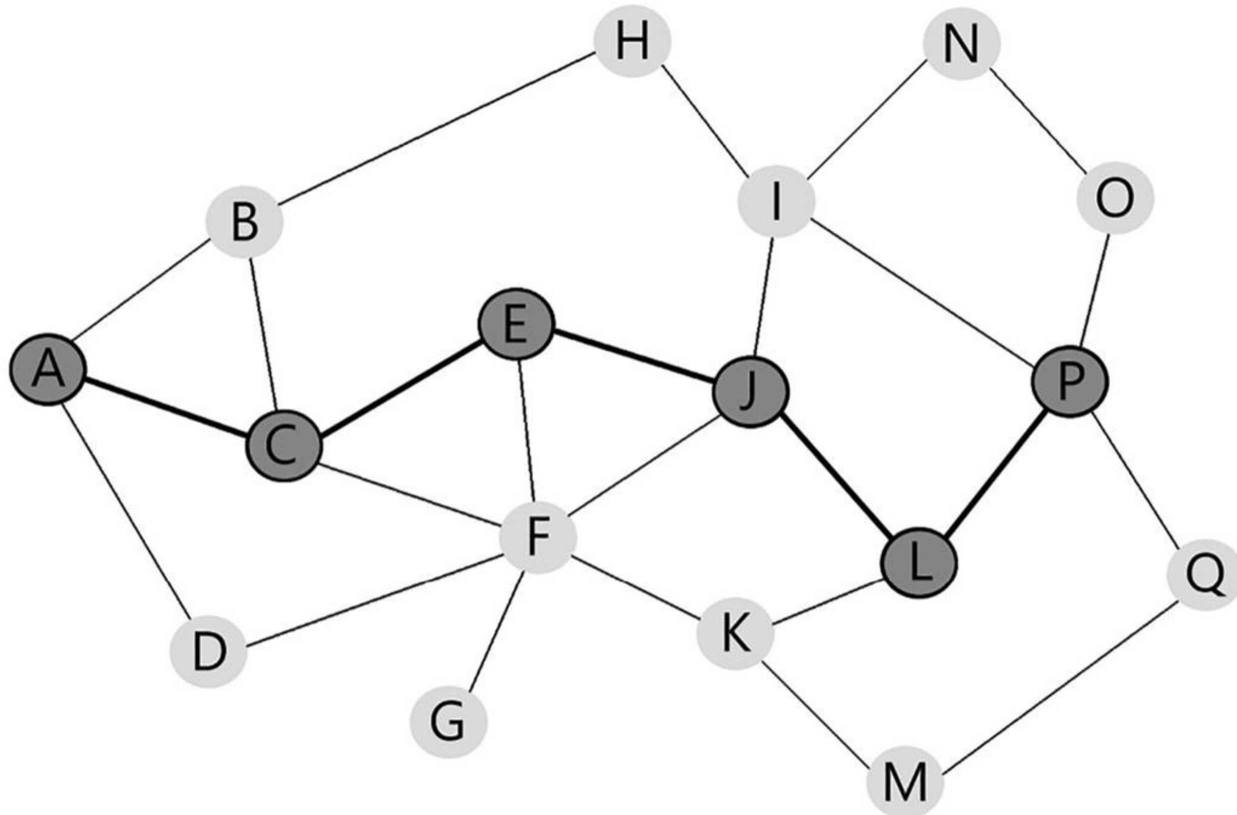

Figure 23-A

Since the Lightning network uses onion routing technology, the nodes in the middle don't necessarily know where the payment originated from or where it is going for its destination. Node J for example is told "route this payment from E to L" without being told more than it needs to know.

The result of this network of channels is that one base layer transaction to open a channel gives you access to many individual payments to various separate entities, and thus Bitcoin can be scaled rather significantly.

Imagine a global system with a massive number of interconnected Lightning nodes. Anyone can enter the network with a new node and start creating channels. Alternatively, many custodial services also give their users access to the network through their nodes and channels.

Since the network is efficient, transaction fees are often the equivalent of a penny or less. This allows for microtransactions and frequent machine-to-machine transactions. Artificial intelligence programs can control a bitcoin wallet, bitcoin-related Chaumian e-cash tokens, or a Lightning channel (a permissionless, open-source activity) far more easily than they can run a bank account (a permissioned, closed-source activity). A sufficiently advanced program that is assigned to perform a set of tasks can generate a wallet, earn or be given some bitcoin, and then determine that it needs to spend that bitcoin in productive ways as a step toward completing the task. For example, this could take the form of buying additional cloud-based processing power, buying access to certain APIs or data, or similar types of activities. Given sufficiently advanced programming, the scope for what machines might pay each other for is challenging to contemplate at this time, and the speed and efficiency with which the Lightning network potentially allows that to happen is unparalleled.

There is no hard limit to how big the Lightning network can get over time, and how many transactions per second the network can handle, other than the fact that opening and closing channels result in base layer transactions. The Lightning network, if it gets to a size of having millions of open channels in the future, can theoretically handle an almost unlimited number of peer-to-peer transactions per second, but there is an upper limit on how many channels can be opened or closed within a given period of time, depending on what percentage of Bitcoin base layer transactions are used for opening and closing Lightning channels.[349] Future developments could allow more participants to share a channel, and thus could substantially raise the effective scaling ceiling. Custodians, including typical account-based financial services companies as well as ones using more automated and permissionless Chaumian mint e-cash technology, can already allow many people to share the same Lightning channel and thus scale the network to billions of people, but they require trust from the users.

Although it has some constraints, especially in this early development phase, this type of network makes lot of sense for payments. Peer-to-peer channels are better than broadcast networks for small individual transactions or connections between separate payment ecosystems. They're fast, cheap, and relatively private.

Plus, the network can do micro-payments that are much smaller than what payment networks like Visa and Mastercard can do. With Lightning, a user can send payments worth pennies or less. This opens new use-cases that aren't possible with credit cards, for example, such as rapid machine-to-machine payments, or the usage of micro-payments as a spam-prevention technique.

All of these capabilities, including the base layer and channels opened on top of the base layer, are global and permissionless. Users can just do it, without asking the permission of a bank or other central entity. To prevent it, governments would need to actively tell their citizens that it's illegal to use certain types of benign, free, open-source software that are lightweight enough to run on a basic laptop — and then figure out how to enforce that.

IMPLEMENTATIONS AND APPS

Much like the Bitcoin network itself, no company controls the Lightning network.

The foundation of the network is an agreed-upon minimal protocol, which developers of Lightning node software adhere to if they want to operate with each other and the network. These standards are kind of like basic email standards or basic internet standards for various applications to communicate with, and they survive for as long as the network effect around the protocol remains robust.

Lightning node software is referred to as a Lightning implementation. Lightning Labs, Blockstream, ACINQ, and Block, Inc. are the businesses developing the four main Lightning implementations that various developers make use of as of this writing, but there are others out there as well.

If you want to be hands-on, you can choose which implementation to use, customize an implementation, or even build your own implementation from scratch. Since it is an open-source protocol, there is no gatekeeper to stop anyone from building their own Lightning implementation and using it to interface with the rest of the network.

From there, many companies can incorporate these Lightning implementations into easy-to-use apps. An end-user won't typically use a Lightning implementation directly; they will use a mobile app that allows them to connect with the network and obscure most of the technical details from them, including the details of the Lightning implementation under the hood.

LIQUIDITY AND NETWORK EFFECTS

Liquidity is the biggest limitation of a network that relies on individual routing channels.

If there are only hundreds of participants, then it could be hard to find a route that connects any two arbitrary nodes and has enough liquidity on each channel in the path to pass the payment through. A lot of attempted payment routes will fail. The funds won't be lost, but the transaction will fail to initiate. The network will be limited, and the user experience will be poor.

Once there are tens of thousands, hundreds of thousands, or millions of participants, and with larger average channel balances, there are many possible paths between most points on the network; routing a payment from any arbitrary point to any other arbitrary point on the network becomes much easier and more reliable.

In the Lightning network, the larger the payment that you want to send, the harder it will be to find a set of channel paths that collectively have enough liquidity to handle that payment. For example, it's easy to send the equivalent of $25 between two points on the network, because your software merely needs to find a set of interconnected nodes that end up each having at least $25 worth of liquidity in the direction that you want. However, it's harder to send the equivalent of $2,500 to many destinations, because there are fewer channels with that much liquidity, and instead your payment may need to be split up and sent in parallel through multiple paths, and so there needs to be many possible paths between your node and the target node. Additionally, the target node itself may simply not have enough total inbound liquidity to receive a payment of that size.

The more channels that exist, and the bigger the channels are, the more reliable it becomes to route larger payments.

Due to this dynamic, the Lightning network wasn't a light switch that could just be turned on and work perfectly from day one. It had to be painstakingly built, channel by channel, for years. The early users were developers and early adopters with high conviction working their way through a difficult-to-use network, and only after they spent years working on it did it become relevant for a typical user who just wants cheap and fast payments.

Furthermore, tools had to be built along the way to make it easier for node operators to manage liquidity optimally. Those have gotten better but it's still a work in progress. Notably, the quality of liquidity can be even more important than the amount of liquidity in a channel network. There are measurements like the "Bos Score" that rank nodes based on not just their size, but also their age, uptime, proximity to other high-quality nodes, and other measures of reliability. As Elizabeth Stark of Lightning Labs has described it, the Bos Score is like a combination of Google PageRank and a Moody's credit rating.[350]

So far, Lightning has been an important enhancement to the Bitcoin network, since it has given users the option for much faster payments that make use of the security of the underlying Bitcoin base layer. I expect it to continue to improve, and over time I think that additional protocols like Fedimint will further enhance the Lightning network's ease of use for non-technical users.

In time, we'll see which other layers and scaling methods may be developed and become widely adopted to fulfill a broader set of use cases.

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347 Joseph Poon and Thaddeus Dryja, "The Bitcoin Lightning Network: DRAFT Version 0.5." See also Poon and Dryja, "The Bitcoin Lightning Network: Scalable Off-Chain Instant Payments," which is often considered the official Lightning white paper.

348 See for instance Lyn Alden, "Analyzing Bitcoin's Network Effect."

349 Bobby Shell, "How Many Transactions Can the Lightning Network Handle?"

350 Lyn Alden, "A Look at the Lightning Network."

CHAPTER 24

PROOF-OF-WORK VS PROOF-OF-STAKE

An earlier chapter in this part of the book discussed various blockchain design trade-offs as it relates to speed, throughput, privacy, expressivity, and energy. Out of those, the usage of energy for ordering blockchain transactions and maintaining an unforgeable history is worth dedicating a couple chapters to, since it is poorly understood and yet critically important.[351]

As an alternative to the Bitcoin network’s energy use, there have been several consensus models proposed and implemented, with proof-of-stake systems being the most common alternative. Proof-of-stake systems use existing coin holders as validators to add new blocks of transactions to the blockchain. There are some interesting aspects to these systems, but they make several huge trade-offs relative to proof-of-work systems.

In short, the input of energy into a blockchain is what allows the network to reduce governance as an input as much as possible. If blockchain designers eliminate energy as an input, they bring back a significant degree of governance into the network, which at least partially defeats the purpose of using a blockchain in the first place. Energy can be relied upon as a neutral arbiter of truth, and this chapter will go into detail as to why that is the case.

PROOF-OF-WORK REVIEW

As described in an earlier chapter, the Bitcoin network is programmed to create a new block on average every ten minutes and add that block to the blockchain, which consists of hundreds of thousands of blocks since inception in 2009.

A new block is produced by a bitcoin miner (a specialized computer) contributing processing power (and thus electricity) to solve a cryptographic puzzle that the previous block created. The entity that solves the puzzle can create a new block, package thousands of Bitcoin transactions currently in the queue into that new block, and attach it to the blockchain for the next block to be built on. That's how transactions get ordered, and how the ledger gets updated. The network is programmed to target average block times of ten minutes, meaning on average every ten minutes a block of thousands of transactions is added to the blockchain.

Processors use random guesses to solve the puzzle left by the prior block, and the law of large numbers makes it so that the more specialized processing power you have, the more blocks you will find.

If miners drop off the network and new blocks on average start taking longer than ten minutes to produce, the network is automatically programmed to make the puzzle easier by a quantified amount, so that blocks go back to an every-ten-minute average schedule. In contrast, if a lot of miners join the network and blocks get added to the blockchain faster than every ten minutes on average, the network will make the puzzle harder. This is known as the "difficulty adjustment." It occurs automatically every two weeks and is one of the key programming challenges that Satoshi Nakamoto solved to make the network work properly.[352]

As a result of this design, at any given time there are millions of bitcoin mining machines around the world looking to solve the puzzle and create the next block, and there's a natural feedback mechanism to ensure that blocks are created on average every ten minutes regardless of how much computational power joins or leaves the network.

In the first half of 2021, China (which at the time was by far the largest country in terms of miner concentration) banned cryptocurrency mining and approximately half the global bitcoin mining network went offline and started moving elsewhere. Bitcoin's payment network briefly slowed down, but otherwise kept working with 100% uptime. The difficulty adjustment then kicked in and brought the network back up to its target speed. Imagine if large cloud infrastructure providers like Amazon or Microsoft were told with one week's notice that they had to move half of their server capacity internationally; they would likely experience uptime issues for their services for the rest of the year or longer as they moved and rebuilt half of their infrastructure. The Bitcoin network instead continued to operate with 100% uptime. And ironically, a considerable amount of mining came back online in China after the ban; even their authoritarian government has been unable to completely stamp it out.[353] As of this writing, most estimates point to China being the second-largest mining jurisdiction after the United States.

If a miner creates an invalid block, meaning one that doesn't conform to the shared rules of the existing node network, the network discards it. If two miners produce a valid block at around the same time, the winner will be decided by which has the next valid block produced and added onto it, thus becoming the longer (and official) blockchain. If those second blocks are also close, then it will come down to who wins the third valid block, or fourth valid block. Eventually a heavier chain wins, as a greater share of the network is finding it and building on top of it.

This process is known as "proof-of-work." Millions of machines are using electricity and specialized processors to apply processing power to guess the answer to cryptographic puzzles left by the most recent block. This may seem like a waste of energy, but it's what keeps the system decentralized and reduces the need for human governance. Energy is the arbiter of truth, in this case. There is no central authority or oligopolistic set of validators that decides what constitutes a valid block or a valid set of transactions or which transaction occurred before another transaction; the blockchain with the most work in it is mathematically verifiable at any given time and is recognized as truth by the rest of the node network — all based on code. The blockchain with the most work put into it, and that also meets the consensus criteria that the Bitcoin node network checks, continually becomes recognized as the global consensus ledger.

The more energy that is actively being consumed by the Bitcoin network, the more costly it is for any entity to gain and maintain over 50% of the processing power of the network, which would allow them to censor transactions and/or perform various double-spend attacks. Many of the tiny non-Bitcoin blockchains have been victims of 51% attacks of this sort, while Bitcoin has a much larger and more diversified mining ecosystem, which so far has made it quite resistant to attacks.

Satoshi Nakamoto used a proof-of-work transaction ordering mechanism in his design due to its trustless nature, and he described it as follows:

> Proof-of-work has the nice property that it can be relayed through untrusted middlemen. We don't have to worry about a chain of custody of communication. It doesn't matter who tells you a longest chain, the proof-of-work speaks for itself.[354]

The primary advantage of a proof-of-work system is that the history of the ledger is unforgeable unless someone is willing and able to commit more processing power than the total of the entire history of the Bitcoin network to undo it. Again, Satoshi himself provided useful insight on this:

> The network timestamps transactions by hashing them into an ongoing chain of hash-based proof-of-work, forming a record that cannot be changed without redoing the proof-of-work. The longest chain not only serves as proof of the sequence of events witnessed, but proof that it came from the largest pool of CPU power.[355]

Hugo Nguyen, in his 2018 essay "Work is Timeless, Stake is Not" describes this effect as follows:

> Energy expended per block not only secures the UTXOs [transactions] belonging in that block but also retroactively secures all global UTXOs that occurred in past blocks. The reason for this is because it would be impossible to revert past UTXOs without reverting the current block first. Each new block effectively "buries" all existing UTXOs under its weight.[356]

We can imagine Bitcoin's blockchain ledger as a giant decentralized digital monument dedicated to preserving the objectivity of the past, built out of processing power, and growing larger each day. To re-arrange the past according to Bitcoin's consensus mechanism, an entity would need to wield an unfathomable amount of energy and processing power in the present.

PROOF-OF-STAKE HAS NO UNFORGEABLE HISTORY

Proof-of-stake is a system whereby holders of the cryptocurrency temporarily lock up or "stake" their coins, use them to vote on new block creation, and get rewarded with more coins for successfully creating new blocks. Instead of committing electricity and processing power to create new blocks on the blockchain, they're proving that they have a significant stake of coins in the network and are using this as their transaction signing authority.

The primary advantage of a proof-of-stake consensus model is that it allows a small blockchain to increase the cost of brute-force attacking it compared to if it was utilizing a proof-of-work mechanism. Many small proof-of-work blockchains have a low cost to perform 51% attacks on, which allows the attacker to censor the network or reverse recent transactions. A small proof-of-stake blockchain, on the other hand, is difficult to attack externally with brute-force because the external attacker must buy a large percentage of the coins, which drives up the price and therefore makes it increasingly difficult for the attacker to gain enough coins to perform the attack.

A secondary advantage of a proof-of-stake consensus model is that by reducing the external cost of transaction ordering, they can redirect that saved expense toward burning coins. In other words, they can create outright deflationary monetary policies for their coins. The system can be designed so that it continually issues a significant number of new coins as a reward for validators, while burning (destroying) coins with extra transaction fees as well, thereby avoiding an inflationary monetary policy and potentially achieving a deflationary monetary policy, as long as the network remains in high demand with users willing to pay significant transaction fees.

However, a proof-of-stake system has numerous downsides, with far more attack surfaces compared to a proof-of-work system. By detaching themselves almost entirely from the physical realm, proof-of-stake blockchains turn themselves into perpetual motion machines based on circular logic, with low fault tolerance. When I first explored proof-of-stake as a concept it seemed very interesting, but the more I dug into it, the more I realized how important proof-of-work is in contexts where immutability really matters.

The primary (and insurmountable) shortcoming of a proof-of-stake system is that the history of its ledger has no unforgeable costliness. The ledger just consists of a series of signed transactions by validators (coin holders). Anyone can therefore create a nearly infinite number of alternative histories of transactions, i.e., alternative ledgers, and there is no way for someone to look at them and independently determine which one is the “real” history. There is no way to prove who the validators historically were, and what transactions they historically signed.

The closest way to know what the real history was in a proof-of-stake system is for a node to never, ever, go offline. If they ran their node from the inception of the network until the present time, never once going offline, and watching each block be produced from genesis, then they may be able to declare that they know the full and real history of the ledger. But how do they prove this to others? Do they become the central authority, and thus defeat the purpose of a decentralized blockchain?

The ability for a node to leave and rejoin the network without relying on trust was important enough to Satoshi that he mentioned it in the abstract at the top of his original 2008 Bitcoin whitepaper:

> A purely peer-to-peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution. Digital signatures provide part of the solution, but the main benefits are lost if a trusted third party is still required to prevent double-spending. We propose a solution to the double-spending problem using a peer-to-peer network. The network timestamps transactions by hashing them into an ongoing chain of hash-based proof-of-work, forming a record that cannot be changed without redoing the proof-of-work. The longest chain not only serves as proof of the sequence of events witnessed, but proof that it came from the largest pool of CPU power. As long as a majority of CPU power is controlled by nodes that are not cooperating to attack the network, they'll generate the longest chain and outpace attackers. The network itself requires minimal structure. Messages are broadcast on a best effort basis, and nodes can leave and rejoin the network at will, accepting the longest proof-of-work chain as proof of what happened while they were gone.[357]

Proof-of-stake systems give up this ability to leave and rejoin the network without relying on trust. If a node leaves and later rejoins the network, they have no way to prove what the true history of the ledger is, and what occurred while they were offline. If there are competing versions of what the history of the ledger is, they have no ability to determine which one is valid. They would have to look toward some authority, some node that can claim that it has always been online, and trust it.

Worse yet, even a node that has somehow been online continuously since genesis of the proof-of-stake blockchain has the possibility of getting siloed away from most of the network as part of a clever attack. Hugo Nguyen, in his 2018 essay "Proof-of-Stake, Private Key Attacks and Unforgeable Costliness the Unsung Hero," describes this effect as follows:

> Second & much more importantly, once the PoW node software has been downloaded, it's reasonably safe for the PoW node operator to turn off the node for an arbitrary amount of time. Past the bootstrapping stage, PoW is highly permission-less: nodes can come & go whenever they like. The only exception to this is in the event of hard forks, which require the node operators to repeat the bootstrapping process (another reason hard forks should be used very judiciously & avoided if possible).
>
> In contrast, a PoS node operator, even with the correct software downloaded, will regularly need to reach out to trusted third parties to ensure he stays on the canonical chain. The fear of losing contact with the main network & getting tricked onto the wrong chain will continue for eternity, possibly long after the trusted third parties cease to exist! This marks a significant degradation in security.[358]

In other words, with proof-of-stake systems we do have to worry about the chain of custody of communication, since unlike proof-of-work, proof-of-stake does not speak for itself. Gigi, the pseudonymous author of the book *21 Lessons*, also summarized the difference well:

> Proof of work is not only useful but absolutely essential. Trustless digital money can't work without it. You always need an anchor to the physical realm. Without this anchor, a truthful history that is self-evident is impossible. Energy is the only anchor we have.
>
> Proof of work = trust physics to determine what happened.
>
> Proof of stake = trust humans to determine what happened.[359]

This problem of trust in a proof-of-stake blockchain applies to individual node operators, and from there it also applies to the entire blockchain. If there is a bug in the network and it stops operating for a time, then that creates an obvious problem — not a single node can say it never went offline.

In 2022, the Solana proof-of-stake blockchain unexpectedly went offline on five separate occasions, and it did so again in 2023. Due to a code exploit in 2022, the Binance Smart Chain (also a proof-of-stake system) deliberately went offline once. These were both in the top ten cryptocurrencies by market capitalization when they went offline. When the validators of such a network eventually fix the problem and restart the blockchain, how do they know where to start it from, since there is no self-verifiable, unforgeable history of the ledger? Anyone can make an unlimited number of alternative histories for virtually zero cost, with no way to prove which one was historically correct.

The answer is that they govern it like an oligopoly; the major validator operators literally get into a (chat) room and manually figure out where to restart the blockchain from, based on their own records. Since the requirements to run a validator for these blockchains are rather high and the coins are rather concentrated, there are a rather small number of large validating entities that really matter. This manual governing process is the alternative if one wishes to avoid using energy directly.

As an attempt to solve this dilemma, a proof-of-stake blockchain could create regular checkpoints, so that if the system goes offline, they can restart from the latest checkpoint. But that creates a new question: Who determines what checkpoints to use and where to store them? Why should others trust those checkpoints? So far, the best (and most ironic) solution to this dilemma has been for proof-of-stake systems to regularly insert their checkpoints into the Bitcoin blockchain, and thus rely on the unforgeable history of decentralized proof-of-work.

An analogy I like to use for the proof-of-stake vs proof-of-work comparison is that they are respectively like volatile and non-volatile computer memory.[360] When you use a computer, you are interacting with two main types of memory that each serve a different purpose.

Volatile memory is very fast, but when it powers down and powers back up, it loses all its stored data. It's only meant for short-term memory usage while you're performing a function. Random access memory, or RAM, is a type of volatile memory that many people are familiar with for this type of memory. Conceptually, a proof-of-stake blockchain is kind of like this. If a node leaves the network and returns, it has no way to determine for itself where to restart from, other than relying on a trusted third party. If the whole network goes offline and then comes back online, participants have no way to determine what the real history of the ledger was and where to restart from, other than by oligopolistic validator operators getting together to agree and manually restart it.

Non-volatile memory is not quite as fast, but when it powers down and powers back up, it retains the memory it had before it powered down. Due to this robust aspect, it can be used for long-term data storage. Hard drives or solid-state drives are examples that many people are familiar with for this type of memory. Conceptually, a proof-of-work blockchain is kind of like this. If a node leaves the network and returns, it can easily look around for propagating blockchains, identify the one with the most processing power inserted into it, directly verify it, and use that one. If the whole network goes offline and then comes back online, the nodes implicitly understand how to identify and continue building on the biggest blockchain, which still exists and is the one with the most verifiable amount of processing power embedded into it that follows the network's ruleset.

A way to summarize this section is to simply say that proof-of-stake systems rely on circular logic to gain their various benefits. In a proof-of-work system, the history of the ledger is accepted as the one that meets the rules of the node network and has the most work embedded into it. In a proof-of-stake system, the coin holders determine the history of the ledger, and who the existing coin holders are is determined by the history of the ledger. That usage of circular logic is why a proof-of-stake system has poor fault tolerance, no unforgeable history, and no inherent ability to recover from the network going offline other than from oligopolistic decision-making (human governance) or regularly checkpointing into a proof-of-work system.

PROOF-OF-STAKE IS FAR MORE COMPLEX

Proof-of-work is simple because it speaks for itself; there is no need to punish bad miners that try to validate the wrong chain or make invalid blocks that don't fit the rules of the node network. Their punishment is simply that they spent electricity on blocks that weren't valid or weren't included in the longest eventual chain, and thus lost money. They self-inflict their own wound, and thus it rarely happens on purpose. There is a tangible connection between the blockchain and real-world resources.

Proof-of-stake is more complex because it doesn't speak for itself; there is no connection to real-world resources and the system needs a way to punish stakers that improperly vote on the "wrong" chain. In addition, they need a way to make sure stakers aren't voting on all possible chains (which can't be done with proof-of-work, because it takes real-world resources for each "vote"). So, proof-of-stake consensus methods are more complex systems that will try to remove stakers' coins if they vote improperly, with ways of checking to see if validators are voting on multiple chains. This is known as "slashing."

Proof-of-stake network require at least an order of magnitude more lines of code to function, because rather than letting energy serve as the arbiter of truth, they are instead relying on a complex series of circular events to try to organize the ledger and solve disputes. By eliminating the input of energy to solve fundamental problems and inject true entropy into the system, they create different problems. By trying to solve those problems, they create still more problems, and around and around it goes.

At the end of the day, it boils down to governance in a proof-of-stake network. Developers and coin holders end up serving as the executives and shareholders respectively in an equity-like structure.

The combination of proof-of-work and difficulty adjustments was a true innovation that allowed for the decentralized and unforgeable ordering of transactions. In other words, Satoshi Nakamoto created a true timechain with an unforgeable history, rather than merely a blockchain. Proof-of-stake consensus mechanisms instead recreate corporate equity structures in a digital realm, including their need for partially centralized governance due to lack of true fault tolerance. Proof-of-stake as a consensus mechanism allows for the operation of a blockchain, but not a true timechain.

PROOF-OF-STAKE IS INHERENTLY CENTRALIZING

Investors who are familiar with real-world natural resource mining companies know how poor their returns tend to be over the long run. They may perform very well in inflationary decades, but for the long periods in between, mining companies in aggregate tend to destroy capital and financially underperform the very commodity that they spend their resources mining. Only the very best outperform.

This is because commodity miners have little or no control over their expenses (like diesel fuel and labor) or the price of their own product (the commodity they are mining). Let’s take a copper miner as an example. They can’t really choose their jurisdiction; they must go to where the copper deposits are. From there, they must pay for labor, equipment, and a lot of diesel fuel, and they have limited control over the price of any of these inputs. Similarly, they have no control over the price of copper itself, which fluctuates wildly based on global supply and demand.

Commodity miners can decide when to take risks and invest more money to develop a mine, or when to reduce risk, reduce investment, strengthen their balance sheet, and so forth. That’s about it, and that’s what separates a good miner from a bad one. When commodity prices are high, it becomes more profitable to mine deposits, and more miners start expending resources to develop those deposits. Then, when commodity prices go down, many of those miners’ mines are no longer profitable, and they go bankrupt or are otherwise financially impaired. These are the reasons that the mining industry tends to have exaggerated booms and busts.

The same is mostly true for cryptocurrency miners. They buy the latest specialized processors, they build datacenter infrastructure to host them, and they buy electricity. They can go to where the cheapest electricity is, but overall, they don’t have much control over the price of these inputs. Once they are set up, they mine the cryptocurrency, and they have no control over the purchasing power of the cryptocurrency that they are mining. As a result, it’s a very difficult business, and they don’t tend to get very big.

Larger bitcoin miners save some money on overhead costs relative to the size of their operation, but only up to a point. In contrast, many of the cheapest forms of stranded electricity and productive usages of waste heat are only found in small amounts, which is advantageous for smaller miners. As a result of both factors, cryptocurrency miners in a proof-of-work system tend to not centralize very much. Instead, they tend to remain decentralized and ever-changing.

In contrast to all of this, proof-of-stake tends to be rather centralizing and persistent. Once a large coin holder gathers a significant number of coins, becomes a validator, and starts earning more coins, they begin an exponential journey toward increasing their share of the network. In contrast to a proof-of-work miner which has high and fluctuating real-world expenses, a proof-of-stake validator's expenses for maintaining their coins and validator are nearly zero. They can continue to collect new coins from validating and use those new coins to generate even more coins.

Just like how corporate equity ownership tends to consolidate toward the top 10% and especially toward the top 1% in society over the long run (since equity holdings continually provide returns and have no maintenance cost for the wealthy holder), coins in proof-of-stake systems tend to consolidate toward the largest holders. Over time, this means that the wealthiest members of the network gain the ability to censor the network, with no recourse for smaller users.

If a proof-of-work blockchain is struck by a 51% censorship attack by a group of miners, then this is indeed a problem, but a reversible one. Other people, such as the various censored entities on the network, can construct or acquire new processors, plug them in, increase the overall amount of processing power on the network, and reduce the attackers' total processing power to less than 51% of the network. There is no limit to how much additional processing power can come in and un-censor the network, other than real-world resources external to the network. In other words, for a proof-of-work blockchain, a 51% censorship attack is a "check" but not a "checkmate."

In contrast, if a proof-of-stake network is struck by a censorship attack by a majority of validators (which in practice currently is a small consortium of the wealthiest coin holders, including large custodians that pool together the coins of smaller coin holders and are controllable by their governments similar to how banks are), then censored entities have no recourse to get their transactions uncensored other than by forking off in their own direction. During an attack, most new coins being generated are being given to the biggest validators (the ones performing the censorship attack), and there's no other way to get new coins and dilute the control of the majority stakers. It’s a “checkmate” scenario rather than merely a “check,” unless the validators can be convinced or coerced to un-censor the network, or if extreme forks are done to split the network and try to recover from that weakened state.

To summarize, proof-of-stake blockchains have little or no operating expense for validators, and thus coins tend to concentrate into wealthy hands. And if that small, wealthy group ever decides to censor certain transactions for any reason then there is no process — other than a minority fork — to regain control from them and un-censor those transactions. Proof-of-stake validators get to decide who becomes validators, and whether more validators can join the network. Therefore, the network is permanently capturable. In contrast, proof-of-work miners cannot prevent other miners from expending processing power and electricity to create new blocks of transactions. Therefore, the network is temporarily capturable but not necessarily permanently capturable.

PROOF-OF-STAKE HAS LIMITED DISTRIBUTION CAPABILITY

In addition to ordering transactions and serving as a decentralized timestamping service, a proof-of-work consensus model allows a blockchain to bootstrap anonymously and without raising capital. It’s an ideal way to distribute coins as they are initially created.

When Satoshi Nakamoto created Bitcoin and put it out into the wild in January 2009, he did so anonymously and without raising capital. He merely published a white paper, various emails, and then the open-source software. It’s actually quite notable that he gave away all the key insights before he published the software itself, which demonstrates that he wasn’t operating under a profit motive. The original software served as a combined node-and-miner client, and all the bitcoin eventually sprung from this program and its various backward-compatible successors. As early users expended a rather minimal amount of electricity from their computers to run the software early on, they added new blocks of transactions to the blockchain and produced initial coins for themselves in the process.

All coins in the Bitcoin network are created when miners add new blocks to the blockchain. In the first 210,000 blocks (approximately four years) of the network, a miner was allowed by the node software to give themselves 50 coins per block they produced, in addition to any transaction fees that the senders provided to ensure that their transactions get into a block. The new coins that are created in each block are referred to as a “block subsidy.” Every 210,000 blocks, that block subsidy number automatically gets cut in half, until eventually there will be no new coins created and miners’ revenue will consist entirely of transaction fees.

In addition to incentivizing people to contribute processing power to operate the network, this block subsidy is what distributes the coins. Satoshi didn’t grant himself any coins. He didn’t arbitrarily hand coins out to his friends. He didn’t create an investment contract, raise capital as a security, and give those capital providers initial coins. Instead, he merely put out an open software client, and every single spendable coin had to be earned by a user contributing processing power to the network, or from buying the coin from a user who did.

Proof-of-stake blockchains lack this easy bootstrapping capability. Since coin holders (“stakers”) create new blocks of transactions in a proof-of-stake blockchain, an obvious problem arises: Who are the initial coin holders? No transactions can be processed without an initial set of coin holders, but where did those initial coin holders get their coins from?

A common answer is that the developer creates an investment contract: Investors pay in some way and receive the initial coins. In other words, the project begins its life as a financial security. Alternatively, the creator or creators could distribute coins to themselves and their friends or could create mechanisms to hand out free coins initially (which is very hard to do on any sort of fair basis).

Once a proof-of-stake system is in operation, it then begins a rather centralizing process as described earlier. Those who have a lot of coins can stake them, use them for new block validation, and earn more coins exponentially, with minimal need to ever spend them.

A proof-of-work blockchain tends to be inherently distributive. Coin holders don’t receive any new coins simply for having coins; they can only earn new coins if they exchange something to buy them (such as dollars or other assets they own), or if they expend energy and other resources to mine them. Any expenses that the coin holders have as a person or as a business entity will generally require selling coins, unless they have some external income source that exceeds their expenses.

A proof-of-stake blockchain tends to be inherently concentrating. Coin holders receive new coins in proportion to coins they hold if they are staking them (either themselves or with a third-party staking provider to handle the details for them). This requires little or no expenditure of resources. If the yield they earn from this staking exceeds their personal or business expenses, then they can compound their coins indefinitely and exponentially. This is in addition to any external income source they might have.

ARE THERE USES FOR PROOF-OF-STAKE SYSTEMS?

My analysis leads to the conclusion that proof-of-stake systems are not suitable consensus mechanisms for building robust decentralized global money. In other words, a proof-of-stake blockchain is not robust enough to create "money for enemies" on a global, decentralized scale. The lack of unforgeable costliness to prove the correct history of the ledger is too large of a problem to overcome in that regard. By stripping out the input of energy, proof-of-stake systems inherently require more governance instead, and therefore become equity-like and unfit for geopolitical challenges.

But does that mean that proof-of-stake systems have no long-term rational use-case? As of this writing, my answer is that I don't know.

A common logical fallacy is that of a "strawman," where someone wishes to counter an opponent's argument, but instead of properly doing so, they construct a much easier but false version of the opponent's argument and then counter that one. The opposite of this fallacy is to "steelman" an argument, which means to construct the strongest possible version of the argument that you can think of — ideally one that is even more convincing than what the opponent has made — and then either counter that one or admit it has merit. It's an important exercise for being intellectually honest.

A blockchain, especially the truly decentralized variety, is basically a database that is small and tight enough that thousands or millions of entities around the world can store it on their local devices and constantly update it peer-to-peer using an established set of rules.

A fully centralized database has fewer limitations because it doesn't need to be small and tight. A large service provider can have an utterly massive database, contained in a server farm. That can make things run very efficiently, but unlike with a blockchain, external entities can't directly audit its content and changes, and have no control over it.

Your social media account is an item in a corporation’s database; it can be deleted or changed, and you have no say in this. You have no way to audit what information they hold about you in their database. The same is true for your bank accounts, your criminal records, your health records, any cloud services you use, and so forth. Corporations and government entities have databases and may at times choose to let you access those databases with limited permissions, or not. They are fully centralized, non-auditable, and easily changeable by the organization that runs it.

As this part of the book is exploring, the best application of a sufficiently decentralized database seems to be money. Money is a ledger, and the more open and immutable it is, the better it is from a user perspective. The ability to store value in a distributed ledger by simply saving or memorizing a number and transfer that value to others whenever you want, in a way that millions of other participants recognize and that no centralized entity can change or prevent or debase, is quite useful.

It’s also likely useful as a time capsule of history. There are certainly uses for putting some arbitrary data into the Bitcoin blockchain if one is willing to pay the fees to do it. Documents, books, pictures, or timestamps from other software programs can be put into the blockchain, and while they might not serve as proof that they are objectively true, they can serve as proof that they have been untampered with from the point of being entered into the blockchain.

Developers of proof-of-stake smart contract platforms propose that there are many more potential applications that benefit from blockchain technology as well, besides just money and small amounts of immutable data. That remains an open question among cryptocurrency traders and investors: Which other applications? The tokenization of assets and collectibles seems to be at the forefront of these applications, along with various pseudo-decentralized ways to trade or leverage them using smart contracts.

The biggest challenge with these proposals is that the more features are incorporated into a blockchain on the base layer, the less “small and tight” it is, and therefore the less decentralized it tends to be. If a blockchain is not small and tight enough that users can run their own node and interact with the network without a trusted third party, then doesn’t it defeat the purpose of what it is trying to do?

Are there shades of partial decentralization that people will accept in exchange for more features that the database can offer? And can those partially decentralized blockchains survive attacks, disagreements, and other tests over the long term? Since we know that there are use-cases for fully centralized databases (e.g., all the various social media networks, cloud providers, and other systems we interact with on a regular basis), as well as use-cases for fully decentralized databases (e.g., Bitcoin), are there use-cases for a “partially centralized and partially decentralized” database?

If the answer is yes, then that’s basically the steelman argument for the long-term viability of complex proof-of-stake blockchains or similar protocols that embed smart contracts into their base layer.

This set of hypothetical partially decentralized databases wouldn’t conceptually compete with Bitcoin as a truly decentralized and nearly immutable monetary asset at a geopolitical scale, but could they coexist alongside Bitcoin as semi-open operating systems for apps that benefit from partial auditability or partially decentralized control?

For example, if a database is controlled to some extent by a central organization, but it is open source and it is designed in such a way that its contents can be independently backed-up and audited in real time by certain high-performance external nodes, does that concept have an addressable market? Perhaps for the tokenization of assets? And what about a federated database, meaning a database that requires the cooperation of several large organizations to change, or that requires proof-of-stake by large (and generally oligopolistic) entities, rather than a singular entity? Could that have long-term value?

As of this writing, the normal trading window for U.S. equities is from 9:30 a.m. to 4 p.m., five days per week, and adds up to 32.5 hours. Since there are 168 hours in a week, that means that U.S. equities can be traded just 19.3% of the time. From there, they subtract certain holidays, and therefore equities trade around 19% of the time in normal market windows. Wealthier investors can trade in after-hours trading, but with less liquidity. Is it reasonable for entrepreneurs to investigate making equities tradeable the other 81% of the time, too? And for everyone? I think so.

Additionally, equity and other security trades take days to fully settle. The time has come down over the years, but it’s still operating on legacy settlement rails.[361] What if each trade could fully settle in seconds or minutes? And for holders of securities that need liquidity, what if these assets could easily be shopped around for different collateralized borrowing opportunities?

Plus, it's a challenge for most people (at least outside of the upper classes) in developing countries to even access equities and other securities in general. This applies to both their domestic securities as well as to global securities. Online brokerages made it easier starting in the 1990s, and brokerages in the form of mobile apps made it even easier over the past decade, but there is still an access problem — especially when trying to access equities of a different country. What if traditional securities, such as stocks and bonds from around the world, plus all commodities and currencies as well as real estate or fine art or private businesses or certain digital collectibles, could be tokenized and accessible to anyone in the world with a smartphone, tradeable 24/7 across multiple different exchanges, fully settle within minutes, and be usable as collateral on multiple different liquidity platforms? Much like stablecoins, they would still be centrally issued, but the liability side would be a digital bearer asset, and a rather efficient one at that.

Lastly, what if smaller businesses could securitize their equity more easily? What if everyone in a community could invest in a new startup restaurant nearby, in exchange for some equity token that gives them a share of profits, or discounts or perks for frequent patronage? This fits well with a hard money world; if most things are equity-financed rather than debt-financed, shouldn't it be easier via technology for even small entities to issue startup equity, and to be able to use that equity as collateral when needed?

Tokenizing the claims to real-world traditional assets in some form or another seems to be a reasonable expectation, and it would represent an upgrade to the tech rails that existing securities operate on. Some developers propose that this sort of technology should exist on Bitcoin sidechains. Other developers propose that separate dedicated base layer blockchains are best for this. Still other developers propose that a blockchain isn't really needed for this and that other types of distributed ledgers could provide the same functionality for centralized security issuers.

From my perspective, proof-of-stake smart contract blockchains or blockchain-like protocols are operating system equities (i.e., securities), competing among themselves for network efficiency and reliability. There may be a global market for them when it comes to efficiently enabling the issuance of security tokens, similar to how exchange companies or tech platform companies operate today. I don’t have a firm view on this matter other than that they are not well-suited to being robust global money, due to their lack of an unforgeable history.

A big problem in recent years has been that so many venture capitalists and early developers keep dumping low quality unregistered cryptocurrency projects on retail investors, like how boiler room operators dumped bad penny stocks on retail investors in the 1990s. In normal venture capital investing, founders and investors lock up capital for 5-10 years before obtaining exit liquidity for the startup company that they financed. Their financial success is heavily tied to the success of the fundamentals of the business. For the founders and early investors to get most of their liquidity out, either the startup company goes through the process of becoming publicly traded, and thus provides an extensive set of disclosures and risk analysis, or the company becomes purchased by a larger company and vetted by their professional analysts and auditors, or they sell private shares to another accredited investor in a private deal. However, with cryptocurrency, a lot of founders and venture capitalists have resorted to “fast exit liquidity” where they lock up coins for a couple years, get them listed on an exchange, hype them up with their own marketing efforts, and then dump them on retail investors without disclosures. This violates the securities laws of many jurisdictions and allows the founders and venture capitalists to walk away rich even if the project flops a few years after it begins.

In other words, just like how the internet made it easier for people to produce and distribute their own books and songs, smart contracts have made it easier for people to produce and distribute their own financial assets. And while this removal or diminishment of the “gatekeeper” can indeed be empowering, it also lengthens the long tail of low-quality items that make it out into the marketplace, which potential customers need to take into account. Worse yet, newly issued financial assets have a much larger potential to be outright scams than books or songs or other types of content, and thus can be more harmful to people that fall for them. As a result, years of cryptocurrency token issuance have had less impact on the creation of real goods and services than Kickstarter campaigns and similar types of crowdfunding have had.

For this reason, after enough scams I think most potential users of security tokens will come to understand that most of them are worthless, and that a security token with real value is likely to be one that is acknowledged by some registration authority (for large businesses) or that they know first-hand, such as a local business (for small businesses).

ENERGY AS THE ARBITER OF TRUTH

Prior to the invention of proof-of-work and especially prior to the invention of Bitcoin, everything that was digital was almost freely copyable. In fact, that was the main feature, rather than a bug. That’s where software’s massive productivity enhancement comes from; the digitization of things allows for the increased proliferation of those things at a negligible marginal cost.

If someone expends time and resources to create a book, song, picture, movie, game, application, or other digital thing, then the difference in cost to distribute it to a hundred people, a thousand people, a million people, or a billion people, is almost negligible.

This impressive feature does, however, create some problems. For example, software companies have spent decades trying to figure out how to make sure only paying customers get access to their products and have used various things like software license keys or cloud-based accounts to minimize unlicensed usage. Similarly, the easy and global spread of digital music files forever changed the economics of the music industry. Digital piracy has been a concern for content producers of all types for decades.

Internet spam became another problem. If it is costless to send an email, post a message, or create an account, then how do we prevent someone from abusing this feature, or writing a program to do it repeatedly at superhuman speed? That type of spam is what Adam Back invented Hashcash back in the 1990s to try to solve; digital interaction was so frictionless that he invented the proof-of-work concept to purposely give it a little bit of friction back, to impose a micro-cost on certain digital actions when it is appropriate to do so.

A related problem to spam is impersonation. Anyone can create an online account on a given platform and claim to be someone that they are not. Bots can be programmed to do this automatically by the thousands. Given sufficient programming, artificial intelligence can allow people to spin up entire fake communities, with unique personalities and fake followers of those personalities. This could happen in the trillions, and far outstrip the number of actual humans interacting online.

Here in the 2020s as an active user of social media with a large following of well over half a million people, I encounter spam and impersonation constantly. It's remarkable how unsolved this problem has been for decades at this point. My posts on Twitter immediately get flooded with dozens of automatic bot replies that seem like they should be filterable but thus far have been resilient against such attempts to filter them. People pretend to be me on Facebook, Instagram, YouTube, and other platforms. I have contacted social media companies to successfully delete hundreds of false accounts of people claiming to be me, but they pop up as fast as I can have them deleted. Some of those accounts have successfully scammed people, by offering them access to some "exclusive" investment opportunity while pretending to be me, and then just taking their money and disappearing.

And now that artificial intelligence is making the creation of pictures, videos, texts, programs, and other things almost costless, it's hard to know what content is genuine compared to what is a high-quality fake video or personality. When we see a picture or a video that might be important from a corporate, social, political, or geopolitical perspective, how can we know that it is actual footage rather than an AI-generated digital forgery?

Michael Saylor, who is the co-founder and executive chairman of MicroStrategy and has a larger social media presence than me, has faced an impersonation problem on a larger scale than I have. He has often described fake bot accounts online as "ghosts" since you can't really know if they are real or not, and he has proposed the usage of the Bitcoin network and associated proof-of-work mechanisms to filter out spam and impersonation. In a 2022 speech, he described the implications for Bitcoin and proof-of-work rather visually:

> Most people don't realize this, but Satoshi opened a portal from the physical realm into the digital realm. And energy began to flow into cyberspace, bringing life to a formally dead realm consisting only of shadows and ghosts. Bringing conservation of energy and matter, objectivity, truth, time, and consequence into the digital realm, delivering property rights, freedom, and sovereignty that is separate from the physical and the political realm, to humanity.[362]

The Bitcoin network uses the input of energy to eliminate the need for centralized human governance, at least for money and certain other forms of information. The input of energy, in the form of processing power, allows for anonymous computers and their operators around the world to work together to build and maintain a global ledger, with an objective sequence of events. The network's proposal is simple and nearly uncontestable: The blockchain with the most processing power embedded into it, and that also follows the consensus rules as determined by the distributed network nodes, is the official ledger.

In other words, Bitcoin is a network where humans let energy be the arbiter of truth for transaction processing, rather than a centralized entity like a bank or a technology company or a government. It's automated accounting, and represents a ledger suitable for the 21st century. Other digital realms that we interact with can be connected to the Bitcoin network in various ways to inherit some of its scarcity, so that they can benefit from the borderless flow of value and connect with a reliable record of past events, while reducing spam and impersonation.

For example, someone can create a public/private key pair, embed the public key into the Bitcoin blockchain with a real-world resource cost due to transaction fees, verify to many people in person that this key is indeed theirs, and use their private key that goes along with that public key to sign any digital content that they create or authorize. The same is true for any large journalist organization with known integrity standards. From that point on, this allows people to differentiate forgeries from genuine content (at least to the extent that it was created by that individual or organization, not necessarily that it's objectively true), and it makes it so that a million impersonators cannot use similar key pairs that have been embedded, with real-world expense, into the Bitcoin blockchain.

In a world of sufficiently advanced artificial intelligence and virtually costless impersonation or forgeries, we might learn to demand proof-of-continuity (cryptographic public/private key pairs) and proof-of-work (evidence that real-world resources were expended to add weight to a given public/private key pair), before taking certain types of digital content seriously.

Additionally, certain information might be deemed important enough that it's worth paying transaction fees to embed it directly into the Bitcoin blockchain, which allows that information to be accessible in a provably unaltered way for as long as the network continues to exist.

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351 These sections draw on Lyn Alden, "Proof-of-Stake and Stablecoins: A Blockchain Centralization Dilemma"; and Alden, "Bitcoin's Energy Usage Isn't a Problem. Here's Why."

352 van Wirdum, *The Genesis Book*, ch. 15; Gladstein, *Financial Privilege*, 24–33.

353 Tanzeel Akhtar and Sidharta Shukla, "China Makes a Comeback in Bitcoin Mining Despite Government Ban," *Bloomberg*, May 17, 2022.

354 Satoshi Nakamoto, "Re: Bitcoin Minting is Thermodynamically Perverse," BitcoinTalk forum, August

7, 2010.

[355] Nakamoto, “Bitcoin: A Peer-to-Peer Electronic Cash System,” 1.

[356] Hugo Nguyen, “Work is Timeless, Stake is Not,” *Medium*, October 12, 2018.

[357] Nakamoto, “Bitcoin: A Peer-to-Peer Electronic Cash System,” 1.

[358] Hugo Nguyen, “Proof-of-Stake, Private Keys Attacks and Unforgeable Costliness the Unsung Hero,” *Medium*, April 3, 2008.

[359] Gigi, “A Failure to Understand Proof of Work,” *Twitter*, May 13, 2021.

[360] Lyn Alden, “What is Money, Anyway?”

[361] Carla Tardi, “Settlement Period: Definition, Process, SEC Rules,” *Investopedia*, March 17, 2023.

[362] Michael Saylor, “GALA 2022 Keynote Speech.”

CHAPTER 25

HOW BITCOIN USES ENERGY

In 2017, the World Economic Forum published an article about how the Bitcoin network could consume all the world's energy by 2020.[363] *Newsweek* published a similar piece in the same month about the same subject, and so did several other media outlets and institutions.[364]

They ended up being off by three orders of magnitude. By 2020 the network was still consuming less than 0.1% of global energy consumption. As I write this book during 2022 and 2023, it's still a tiny fraction of one percent.

There has been no shortage of alarmist and factually incorrect analysis of the Bitcoin network's energy consumption over the years. This chapter covers how Bitcoin consumes energy and what types of energy it tends to consume.[365] The important takeaways are that 1) Bitcoin's energy usage in the long run is strictly limited by the utility it provides to users, and that 2) Bitcoin primarily consumes stranded energy that would otherwise be wasted.

MINING REVENUE: SUBSIDIES AND TRANSACTION FEES

Looking at total bitcoin mining revenue gives us a decent proxy for the upper limit to how much money the network can collectively spend on electricity each year. Electricity represents miners' biggest operating expense by far; over a multi-year period, miners need to remain solvent and thus can't spend more than they make. Miners of course also have equipment costs, real estate costs, and labor costs. Miners can also make some side revenue streams by buying electricity usage rights for low prices and selling them at certain times for high prices during shortages, or by making profitable use of the waste heat from their processors. Both of those uses are productive.

When Bitcoin was created, it was designed so that every ten minutes when a miner produces a new block of transactions, the miner that produced it earns 50 newly generated bitcoin. After four years, the network was pre-programmed to drop to 25 new bitcoin per block. Four years later, it was 12.5 bitcoin per block. Four years after that, it was down to 6.25 bitcoin per block. These newly created coins are referred to as the “block subsidy” and represent most of bitcoin miners’ revenue in this era of the network.

This pattern will continue every four years until new bitcoin generation reaches zero, and the hard cap of 21 million bitcoin is reached sometime after the year 2100. Within a few decades, miners will earn a vanishingly small number of fractional bitcoin for producing new blocks. Out of the 21 million total bitcoin, nearly 19.5 million have already been created.

However, miners also earn transaction fees. Senders pay transaction fees, denominated in fractional bitcoin, to ensure their transaction gets into the blockchain in a timely manner. In the early days, blocks were often not full, so transaction fees were minimal. When Bitcoin usage became more widespread, blocks frequently became full, and transaction fees became a small but more meaningful portion of miner fees.

Figure 25-A shows the Bitcoin network’s average market capitalization, annual miner revenue (including block subsidies and transaction fees), and the percentage of the market capitalization spent on miner revenue each year.

Miner Revenue as a % of Market Capitalization

Year	Average Market Cap	Annual Miner Revenue	% of Market Cap
2011	$38.6 million	$17.6 million	45.7%
2012	$80.0 million	$21.1 million	26.4%
2013	$2.23 billion	$308 million	13.8%
2014	$6.76 billion	$785 million	11.6%
2015	$3.93 billion	$375 million	9.6%
2016	$8.95 billion	$571 million	6.4%
2017	$65.9 billion	$3.37 billion	5.1%
2018	$129 billion	$5.50 billion	4.3%
2019	$132 billion	$5.20 billion	3.9%
2020	$205 billion	$5.01 billion	2.4%
2021	$892 billion	$16.8 billion	1.9%
2022	$535 billion	$9.51 billion	1.8%

Data Source: Glassnode

Figure 22-A

Bitcoin miner revenue has grown at a historically strong rate, but the network always spent a smaller percentage of its market capitalization on miner revenue than the prior year. This isn't a decision by any centralized party; it's a combination of the declining block subsidy and individual miner decisions regarding whether to mine or not based on the economics of the situation.

That declining block subsidy is what journalists and other people who don't understand the algorithm often miss. It results in Bitcoin's supply inflation rate going down, along with miner revenue as a percentage of Bitcoin's total market capitalization, until it reaches more of a steady state based on transaction fees alone.

Ironically, some analysts and critics of the network are concerned that Bitcoin *won't use enough energy* to remain secure in the future when it relies mostly on transaction fees. I don't view that as being a significant risk, but it has a higher likelihood of being a problem than the reverse situation of the network using too much energy (which by design is impossible; it can only use energy over the long run if people are getting a lot of utility out of it).

Figure 25-B shows just the portion of the miner revenue that comes from transaction fees, which is a subset of the previous table.

Miner Fees as a % of Market Capitalization

Year	Average Market Cap	Annual Miner Fees	% of Market Cap
2011	$38.6 million	$30.1 thousand	0.078%
2012	$80.0 million	$64.9 thousand	0.081%
2013	$2.23 billion	$2.17 million	0.097%
2014	$6.76 billion	$2.44 million	0.036%
2015	$3.93 billion	$2.34 million	0.060%
2016	$8.95 billion	$13.6 million	0.152%
2017	$65.9 billion	$552 million	0.837%
2018	$129 billion	$284 million	0.221%
2019	$132 billion	$156 million	0.118%
2020	$205 billion	$326 million	0.159%
2021	$892 billion	$1,020 million	0.114%
2022	$535 billion	$141 million	0.026%

Data Source: Glassnode

Figure 22-B

We can see that transaction fees are a tiny portion of Bitcoin's market capitalization each year. The highest year in percentage terms was 2017 during that bubble peak. Efficiency improvements such as SegWit, transaction batching, and reductions in OP_Return usage have occurred since 2017, so fees have been rather muted since 2017 despite an increase in network usage. As of this writing in the midpoint of the year, 2023 is shaping up to be a higher fee year than 2022, which was unusually low.

The Bitcoin network is now down to less than 2% of its market cap being spent on miner revenue each year, including a tiny fraction of one percent on fees. In 2024 there will be another block subsidy halving, which may bring miner revenue down closer to 1% of market capitalization or less. In 2028 there will be yet another block subsidy halving, and another in 2032. After that point, the block subsidy will be so tiny that a large portion of miner revenue will be made up of transaction fees, and miner revenue will likely be less than 1% of market capitalization, approaching some steady-state situation based on fees that is hard to model (since it depends on overall network adoption, utility, and velocity).

Since we can't know for sure what the steady state will be due to variable market-driven transaction fees, Figure 25-C shows what assumptions are needed to reach a certain annual miner revenue figure. Potential long-term Bitcoin market capitalizations are shown on the vertical axis and annual miner revenue as a percentage of market capitalizations are shown on the horizontal axis, allowing the reader to see what each combination would result in for annual miner revenue.

Miner Fees as a Percentage of Market Capitalization

	0.05%	0.10%	0.25%	0.50%	1.0%	2.0%
$100 Billion	$50M	$100M	$250M	$500M	$1B	$2B
$500 Billion	$250M	$500M	$1.25B	$2.5B	$5B	$10B
$1 Trillion	$500M	$1B	$2.5B	$5B	$10B	$20B
$5 Trillion	$2.5B	$5B	$12.5B	$25B	$50B	$100B
$10 Trillion	$5B	$10B	$25B	$50B	$100B	$200B
$20 Trillion	$10B	$20B	$50B	$100B	$200B	$400B
$50 Trillion	$25B	$50B	$125B	$250B	$500B	$1T
$100 Trillion	$50B	$100B	$250B	$500B	$1T	$2T

Figure 25-C

If Bitcoin fails to grow for one reason or another and becomes a stagnant project or permanently remains around its current market capitalization of less than $1 trillion, its miner revenue will significantly decrease from current levels as block subsidies diminish. By the 2030s, bitcoin miner revenue will probably be around 0.50% of market capitalization or less, and so the network will be stagnant at 2018-2020 energy spending levels or less.

If Bitcoin becomes systemically important, such as $5-$10 trillion in network value (representing a per-coin price of $250k to $500k) with hundreds of millions of users, then at 0.50% annual miner revenue relative to market capitalization, that would be $25-$50 billion. This could represent perhaps 0.3% to 0.5% of global energy usage.

If it reaches a very high price of one million dollars per coin, for a critically important market capitalization of $20 trillion or more, with billions of users, then at 0.25% to 0.50% annual miner revenue relative to market capitalization, that would be $50-$100 billion. This could represent perhaps 0.6% to 1.0% of global energy usage, which seems appropriate for a network used by billions of people for multiple purposes, as it would need to be at that point in order to reach such a high value.

By that point, Bitcoin would be big enough that it would likely be replacing energy used by parts of the global banking system, rather than adding to it. There are tens of millions of people working in banks and fintech companies around the world, with energy-intensive office buildings, office equipment, payment servers, and tons of administrative overhead. The application of software to money at the root layer, just like other industries, can create efficiencies and reduce the need for employment and equipment and real estate and overhead in certain parts of legacy infrastructure, freeing up those human resources and corresponding energy uses for other productive purposes.

We can also run these figures for annual transaction volumes rather than market capitalization, which is likely a better way of looking at it. Volumes are more closely tied to the fee market than market capitalization is, but transaction volume is harder to measure than market capitalization, since there are multiple different ways to measure transaction volume.

For example, if a person sends bitcoin from one address that they control to another address that they control, should that count as part of the network's transaction volume? Coin Metrics, a blockchain analytics firm, calculates an adjusted estimate of Bitcoin network transaction volume that excludes various short-term transaction hops (therefore factoring out a lot of exchange cold storage shuffling and the usage of privacy tools). Figure 25-D shows the network's monetary velocity by year, as calculated from average market capitalization and annual adjusted transaction volumes.

Bitcoin Monetary Velocity (Adjusted)

Year	Average Market Cap	Annual Adj Volume	Adj Velocity (Vol/Cap)
2012	$80.0 million	$910 million	11.4
2013	$2.23 billion	$22.0 billion	9.9
2014	$6.76 billion	$34.3 billion	5.1
2015	$3.93 billion	$32.4 billion	8.3
2016	$8.95 billion	$87.9 billion	9.8
2017	$65.9 billion	$671 billion	10.2
2018	$129 billion	$753 billion	5.8
2019	$132 billion	$673 billion	5.1
2020	$205 billion	$1.00 trillion	4.9
2021	$892 billion	$4.67 trillion	5.2
2022	$535 billion	$4.10 trillion	7.7

Data Sources: Glassnode, Coin Metrics, Messari

Figure 25-D

Figure 25-E is a table of the Bitcoin network's adjusted transaction volume, annual miner revenue (including block subsidies and transaction fees), and the

percentage of the annual adjusted volume spent on miner revenue each year.

Miner Revenue as a % of Adjusted Transaction Volume

Year	Annual Volume	Annual Miner Revenue	% of Annual Volume
2012	$910 million	21.1 million	2.319%
2013	$22.0 billion	$308 million	1.401%
2014	$34.4 billion	$785 million	2.284%
2015	$32.4 billion	$375 million	1.157%
2016	$87.9 billion	$571 million	0.650%
2017	$671 billion	$3.37 billion	0.502%
2018	$754 billion	$5.50 billion	0.730%
2019	$673 billion	$5.20 billion	0.772%
2020	$1.00 trillion	$5.01 billion	0.501%
2021	$4.67 trillion	$16.81 billion	0.360%
2022	$4.10 trillion	$9.51 billion	0.232%

Data Sources: Glassnode, Coin Metrics, Messari

Figure 25-E

Figure 25-F is the same table, but only including the transaction fee portion of miner revenue.

Miner Fees as a % of Adjusted Transaction Volume

Year	Annual Volume	Annual Miner Fees	% of Annual Volume
2012	$910 million	$64,899	0.007%
2013	$22.0 billion	$2.17 million	0.010%
2014	$34.4 billion	$2.44 million	0.007%
2015	$32.4 billion	$2.34 million	0.007%
2016	$87.9 billion	$13.6 million	0.015%
2017	$671 billion	$552 million	0.082%
2018	$754 billion	$284 million	0.038%
2019	$673 billion	$156 million	0.023%
2020	$1.00 trillion	$326 million	0.033%
2021	$4.67 trillion	$1.010 billion	0.022%
2022	$4.10 trillion	$141 million	0.003%

Data Sources: Glassnode, Coin Metrics, Messari

Figure 25-F

We can see in that table that fees were miniscule until 2017. That was when blocks started to become full on a regular basis, and a meaningful fee market developed.

Now that a lot of block space efficiency gains have been realized while the network continues to grow, I expect that potential future increases in transaction volume will create more persistent upward fee pressure by the end of the 2020s decade. This will likely lead to higher structural average transaction fees, but these fees would still be a very low percentage of the average transaction size. As mentioned previously, as of this writing 2023 is shaping up to be a higher fee year than 2022, although it isn't included in the chart since the year is only halfway finished.

Figure 25-H shows potential long-term Bitcoin annual adjusted transaction volumes on the vertical axis and annual miner fees as a percentage of annual adjusted transaction volumes on the horizontal axis, so that the reader can see what assumptions are needed to arrive at various annual miner revenue estimates.

Miner Fees as a Percentage of Annual Volume

	0.001%	0.005%	0.01%	0.02%	0.03%	0.10%
$1 Trillion	$10M	$50M	$100M	$200M	$300M	$1B
$5 Trillion	$50M	$250M	$500M	$1B	$1.5B	$5B
$10 Trillion	$100M	$500M	$1B	$2B	$3B	$10B
$20 Trillion	$200M	$1B	$2B	$4B	$6B	$20B
$50 Trillion	$500M	$2.5B	$5B	$10B	$15B	$50B
$100 Trillion	$1B	$5B	$10B	$20B	$30B	$100B
$500 Trillion	$5B	$25B	$50B	$100B	$150B	$500B
$1 Quadrillion	$10B	$50B	$100B	$200B	$300B	$1T

Figure 25-G

It's hard to say what the Bitcoin network's on-chain transaction volume or adjusted volume will be in a couple of decades. This will depend on a combination of adoption and monetary velocity. Right now, bitcoin are primarily used for investment/savings purposes and less so for spending, and therefore on-chain velocity is low. If we reach a pivot point where bitcoin is more integrated into financial institutions, the exchange rate becomes less volatile, and more people use bitcoin for payments, then its monetary velocity could increase by quite a bit, resulting in some of the higher-end energy usage estimates coming to pass (perhaps upwards of 1% of global energy) in exchange for providing tremendous utility.

Today, the Bitcoin network's electricity consumption is estimated to emit less carbon dioxide than random things we don't think about, like tumble driers or zinc production. If the world was 10% more efficient at turning off our always-on electronic devices when not in use, it would save more electricity than the Bitcoin network consumes.[366]

If Bitcoin becomes wildly successful with trillions of dollars of utility for users, we could potentially see it consume an amount of energy per year that is comparable to the aluminum production industry. In other words, despite reaching a massive scale and serving numerous purposes as a global monetary network, it would still be comparable in energy usage to various other random industries that we don't generally become morally panicked about.[367]

Scaling By Layers and the "Cost Per Transaction" Fallacy

The Bitcoin network can do a maximum of several hundred thousand base layer transactions per day. That's about five transactions per second. The theoretical limit has increased moderately over time due to occasional upgrades that improve transaction density.

This transaction limit is often unfavorably compared to credit card networks, which can process tens of thousands of transactions per second. Due to that, critics often point out that Bitcoin's energy usage per transaction is very high, and thus the network is inefficient and should be avoided for environmental reasons.

The first problem with that reasoning is the fact that Bitcoin uses energy whether transactions are occurring or not, due to the block subsidy that miners earn when they produce a new block, regardless of how many transactions are in that block. The way to think about it is that a large portion of that energy is used simply for securing the network against transaction censoring or deep block re-organizations, and therefore keeping it attractive as a settlement network and store of value while it's still in its nascent state. One block might have 1,200 transactions. The next block might have 2,500 transactions. The block after that might have 1,800 transactions. Meanwhile, the same number of miners are hooked up to the network between those subsequent blocks, using the same amount of electricity. Whether blocks are full or not, they're using roughly the same amount of electricity. And each new block is further securing all prior transactions stretching back to the genesis block.

Whether you choose to make a transaction or not does not materially change how much energy the Bitcoin network is using at that time. Bitcoin's energy usage comes from miners expending energy to earn the block subsidy and average transaction fees; it's denominated in bitcoin and thus based on the value per bitcoin, which mainly comes from people holding bitcoin as a store of value, not spending it. Transaction volumes only affect the transaction fee portion, and only the longer-run average transaction fee matters.[368] Mining hardware is purchased with expectations of running those machines for five or more years. Every bitcoin block increases the finality of all blocks below it, and by extension assures the immutability of the entire blockchain, rather than just performing the transactions that it contains.

You can think of this concept like running your dishwasher each night. Whether it's 30% or 90% full when you run it, it still uses about the same amount of resources per run. The marginal extra dish or utensil doesn't materially affect the dishwasher's energy usage, and thus the "water per dish" metric isn't particularly relevant. Another analogy would be keeping your computer on all day, and either sending 20 emails or 100 emails. The marginal amount of "electricity per email" that you send isn't relevant, because regardless of how many emails you send that day, your computer is on and is using approximately its baseline resource level.

The second problem with that reasoning is the idea that this limit of about five transactions per second is the true limit when it isn't. In reality, the Bitcoin network has multiple layers, just like the current financial system. The base layer that we know as Bitcoin is a settlement network.

Credit card networks are merely layers on top of a deeper payment network. In the United States, as described in prior chapters, we have the Fedwire system which settles approximately one quadrillion dollars of gross volume per year. That's the gross settlement layer that banks use to perform large transactions with each other. This system performs approximately the same number of transactions as the Bitcoin network per year and has scaled up slowly as needed, but those Fedwire transaction amounts are very large, representing millions of dollars each. On top of that layer, there are things like Visa, Mastercard, PayPal, Venmo, people writing physical checks to each other, and so forth.

If you send me a credit card payment, for example, that seems instantaneous to both of us, but behind the scenes it is not. When the transaction seems finished to us, behind the scenes our two banks just conversed and made an IOU between themselves. Sometime later, they will batch it with many other consumer transactions and settle their books with a big settlement transaction. There's no limit to how many surface-layer payments can occur, because there is no limit to the size of those massive settlement transactions. Each settlement transaction represents thousands of smaller payments.

Similarly, the Bitcoin network has additional layers: Lightning, sidechains, custodial ecosystems, and more. However, unlike the banking system that depends on significant settlement times and IOUs, many of Bitcoin's layers are designed to minimize trust and avoid the use of credit, via software with programmable contracts and short settlement times.

WHY BITCOIN MINERS ARE UNUSUAL ENERGY BUYERS

Beyond a simple calculation of how much energy Bitcoin uses, we should also consider the details for how it uses energy and the types of energy it uses.

People often imagine bitcoin miners competing with other industries for electricity, as though bitcoin mining must push out some other use of electricity. However, because bitcoin miners are competing in a very commoditized global business, they inherently require extremely cheap electricity and therefore *can't* compete with normal users of electricity. As a result, bitcoin miners seek out inefficiencies around the world where electricity is being underutilized, wasted, and thrown away nearly for free.

Most energy consumers can't go to where the energy is; the energy must be brought to them. Humans organize themselves based on geography, and historically that was mainly around shipping channels. We live in coastal or riverside cities, in the suburbs of those areas, and around rural areas of fertile land. We don't live around energy sources. Rather than move to where the oil and gas and uranium deposits are, we send folks out to go get the oil and gas and uranium and bring it back to us for consumption in our homes and at gas stations and nearby nuclear stations.

Bitcoin miners are unusual energy consumers in the sense that they can go to wherever the energy source is, as long as they can get some sort of basic low-bandwidth internet connection, including a satellite connection if needed. That means they use energy in quite efficient and unusual ways, and we don't usually see bitcoin miners near cities where electricity tends to be more expensive.

Fidelity’s first digital asset analyst and later founding partner of Castle Island Ventures, Nic Carter, publicly described Bitcoin’s energy usage in an insightful way back in 2018:

> An interesting externality of PoW coins — they are always-willing energy buyers at 3-5 cents/kWH. And some of the best energy assets are off the grid. This global energy net liberates stranded assets and makes new ones viable.[369]

> Imagine a 3D topographic map of the world with cheap energy hotspots being lower and expensive energy being higher. I imagine Bitcoin mining being akin to a glass of water poured over the surface, settling in the nooks and crannies, and smoothing it out.[370]

In 2021, I performed extensive research on bitcoin miners to examine the details and have continued to follow up on that work annually. In that first year, I reached out to Marty Bent, who at the time was the director of business development for a private bitcoin mining company called Great American Mining. Currently he is a board director for Cathedra, a publicly traded bitcoin mining company. He explained some of the details, which continue to be true today:

> Since the Bitcoin network is a distributed peer-to-peer network that doesn’t depend on any one miner to facilitate transactions, bitcoin miners are better positioned to take advantage of the flare gas opportunity compared to other energy intensive compute processes like server farms because they can stomach disruptions in the field without affecting the uptime of the network materially. Whereas a server farm would not be able to because uptime disruption could seriously affect critical business operations. Beyond this, the amount of data that miners send to mining pools is very small and doesn’t require much bandwidth, so they can operate in very remote areas using cellular data much more trivially than other energy intensive data processes.[371]

Although some miners use cheap forms of traditional energy, the following sections offer a sampling of some of the novel ways that bitcoin miners use otherwise stranded or unwanted energy to the benefit of themselves and their counterparties.

1) STRANDED HYDROELECTRIC POWER BITCOIN MINING

For a long time, China was the largest bitcoin mining jurisdiction. At their peak, Chinese miners in aggregate accounted for over 70% of the network, but by spring of 2021 it was estimated to have gradually dipped to under 50%, as more competition arose elsewhere. Then, a 2021 ban on Chinese bitcoin mining, likely to enforce their capital controls, sharply reduced Chinese bitcoin mining exposure, and a significant subset of those miners went elsewhere.[372]

However, for many years, China was an interesting example of bitcoin mining mobility. The province of Sichuan has a lot of overbuilt hydroelectric capacity. During the wet season, they produce more clean electricity than they can possibly use, and so it is wasted. It is stranded power.

Since bitcoin miners can go to where the energy source is, they used to flock to Sichuan during the wet season to make use of that otherwise wasted energy. This was not because they are altruistic environmentalists, but simply because it is cheap and nobody else was making use of it. Electricity that would otherwise be wasted and generate no revenue for the operator, can be sold for extremely cheap levels to someone who can find a use for it, such as bitcoin miners in this case.

With the Chinese bitcoin mining ban of 2021, many of those machines and billions of dollars' worth of annual revenue that they can produce moved to North America and other countries. But for many years, this was a great example of bitcoin miners mopping up stranded and wasted energy. Even after the ban, Chinese bitcoin miners reemerged in a smaller way, because it's hard to fully stamp the industry out.[373]

Many other countries face similar issues with unused portions of hydroelectric power generation and have become bitcoin mining jurisdictions for that reason. Any unused hydroelectric power can be monetized for bitcoin mining, and otherwise may go to waste.

2) STRANDED NATURAL GAS BITCOIN MINING

Many types of petroleum deposits come with associated natural gas.

If there is enough of this gas, it can be collected and sent via pipeline or other transport networks to be used as a primary energy source, since of course natural gas is extremely useful for electricity and heating. However, if it's a small amount, then it's not economical enough to build a pipeline or otherwise collect that gas.

So, what happens? It gets vented or flared into the atmosphere, and therefore wasted. Venting means just letting the gas out into the atmosphere, mainly as methane (which is a stronger greenhouse gas than carbon dioxide). Flaring means the gas is burned for no productive purpose, and thus converted into carbon dioxide and emitted into the atmosphere. It's a complete waste, either way, and yet still contributing to global greenhouse gases.

In terms of scale, the World Bank uses satellite data to estimate that 144 billion cubic meters of natural gas is vented or flared per year throughout the world.[374] That wasted energy alone is enough to power the entire Bitcoin network several times over, according to the University of Cambridge's analysis on the Bitcoin network's energy usage.[375]

There are several private bitcoin mining companies that specialize in hooking up trailers of bitcoin miners on oil production sites with stranded gas to make use of that otherwise-wasted energy. This is a win-win scenario for oil producers and the bitcoin miners. The producers get to sell their stranded gas rather than waste it, while earning higher environmental scores and meeting state flaring limits. Running gas through an electric generator is more efficient at converting methane to carbon dioxide than flaring it. Bitcoin miners get a cheap source of electricity in the process.

3) LANDFILL GAS BITCOIN MINING

Aside from the associated natural gas that is found along with oil deposits, another big way that methane leaks into the atmosphere is through landfills. On a global basis, billions of cubic meters of methane leak out of landfills from decomposing organic matter. Some of the largest landfills capture this methane and use it to generate useful energy, but many smaller landfills around the world, or even large landfills that don't have economic usage for it, just let it leak into the atmosphere.

A company called Vespene Energy raised $4.3 million in 2022 to deploy bitcoin miners at landfill sites to make use of this methane. By capturing methane and burning it into carbon dioxide, it creates usable energy and reduces the overall greenhouse effect. And the only way to make the incentive work is if there is some energy buyer that is flexible enough to set up at small and mid-sized landfills, like bitcoin miners.

> BERKELEY, Calif., Aug. 9, 2022 /PRNewswire/ — Vespene Energy, a methane mitigation company, today announced the close of a $4.3M financing round led by Polychain Capital, and joined by a number of climate-focused funds. Vespene installs highly efficient micro-turbines on municipal landfills to convert waste methane into electricity to power a variety of on-site uses, the first of which will be Bitcoin mining data-centers. Vespene's immediately deployable, and highly scalable technology, enables municipal landfill operators to monetize an otherwise stranded asset while reducing harmful greenhouse gas emissions.[376]

As of this writing, Vespene describes their process on their homepage as follows:

> We leverage landfill methane to create an on-site energy source that can support broad EV fleet electrification and other variable facility loads. By pairing energy generation with interruptible data processing, we ensure that methane is fully destroyed and the energy is always put to beneficial use.[377]

"Interruptible data processing" in this context is primarily a description of bitcoin mining, and likely phrased in that way to avoid concerning people who would otherwise be interested in their services but have incorrect and negative connotations about Bitcoin. Bitcoin mining is just a form of computation and data processing as it relates to transaction ordering, and unlike other uses of data centers, individual bitcoin miners are highly interruptible and flexible.

Some people ask, "can't we capture this methane without bitcoin miners?" but the problem is that without proper economic incentives, it just doesn't happen. People can theorize about what should happen, but then don't do it themselves. The only way it happens at some of the smaller landfill or flare gas sites is for highly flexible consumers of electricity to come in and profitably make use of it on site, and for that purpose bitcoin mining is the most direct way to do it.

This is a new industry, and startups come and go. I don't know how successful this specific company will be over the next five or ten years. But what I do know is that landfills around the world leak energy-dense methane into the atmosphere, and there hasn't historically been a cost-effective, flexible way to make use of it.

4) BITCOIN MINING AS A GRID BATTERY

Electrical grids must constantly adjust for two things: changing electricity supply levels and changing electricity demand levels.

Some electrical sources are very consistent, like baseload nuclear power, which can run 24/7. Other sources, like wind and solar and to some extent hydro, are more variable based on what Mother Nature feels like providing in terms of wind, sun, and rain during a given timeframe. Due to this partial variability, electrical production needs to be overbuilt, so that even on a particularly "low" day of electricity generation, it's still sufficient to provide power to the community as demanded.

On the demand side, there are certain days or seasons that require more electricity than others. For example, I use a lot more gas in winter than in summer, because in the summer it's only used for cooking while in the winter it's used for cooking *and* heating. Meanwhile, I use way more electricity in the summer, since I'm using it for air conditioning in that season, in addition to all my normal baseline usage. Plus, there are peak days, such as the most dangerously hot day of a given year, where just about every single household has the air conditioning system on full blast. Days like that need to be designed for by the electrical grid's engineers. Electricity is more heavily used during certain times of day than others as well.

Plus, electricity can only be sent so far. The longer it is sent over transmission lines, the more loss (waste) occurs. In other words, electricity is somewhat local.

Therefore, due to variability on both the supply side and the demand side on an hourly basis, daily basis, and seasonal basis, electrical grids need to be overbuilt, and to have a lot more power generation capacity than is used on the average day. Some of that capacity could be variable, like natural gas peaking plants that can be rapidly turned on or off as needed to produce electrical power during moments of peak demand. Other types might be ones they can't control, like solar panels and wind turbines. If a power generation company overbuilds solar capacity and wind capacity and isn't using the excess or selling it to another grid, then the electricity is just wasted.

One of the problems with solar and wind power is that the cost of energy storage is very high. Despite all our human ingenuity, we still can't make very cost-effective batteries at a scale suitable for electric utilities because they require a lot of metals and mining. It's an extraordinarily hard physics problem. We can of course make storage batteries for certain niche use-cases, but it's not cost effective or environmentally friendly to use them very broadly on a large scale.[378]

Bitcoin mining makes it profitable to overbuild renewable sources of energy production, since it allows that surplus supply to be monetized. Every community that wants reliable power needs overbuilt electric capacity anyway, and for wind, solar, and hydro that's even more important because they are variable. However, overbuilding is usually not very cost effective, unless it can be used for something profitable and useful when it's not otherwise needed.

Bitcoin miners are a unique solution to that problem by making overbuilding profitable, and thus play the indirect role of an energy storage solution.

During most of the time when there is more supply than demand, bitcoin miners as one of the electricity consumers in the community can power their machines, earn revenue, and pay their electricity costs. If there is a surge in electricity demand or a reduction in supply that would otherwise cause electricity outages in the region, those bitcoin miners can temporarily shut off.

A well-structed commercial rates contract can make this work smoothly. The utility can offer the miner the lowest possible rate in the area, in exchange for them having a higher tolerance for variability and other points of contract flexibility.

Harry Sudock, the Chief Strategy Officer at a bitcoin mining company called GRIID, explained this to Peter McCormack on his podcast in June 2021:

> [Curtailing is] not the position you ever want to be in as the energy generator. So, let's use a wind turbine as a really easy example. The turbine goes around once, generates electrons. The market price in some regions is negative, so what they'll choose to do is just not to send the energy anywhere. It dissipates.
>
> So, if they're able to strike a deal with another bidder on that energy who can tolerate some intermittent consumption, can use it some of the time, not the other part of the time, that's a really valuable customer to be able to bring to a market that isn't necessarily able to support the energy generation on a broader basis.
>
> So, I think bitcoin miners are special and are a huge technological upgrade from the traditional consumers of electricity. We have two, I think of as "energy superpowers": the first one is that energy is 80% or 90% of our monthly costs; the second is that we can consume on an intermittent basis without harming our business model particularly. So, if someone tells me I need you to shut off your miners 100 hours a year, or 500 hours a year, we don't say no, we just say, "We need to reflect that in the energy price we pay".
>
> So, when I'm looking to negotiate a power contract, the way that I frame this is, "I need you to get me the lowest possible cost that you know how to offer. I'm willing to negotiate on every other part of the profile of the load. How big are we going to build the mine; how often do you need that power back; do you need us to serve any other creative purpose within your energy mix or system; do you need us to split our facility into two and to go locate at two different points within place? Great. Do we need to be able to contribute to the security budget of these other pieces of the operation?"
>
> Our job is to drive that energy price as low and competitive as possible and work with producers on every other variable.[379]

For clarity on Sudock's quote, I would add that their third superpower is their ability to co-locate with the source of electricity generation, and thus cut down on transmission losses to help keep their electricity cheap. Bitcoin miners are unique in that 1) most of their operating expense is electricity, 2) they can tolerate intermittent electricity supply, and 3) they are flexible with their location. As a result, they can sacrifice variables that most other companies cannot, in exchange for requiring rock-bottom electricity prices when electricity is abundant.

Due to their ability to go to the source of power, bitcoin miners can also fill in unexpected holes in demand, or other special situations. In that same podcast, Sudock described this situation:

> This is an anecdote that we're in the midst of working through right now. A community is zoned to have a new hospital built in their area. There are 17,000 energy customers, house to house, in that utility's jurisdiction. They are going to bring a hospital that is going to double the amount of energy that this region pulls down. We can all agree that a hospital is a very worthy use of electricity, no argument there.
>
> They rebuild the transmission lines, they build a new substation that's bigger, that can handle the additional load, and after they do all that, the hospital project falls apart.
>
> So, they're left having invested millions of dollars in this area to attract this large customer. They now have to pass that cost back to those 17,000 households, unless they can find another use for that energy. So, what did they do? They called our VP of Energy Management and said, "We've got an overbuilt supply here. If we don't bring in a large-scale energy customer, these costs are going to get passed to these households that don't have the budget to support rising energy prices."
>
> So, we have this beautiful opportunity to come in, backstop this utility, provide a customer to come in on the back of this deal falling apart, and provide the backbone to this community and to stabilize their energy prices for a decade to come. And so, these are the stories of bitcoin mining that don't get to rise to the surface. It also happens that this energy source is over 60% carbon-free.[380]

When I began publishing research articles about Bitcoin's energy usage in 2021, including describing these various types of power purchase agreements, the network had historically been too small and niche for grid engineers to incorporate it into their plans. Starting in 2022, these power curtailment agreements became more widespread and publicly reported on. Large, publicly traded bitcoin miners in the United States repeatedly curtailed their electricity usage through various fluctuations in 2022 and 2023, major energy producers began setting up bitcoin mining operations, and the Tokyo Electric Power Grid announced plans to mine bitcoin with excess energy.[381]

If the Bitcoin network gets big enough, every always-on source of electricity generation can have bitcoin mining equipment co-located with it, to profitably soak up the variable difference between the supply of that power and the surrounding grid demand for that power, so that it doesn't go to waste. That lowers the cost for the producer and the consumer of that power and can make variable energy sources more cost effective. In other words, spare electricity can always be directed toward useful computation. In this sense, the transaction processing of the Bitcoin network gets dispersed into all the little inefficiencies that exist throughout the global energy system.

This is why I wouldn't consider it a bad thing even if Bitcoin did exceed 1% of global energy usage; by that point it would be highly optimized into the energy system and likely be a net good for the energy system, rather than a net bad.

Bitcoin mining is a highly commoditized industry. The only way for a bitcoin miner to remain solvent over the long run is to use the cheapest sources of electricity, and the cheapest sources are the ones that are otherwise stranded or wasted. During a temporary bitcoin bull run, bitcoin miners can get away with using just about any source of electricity and remain profitable, but over multiple bull/bear cycles, the trend is clear: Only the cheapest sources of electricity are viable for bitcoin miners that wish to remain solvent cycle after cycle. They'll need to make agreements with grids to help balance the load, and/or be co-located with the electricity producer to monetize surplus electricity, and/or they'll need to make use of various geographically stranded off-grid energy resources.

5) BITCOIN MINERS AS HEATERS

Most of the energy consumed by bitcoin miners is released as heat. A computer processor is basically a heater that happens to perform calculations while it heats. One of the ways to make bitcoin mining cost effective, in addition to finding the cheapest (and thus stranded) sources of electricity, is to use the heat for productive purposes.

A person or company can literally replace a space heater or pool heater with a bitcoin miner, although they do have a higher up-front cost in exchange for generating revenue while they heat. On a larger scale, space heaters and greenhouse heaters can be replaced by bitcoin miners as well. Novel implementations have already done this, but as the network matures over time, I expect every bit of advantage to be exploited by miners, including finding ways to use waste heat more than they do now.

It wouldn't make any sense to dislike space heaters that happen to also perform computations while they produce that heat, compared to normal space heaters that just heat without doing anything else. The antagonism toward the Bitcoin network's electricity usage is inherently based on the belief that the electricity is wasted, when really that electricity goes toward 1) securing the Bitcoin network, and 2) heating the area around the processor.

Satoshi himself observed this back in 2010, since discussions around Bitcoin's environmental impact were brought up right from the beginning. Here is how

Satoshi envisioned it:

> The heat from your computer is not wasted if you need to heat your home. If you're using electric heat where you live, then your computer's heat isn't a waste. It's equal cost if you generate the heat with your computer. If you have other cheaper heating than electric, then the waste is only the difference in cost. If it's summer and you're using A/C, then it's twice. Bitcoin generation should end up where it's cheapest. Maybe that will be in cold climates where there's electric heat, where it would be essentially free.[382]

6) ADVANCING NEW ENERGY TECHNOLOGIES

A company called Product Recovery Technology International or "PRTI" for short has spent the last decade converting wasted tires into hydrocarbon commodities. The world throws out over a billion tires per year, made from hydrocarbons, and most of them are just burned or buried.

PRTI developed a unique sealed boiler process to take those wasted tires and boil them down into their various hydrocarbon commodities and sell those commodities. However, they also produce some natural gas in this process, which they can use to generate electricity. Since their locations tend to be wherever the tires are sent to rather than in dense population centers, their local electrical grid doesn't generally have very much use for that electricity and can only pay very low rates for it. And it's not enough spare gas to build a pipeline or otherwise use it for many purposes.

So, PRTI takes that extra natural gas that they generate, and mines bitcoin on site with it. This improves the economics of the operation, so that they can continue to do the good work of recycling tires and thereby cutting down on that massive global source of pollutants and litter. Bitcoin mining just happens to be the most economic use of the stranded energy they produce from their innovative process.

As another example, there is a form of renewable baseload power called Ocean Thermal Energy Conversion or "OTEC" for short. It was first successfully demonstrated a century ago but hasn't taken off. As large amounts of solar energy strike the world's oceans, it heats the surface significantly compared to the colder depths. This column of warmth represents a way to generate electricity and represents a natural energy storage medium. Using a giant tube and a specific energy conversion process, large platforms or ships can tap into this difference between warm surface water and cold deep water to generate baseload power. They can use this to generate electricity and send it to land directly or can use the electricity to produce liquid fuels.[383]

The problem with OTEC so far has been about scaling. Small OTEC plants have been demonstrated for test purposes but are uneconomical. Medium-sized OTEC plants don't make much sense either, because they require a lot of infrastructure to get that power back to land relative to how much power is being generated. Large OTEC plants do make economic sense, but nobody will build a large one before medium-sized ones are properly tested.

However, medium-sized OTEC plants could be economical if they don't need to send their power back to land. If they can be free roaming offshore and go to the warmest parts of the ocean near the equator, then even at that middle size they can potentially be economical. The problem is that there isn't any demand for electricity out in the middle of the ocean, or at least there didn't use to be. If they put bitcoin miners on the OTEC ship, then they can monetize the electricity out in the ocean, prove the concept, and hopefully one day get funding for the large-sized platforms that can power coastal populations.

A company called OceanBit is attempting to do just that. With bitcoin mining, they believe they can rejuvenate OTEC as an active area of research and development. One of their co-founders, Nathaniel Harmon, also developed a method to incorporate bitcoin mining directly into the OTEC process, by using some of the cold water that they are pumping up to keep the miners cool and adding the hot waste heat from the miners into the warm surface water that they're already using. I spoke with the co-founders Nathaniel Harmon and Michael Bennett in depth about their work in 2022, and as someone with a background in electrical engineering, I find the technology to be promising.

7) BOOTSTRAPPING DEVELOPING COUNTRY ELECTRICITY INFRASTRUCTURE

Many low-income countries have a lot of energy resources, including hydroelectric capacity. However, they often have a chicken-and-egg problem. It's expensive and uncertain for developers to build the electrical transmission and distribution infrastructure to move that power from where it is generated to where it would be consumed. People in non-electrified areas don't have much money or electronic devices, and so the developer has trouble seeing how they will get a return on their investment. But for people in those areas to get more money and use more electronic devices, they need electricity to be available to them. Electricity is a key ingredient to becoming more productive and generating more wealth.

Bitcoin presents an interesting opportunity for some of these developing areas to build out their electrical capacity and generate revenue. If a power source is developed, bitcoin miners can come in and give that site immediate profits as a guaranteed anchor buyer at low prices, until that electricity is put to better use as more people in the area begin to use electronic devices over the following years. As Alex Gladstein of the Human Rights Foundation described in a 2021 articled called “The Humanitarian and Environmental Case for Bitcoin”:

> Billions of people in developing nations face the stranded power problem. In order for their economies to grow, they have to expand their electrical infrastructure, a capital-intensive and complex undertaking. But when they, with the help of foreign aid or investment, build power plants to try and capture renewable energy in remote places, that power often has nowhere to go.
>
> In many countries across Africa, for example, there are vast solar, wind and hydro resources. These forces could drive economic activity, but local communities and governments usually lack the resources to invest in the infrastructure to kickstart the process.
>
> Foreign donors and investors are not keen to support projects that do not have a pathway to sustainability or profits. Without strong transmission lines to deliver energy from harvest points to population centers, power plant builders could wait years before they can run without foreign subsidy.
>
> Here is where Bitcoin could be an incentives game-changer. New power plants, no matter how remote, can generate immediate revenue, even with no transmission lines, by directing their energy to the Bitcoin network and turning sunlight, water or wind into money.
>
> As local authorities or customers gradually link up to the power plant, and are willing to pay more for the energy than what miners can afford, the Bitcoin load is lowered, and communities can grow. In this way, economic activity and renewable grids can be bootstrapped by Bitcoin mining. And international aid could provide the spark.[384]

In 2020, Ross Stevens, the founder and CEO for the alternative asset manager Stone Ridge presented an interesting perspective on Bitcoin’s energy usage. He described how bitcoin mining is the first profitable use of energy in human history that doesn’t need to be situated near human settlements. Instead, bitcoin mining can be situated near sources of untapped energy, which allows for the development of infrastructure and provides an incentive for people to come and settle near the untapped energy source. As he wrote in his December 2020 shareholder letter:

> Thus, Bitcoin can make monetizable isolated energy sources all over the world – like waterfalls, running rivers, or creatable dams – now entirely untapped because they would be cost prohibitive to connect to electric grids close enough to residential or industrial areas.
>
> In doing so, Bitcoin can fundamentally change the economics of energy by introducing a highly profitable use of electricity that’s location independent. The world has never had a profitable use of energy that’s location independent. Now it does. And since fossil fuels are already too expensive to be a profitable source of Bitcoin mining energy, I believe the only long-term, profitable Bitcoin mining will be powered by hydro.

> Imagine a future with Bitcoin mining firms, unsubsidized, in extraordinarily isolated locations – visualize a waterfall in a largely population-free part of an African country suffering from abject poverty – easily connected to the Bitcoin network, building serious energy infrastructure to monetize the local clean energy source for mining. However, once the industrial-strength, profitable infrastructure is in place, let's extend it. Let's build roads. And housing. And schools. And hospitals. Ultimately leading to human settlement.
>
> The net result can be people locating around new, Bitcoin-driven hydroelectric energy infrastructure, with more and more of humanity clustering around cheap, clean energy sources. Historically, our energy challenge has been to move the power to the people. With Bitcoin, we can move the people to the power.[385]

During 2022, this vision started to become a reality in Africa. A company called Gridless began using bitcoin mining to incentivize and sustain the deployment of small-river hydropower in locations in East Africa. As of this writing, here is how they describe it on their homepage:

> There is immense demand for reliable, clean, and affordable energy across Africa, yet mini-grid energy generators struggle for sustainability. Gridless works with renewable, rural, mini-grid energy generators to monetize the full capacity of their output as a buyer of last resort, as well as serving as an anchor tenant for new energy generation creation.[386]

This makes power development in Africa safer and more economical for the developer, and thus helps projects become built rather than remain in development limbo. In late 2022, the company raised $2 million in venture capital to expand their operations. As *Bitcoin Magazine* reported:

> In its first year of operation, Gridless has entered five different project contract pilots in rural Kenya alongside HydroBox, an African hydroelectric energy company. Three of these pilots are now operational. Gridless finances the construction and managers the operation of the data centers in these rural communities. The company has now set its sights on expansion into other areas in East Africa.[387]

A bitcoin-focused entrepreneur, Obi Nwosu, described these locations as being "frontier towns" in 2022, referencing the towns that sprung up around gold mining locations in the 1800s as people settled west across North America. Bitcoin mining can incentivize the production of otherwise untapped sources of power — such as small rivers — and can make microgrids more economically viable. Once developed, these power sources provide opportunities for people to come live and work in that area, starting with the power or datacenter workers, extending to their families, extending further to support services, and expanding out from there into full-fledged villages. With an operational microgrid in place, the area can become more productive and thus wealthier, which enables people to afford more devices and consume more power, and enjoy a higher quality of life.

A PRO-ENERGY TECHNOLOGY

It’s unintuitive to most people that energy is not fungible. This is true for certain types of hydrocarbons such as stranded natural gas, but it’s especially applicable to electrical power. Electrical power is produced at a specific time and place and can’t be transported very far without heavy losses. Certain sources of variable power such as solar panels and wind turbines produce excess electricity at certain times, which is curtailed (e.g., dissipated as waste heat). Certain sources of always-on sources of power such as hydroelectric dams often have insufficient electrical demand installed around them, or have variable demand, and thus that electrical generation is wasted as well. People often imagine every unit of electricity generation being put to productive use, and that every new source of electricity demand must directly compete with some existing source of electricity demand. However, as this chapter described, a considerable amount of electricity is wasted, due to the lack of a sufficiently flexible buyer to come and pay a marginal cost for it.

When the tractor was invented, it allowed one person to do the work of what had previously required a dozen people to do. Tractors, however, required additional energy in the form of hydrocarbons. If we analyze them based on external energy usage alone, then we will conclude that it is a more energy-intensive farming practice than farming by manual labor. However, upon deeper analysis, we can see that this energy usage replaces all the caloric energy of those farmers and frees up their invaluable time and energy to produce other things.

Likewise, Bitcoin uses energy, but by doing so it can maintain and update a global ledger in a decentralized, automated way, compared to current banking ledgers that rely on centralized and often manual processes based on trust. And compared to proof-of-stake networks, Bitcoin does this in a way that preserves the concept of unforgeable costliness, meaning that even if the network temporarily goes down, the history of the ledger can’t be faked or argued over. In other words, Bitcoin adds energy into the process to minimize how much governance is required. If digitally native monetary network like Bitcoin becomes more widely used, then the legacy finance industry doesn’t need to be as large and resource intensive as it is now.

Any company mentioned in this chapter is subject to risk, and therefore to potential failure. Over multi-year periods, many startup companies fail.

However, even as specific companies may come and go, the novel way in which the network consumes energy leads to many interesting possibilities. The world has never had such a flexible consumer of energy before in terms of both the location and intermittency of that energy. If the Bitcoin network continues to prosper and use energy, then various inefficiencies in our existing energy production can be stabilized and put to economic use. In addition, various sources of clean energy that are otherwise far from existing human settlement can be profitably tapped into, which incentivizes people to move to them.

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CHAPTER 26

CRYPTOCURRENCY RISK ANALYSIS

Readers of this part of the book who have not previously been bullish or interested in Bitcoin may be thinking, “some of this is neat, but I don’t think it’ll work in the long run.” If that is your view, you’re in good company with the author. I think it’s a healthy and natural response to be skeptical of the long-term financial value of this technology.

Gold has been used as money for thousands of years. Government-issued or bank-issued paper currencies and centralized ledger systems have been used as media of exchange for centuries. Bitcoin is a relatively niche software network that has been running since 2009. Let’s not get ahead of ourselves here.

When I first heard about Bitcoin back in 2010 or 2011, I was interested but skeptical. It barely had a market price back then. The innovation was fascinating to me, but I didn’t acquire any coins. I knew of an engineer who was mining it on her high-performance gaming computer, and I briefly considered using my gaming computer to do the same. But like many things in life, I just never got around to it, and eventually forgot about it. It was not important or convincing enough to me to grab my attention in a way that was meaningful enough to incite action.

And then in 2013, I encountered the idea again as it went up in price dramatically. I re-examined it, and once again appreciated the innovation. I looked at some of the cryptocurrency exchanges to perhaps buy a little bit, but they seemed rather sketchy and risky to me. I made a mental note to put more time into researching how to safely buy some next week and then again, I just forgot about it and was busy with other things in life. I was not inherently convinced enough to act.

In late 2017 after it had appreciated in price considerably again, I published a public research article on bitcoin and other cryptocurrencies. I described their operation to a general investing audience and put forth several potential valuation methods for them.[388] I once again concluded that I would avoid buying any for the time being. This ended up being a good decision: It was near the top of one of bitcoin's several price bubbles, and the returns were rather poor for the next three years.

My primary hesitation from the very beginning was that it seemed to me like anyone could just copy the code and create a different blockchain money. With precious metals, each one is scarce, and there are only a handful of different types. With blockchain monies, anyone with a bit of coding experience can copy one of the existing ones, change a few variables, and release it. Therefore, although there will only ever be 21 million bitcoin, the concept can experience supply inflation and dilution by the introduction of countless new blockchain monies. If the market share becomes and remains highly fragmented between countless blockchains, then perhaps none of them will persistently maintain any significant purchasing power, liquidity, or security. Plus, I considered there to be risks associated with government bans, software bugs, and arbitrary changes to the rules of the network.

However, unlike my initial observations of the network in 2011 and 2013, I kept watching the network closely after 2017, including through the bear market of 2018 and 2019. When the price of bitcoin crashed in early 2020 during the COVID-19 pandemic after already having been in a long bear market, I recommended it as an allocation to readers of my investment research website and bought a significant amount myself. I've been structurally optimistic on the network ever since, even as I do acknowledge various risks associated with the concept's long-term survival.

The primary event that made me more interested in Bitcoin was the resolution of the "Blocksize War." From 2015 through 2017, there had been vigorous debate in the Bitcoin ecosystem about whether the maximum block size should be increased with a hard fork or not, meaning a change to the consensus rules that is not backward-compatible with existing nodes. Different factions struggled with each other to shape the design of the protocol, and to see who had the power (developers, corporate miners/exchanges, or individual users/nodes). It was a real-world test of Bitcoin's level of decentralization. In other words, it was a "constitutional crisis" for the Bitcoin network, and it passed the test.

Ever since the network's early history, there was a growing divide between people who wanted to increase the block size and people who wanted to keep it small. Increasing the block size allows the network to process more transactions per unit of time (not considering layer two solutions and sidechain solutions, which weren't fully developed yet). However, increasing the block size also increases the bandwidth and data storage and processing power required to run a full node, and thus puts it out of the reach of the everyday user on a laptop. If users can neither mine nor operate a full node themselves, they must trust large-scale network providers, and Bitcoin would cease to be a permissionless, decentralized peer-to-peer system. It would permanently weaken the consensus function of the node network.

Even Satoshi himself played a dual role in this debate as early as 2010; he's the one that personally added the block size limit after the network was already running, but also discussed how it could potentially be increased over time for better scaling as global bandwidth access improves. After the seeds of this disagreement were laid from the protocol's inception, and with Satoshi long gone, it was from 2015 through 2017 that the Blocksize War went into full conflict.

At one point in 2017, over 80% of miner processing power, the biggest maker of bitcoin mining equipment, the prior lead developer of the Bitcoin network, and several major custodians and exchanges, favored increasing the block size with an upgrade called SegWit2x (not to be confused with the SegWit update). That represented an overwhelming amount of support among the corporate-level players in the industry, or as they described themselves in their New York Agreement, they were "a critical mass of the bitcoin ecosystem."[389]

And yet they failed, and the attempt was aborted. This showed how much power individual node operators have, and showed how hard it is to push unwanted updates to the userbase. It answered the question of "who controls the ledger?"

Multiple separate hard forks were attempted after that. Bitcoin Cash became the most famous hard fork with a bigger block size, and as of this writing its market capitalization is less than 0.5% of Bitcoin's market capitalization. A minority hard fork could simply not compete with the real Bitcoin network.

As I described in a prior chapter, trying do a hard fork from Bitcoin is like copying all the data from Wikipedia and hosting it on your own website, and then getting very little traffic because you don't have the millions of backlinks that point to the real Wikipedia, or the volunteer army of people that constantly update the real Wikipedia. Your split version of Wikipedia would be inherently worse than the real one from the moment you copy it due to its weaker network effect. Similarly, any minority hard fork of Bitcoin inherently has far fewer nodes and far less miner computation, making it less decentralized and less censorship-resistant. That's the problem that Bitcoin Cash and other hard forks ran into.

It's not impossible for Bitcoin to one day perform a successful hard fork, but such a hard fork can only be done with overwhelming consensus by the users if there is a critical issue, and not by a consortium of corporations or minority factions.

From 2020 through 2023, I met with a number of Bitcoin Core developers, several Lightning developers, the builders of other scaling solutions, several billionaires who hold sizable amounts of bitcoin, several founders of exchanges and Bitcoin ecosystem companies, several venture capital firms that financed those companies, several authors of the top-selling Bitcoin-related books, the inventor of Hashcash (proof-of-work), and several human rights activists from various authoritarian countries that use bitcoin and stablecoins. While I was at the Oslo Freedom Forum, I was asked to present as a subject matter expert about Bitcoin's energy usage in the Norwegian parliament building to several parliament members and did so. I also presented to members of the Office of the Superintendent of Financial Institutions in Canada about Bitcoin's energy usage as well. I participated in several conferences and countless podcast interviews associated with the subject and wrote several research articles about it. In 2021, I joined the board of directors of a bitcoin-native financial services company called Swan.com. In 2022, I became a founding advisor to egodeath.capital, a venture fund that provides capital to bitcoin-related startup companies and have worked closely with them ever since.

Throughout this process, I immersed myself deep into the Bitcoin ecosystem, constantly learning. My goal was to explore the various possibilities of this technology as it relates to the evolution of money, while also evaluating the risks and repercussions associated with it.

What made me go from an interested skeptic of the technology to someone who spends a significant portion of my time analyzing and working within the ecosystem, was that each of what I considered to be major risks was completely or partially addressed. I consider there to still be many risks, but as it stands today, I view the technology to likely be powerful enough to overcome them. This chapter will focus on outlining what I have considered to be the major risk categories associated with the Bitcoin network and other cryptocurrencies, and how I see them as manageable or mitigated, but still present.

RISK 1: MARKET DILUTION

The first risk that I identified was that of market dilution. If people keep making new cryptocurrencies, then what stops the entire market from being heavily diluted and fractured? There is no assurance that one or two cryptocurrencies will emerge as the most salable, and therefore accumulate most of the monetary premium among the infinite number of potential coins.

In practice, however, Bitcoin has been the largest cryptocurrency by market capitalization for 14 consecutive years, and only Ethereum has come anywhere close to it at certain points of time. Nothing else is remotely on the same scale. Once a well-designed cryptocurrency becomes large, its security and depth of liquidity overshadows everything else.

As of this writing, Bitcoin has over 90% of the market value of all proof-of-work blockchains. Of those, it has by far the largest computational processing power, meaning that it's the most secure against censorship attacks. Even if a large proof-of-stake network were to surpass Bitcoin in market value during a certain period, I would still consider Bitcoin to be uncontested at what it specifically does, which is to build a decentralized ledger with an unforgeable history.

Because Bitcoin nodes are small and easy to run by design, Bitcoin has by far the greatest number of active nodes out of any cryptocurrency. Every trade-off that other cryptocurrencies make in order to be more expressive or to have higher transaction throughput, generally results in larger node requirements and therefore fewer nodes and less decentralization. If individuals don't have a realistic option to run their own node, then the privacy and the censorship-resistance of the blockchain are heavily impaired.

Protocols in general tend to consolidate toward one dominant standard and maintain that hold for decades or longer, due to network effects. There were competing protocol stacks for the internet, for example. However, once a protocol emerges as dominant, it generally becomes a virtuous cycle of more and more usage. The introduction of any competing protocol starts at a massive disadvantage, because it is not compatible with most applications and devices on the market. Only if a new protocol is an order of magnitude superior would it have any chance of competing against an established protocol; it can't just be marginally better.[390] Plus, the dominant protocols can and do upgrade over time in a backwards-compatible way, which is how they remain relevant over long periods of time.

However, although the design space is very tight (i.e., most improvements make worse trade-offs as far as we know), there is no absolute guarantee that Bitcoin won't be outcompeted or surpassed in some way, and this must be considered a risk. However, there is currently no identifiable competition on the horizon at any similar level of scale, liquidity, security, and immutability. The only comparable network in terms of size is Ethereum, which in many ways is categorically different.

Someone analyzing this space should research the various trade-offs for themselves, and monitor the health of Bitcoin's network effect, market share, and technical capabilities. Large numbers of small illiquid coins can lower Bitcoin's market share in theory, but in practice, only the top couple dozen coins matter in terms of salability, and of those, only the proof-of-work coins have an unforgeable history.

RISK 2: CRITICAL SOFTWARE BUGS

In 2010 when it was still brand new and barely had a market price, the Bitcoin node client had an inflation bug, which Satoshi fixed with a soft fork.

In 2013, a Bitcoin node client update was accidentally not backward-compatible with the prior (and widely used) node client due to an oversight, resulting in an unintended chain split. Within hours, developers analyzed the problem and told node operators to fall back to the prior node client, which resolved the chain split. Since that time over a decade ago, the Bitcoin network has enjoyed 100% perfect uptime. Even Fedwire has encountered outages and failed to achieve 100% uptime during that period (and doesn't even attempt to run 24/7/365 to begin with like Bitcoin does).

In 2018, another inflation bug was accidentally added to the Bitcoin node client. However, this one was identified and discreetly fixed by developers before it was exploited, and so it never caused an issue in practice.

In 2023, people began making use of the SegWit and Taproot soft fork upgrades in ways that were not intended by the developers of those upgrades, including inserting large images into the signature portion of the Bitcoin blockchain. While this is not a bug per se, it shows the risks of how certain aspects of the code can be used in ways that were not intended, and therefore shows the ongoing need for conservatism when performing upgrades in the future.

Bitcoin suffers from the “year 2038 problem” that many computer systems have. During the year 2038, the 32-bit integer used for Unix timestamping will run out of seconds for many computer systems, resulting in an error. However, because Bitcoin uses an unsigned integer for this, it won’t run out until the year 2106. This can be fixed by updating the time to a 64-bit integer or by taking the block height into account when interpreting the wrapped-around 32-bit integer, but as far as I understand it this may require a hard fork, which means an upgrade that is backward-incompatible. This shouldn’t be hard in practice because it’s obviously necessary and can be done well in advance of the problem (years or decades even), but it may open a window of vulnerability. One potential way to do it would be to release an update that is backward-compatible at first, but that activates when the integer runs out and thus solves the problem.

The point of these examples is that Bitcoin and every other cryptocurrency consists of software code written by fallible humans. Bitcoin is purposely simple by design and therefore maintains a smaller, tighter, and more auditable codebase than other cryptocurrencies, but its history is not perfect.

For this reason, when developers release a new update, many node operators are purposely slow to update to it. Developers cannot “push” updates to node operators, which is what makes the system functionally decentralized and immutable, and therefore minimizes the power that developers have. Node operators get to decide if they will update, and in practice it’s best to wait a while for more code reviews and more time in operation to ensure that it’s without critical bugs. If a small portion of the node network updates and a bug is found, they can just roll back to the prior version. However, if a bug goes undetected for a long time and most of the nodes on the network update to it, and *then* it is exploited, that could be disastrous. A fix for that could include a soft fork, and there may be disputes about how to fix it quickly, resulting in chain splits that are not resolved easily. This could damage the reputation of the network as being reliable and set it back many years.

The entire point of Bitcoin is that it provides the node operator with monetary self-sovereignty. It allows the node operator to send and receive transactions without any central entity's permission. The core ruleset is immutable in practice; nobody can force them to update their node, and their node does not allow for the faster creation of coins, or the number of coins to exceed 21 million, or for larger block sizes.

However, monetary self-sovereignty is a Platonic ideal that can only be asymptotically approached; it can never actually be reached in practice. No matter how simple Bitcoin is by design, it can never be proven to be bug-free. Most people will not audit for themselves every line of code for their Bitcoin node client, and even if they do, they could miss a bug just like the developers have sometimes done. If a node operator is forced to hastily update to a new version because their version was found to have a bug, and it's unworkable to fall back to prior versions (perhaps those ones have the same undetected bug), then it temporarily removes the node operator's monetary self-sovereignty and could persistently damage confidence in the network.

RISK 3: GOVERNMENT BANS

Bitcoin is stateless money, and many parts of "the State" don't necessarily like the fact that it exists.

Governments around the world have various banking laws that allow them to monitor bank transactions and freeze accounts. More importantly, governments benefit from seigniorage; they can fix budget deficits by printing more currency to fill the difference, and thus dilute everyone's savings by a little bit at a time in a non-transparent manner. Governments whose debt is denominated in their own currency can never nominally default against their will; they can always create more currency. Their constraints in practice are inflation and public unrest, and their currency can unravel if enough people lose faith in it.

Many authoritarian countries are unattractive places for citizens to keep their wealth, and so citizens want to move their wealth offshore to freer countries with better rule of law for safekeeping. These authoritarian governments therefore do their best to limit capital outflows by controlling the currency and the banking system.

Stateless money allows people to save in a monetary asset that is not issued by a government, and that has a large cost to censor (gaining and maintaining over 50% of the processing power of the global network). It provides a method for portable, self-custodial, peer-to-peer value transfer outside of the banking system. Rather than only wealthy people having offshore bank accounts, Bitcoin gives access to the functional equivalent of an offshore bank account to anyone with a smartphone, except without counterparty risk.

People often think of bitcoin competing with dollars and euros and gold, but the more immediate threat is that it competes with the long tail of the 100+ weakest, smallest, periphery currencies first. Argentinians, for example, scramble for dollar stablecoins, bitcoin, and related assets much more significantly than Norwegians do. Bitcoin and stablecoins threaten the money-printing privileges of many countries, starting with the weakest and going up from there. Governments, however, have various methods to push back on this.

Firstly, governments can sever known cryptocurrency exchanges or brokers from their nation's banking system, through legislation or through informal pressure. A government or central bank can tell all banks that they are not allowed to let customers transfer money to any cryptocurrency exchange or broker or provide banking services to a cryptocurrency-related company. This is very easy for a government to enforce, is a form of capital control, and it limits the speed with which value can flow out of the nation's banking system and into bitcoin, stablecoins, or other cryptocurrencies. During the end of long-term debt cycles when sovereign debt needs to be inflated away, capital controls are a common practice by governments. As a country's public ledger (fiat currency) gets heavily diluted, lawmakers do their best to force people to remain within the ledger as it burns down rather than fleeing to other ledgers.

We already saw partial forms of this in the United States in 2022 and 2023 when many cryptocurrency companies were de-banked due to regulatory pressure. Furthermore, some banks that failed in the banking crisis of 2023 had cryptocurrency assets that were disallowed from being acquired by the banks that bought the remnants of those failed banks. Custodia, which is a Wyoming-chartered bank led by Caitlin Long, warned regulators about some of the banking crises that were likely coming in 2023. And yet Custodia's application for an account at the Federal Reserve was denied, even though they wanted to hold 108% of cash deposits in reserves. There has been a clear push against several types of cryptocurrency-related companies and their ability to maintain reliable connections with financial institutions.

However, even the more severe practice of completely banning banks from sending fiat currency to cryptocurrency exchanges isn't a complete solution for governments, because people can still exchange value peer-to-peer. One prominent example is Nigeria, which has severed cryptocurrency exchanges and brokers from its banking system, but still has one of the highest cryptocurrency adoption rates in the world among its population. A Nigerian can still send money to another Nigerian, and that second Nigerian can send them bitcoin in return. People and businesses can become peer-to-peer brokers, using various ways of accessing bitcoin globally and selling it for a spread to their fellow citizens. There are platforms and marketplaces that help line up buyers and sellers, along with multi-signature escrow services or reputation systems to reduce fraud. It's very hard for a bank to determine that some random payment from one person to another was in exchange for bitcoin, stablecoins, or other cryptocurrency. Additionally, Nigerians that perform remote work for people in other countries, such as programming, graphic design, or virtual assistance, can elect to be paid in bitcoin or stablecoins. Similarly, Nigerians that receive remittances from family in other countries can receive that remittance in bitcoin or stablecoins.

Secondly, governments can react with all sorts of draconian regulations. They can try to tax cryptocurrencies to death. They can make it illegal or impossibly difficult to operate a known cryptocurrency business.

Thirdly and most severely, governments can outright ban it among the public. They can make it illegal to run a Bitcoin node or own any cryptocurrency under threat of imprisonment, for example. For four decades in the United States, from the 1930s to the 1970s, it was punishable by up to a decade in prison for Americans to own gold. Governments take their control over the public ledger very seriously, and attempts by people to take back their own monetary sovereignty to prevent their savings from being debased can be heavily punished.

The problem with these second and third solutions is that they are hard to enforce on a large scale if trust breaks down. People had a lot of trust in the U.S.

federal government during the period between the 1930s and 1970s when gold was illegal to own, and that law was passed when there was a rare supermajority in Congress. For better or worse — depending on how you see it — most people went along with this collectivism. Today in the U.S. and many places, that type of harmony doesn't exist. And while it's easy to impose restrictions on the banking system, it's hard to impose restrictions on individual users. For example, during the era of banned gold, authorities didn't go door-to-door looking for gold, which would be an expensive and dangerous process. Bitcoin is free, open-source, non-malicious software that people can download and run on a basic laptop. Bitcoin is the act of people updating a decentralized global spreadsheet with each other. At an even more basic level, someone can own bitcoin by flipping a coin 256 times to generate a private key and using that to receive bitcoin payments. How does the government stop that or know it belongs to them, especially if enough people do it?

Some governments have strong speech-related laws around this as well. In the 1990s, the United States government tried to crack down on the usage of open-source peer-to-peer encryption, but when the code was published in book form, it was considered a form of speech and protected by the First Amendment, which is purposely very hard to change or get around.

Regardless, many governments can and will try to limit the usage of bitcoin, stablecoins, and other cryptocurrencies to varying extents. So far, governments seem especially concerned with people self-custodying cryptocurrencies and using them privately, because that is what really threatens their control. People owning cryptocurrencies in domestic custodians is not a significant threat, because they are siloed under government control like the banking system already is, and a government can simply tell the custodian that they are not allowed to let people withdraw their coins or can demand that they be handed over to the government.

Just like alcohol usage under prohibition, bitcoin usage is hard to stamp out entirely; it can only be pushed into the black market and made difficult to use. Plus, users of the network tend to respond to attacks on it; multi-country bans would likely result in accelerated adoption of privacy-related technologies in the upper layers of the Bitcoin network and a proliferation of peer-to-peer marketplaces.

Countries that are desperate enough to ban or restrict ownership or usage of bitcoin and other digital assets (and thus limit their ability to attract and retain companies that are participating in this new technology) are likely to do so because they have a severe currency problem or capital flight problem. A willingness for a country to ban the usage of what is basically just a decentralized spreadsheet is often an advertisement for why people in that country likely need it. A country with a robust currency, strong property rights, and where capital wants to be, is unlikely to ban bitcoin. A country dealing with a severe mismanagement of its public ledger is more likely to try to ban bitcoin, or at least add a lot of friction to it.

As Parts 3 and 4 of this book showed, the existing monetary systems are increasingly unstable, and designed to build up entropy over time. If indeed they encounter more severe problems, users of bitcoin or other cryptocurrencies should expect blame to be put on them, as though they somehow caused the existing monetary systems to become destabilized. A counter to that would be to point out that if the mere existence of an open-source software ledger threatens the existing system, then clearly, there's a problem with the existing system rather than this new technology. To argue that a decentralized spreadsheet is a threat to the existing system is, at its core, an admission of failure regarding the existing system. Hundreds of trillions of dollars in credit exists globally that can't be paid back in terms of full purchasing power, and social promises have been accumulated to a point where they can't be made whole in their current forms without big tax increases or cuts to other spending. As these things start to break down, people will naturally want to look for someone to blame, and holders of bitcoin are one of the potential scapegoats to point to.

RISK 4: COMPUTATIONAL THREATS

Bitcoin miners use the SHA-256 hashing algorithm to generate new blocks of transactions for the blockchain. Any normal processor can technically do this, including laptop CPUs for example. In the early days of the network, that was how it was done. However, as bitcoin mining became a large industry, engineers developed more specialized processors to optimize its efficiency. For well-defined processing tasks, application-specific integrated circuits ("ASICs") are far more efficient than a general processor at solving that task once they are designed and produced.

Nowadays, the only way to mine bitcoin in practice is to get ASICs that are specifically designed to do it. There is no amount of general computing that can economically mine bitcoin. If Amazon, Microsoft, and Google were to turn the entirety of their combined cloud server infrastructure toward mining bitcoin or trying to perform a 51% censorship attack on the network, they wouldn't even make a dent. The millions of specialized ASICs around the world that spend all day mining bitcoin are orders of magnitude more powerful for this specific task, which is to guess numbers as quickly as possible for as little electricity per guess as possible.

Therefore, there are some risks associated with the processing equipment involved in bitcoin mining.

Firstly, there are only a handful of top-end chip foundries in the world, which is where various semiconductor products including ASICs are made. On top of that, there are only a handful of companies that currently design SHA-256 ASICs. Therefore, there is a supply chain bottleneck risk associated with making and obtaining bitcoin mining processors.

As of this writing, several large and well-capitalized companies are currently working to diversify the design and fabrication of SHA-256 ASICs. So, this risk can be mitigated, but combined with the prior risk about government bans, supply chain bottlenecks are a realistic threat to monitor.

Secondly, if some entity manages to create a sharply superior ASIC and retains a monopoly on its use, they could pose a censorship threat by outclassing the rest of the processing power on the network. The improvements in ASICs are slowing down, and processors in general (not just ASICs) are likely getting close to the physical limits of Moore's law, where it becomes harder and harder to make meaningful improvements. Transistors are so small now that they are starting to bump into atomic limits. It's hard to envision a much better ASIC that could overwhelm the rest of the network, but the possibility must be considered since there could be some major stepwise development in computing.

Similarly, quantum computing is a long-term possibility. The development and deployment of sufficiently advanced quantum computers may be able to determine a private key from a public key, which is not remotely possible for traditional processors. If that occurs, then it would begin breaking the security assurances of the Bitcoin network. There are, however, possible upgrades to prevent this. Specifically, quantum-hard algorithms can be utilized, but that would require at least a soft fork and perhaps a hard fork and will likely increase the bandwidth and storage requirements per transaction.

Some types of far-out technologies, such as nuclear fusion or quantum computing are often discussed but historically have not come close to fruition. Scientists and journalists occasionally create brief glimmers of them, such as reports about micro-nuclear reactions or tiny quantum computers, but it's a very different thing for these technologies to be developed and deployed in practice. However, we must analyze them and be prepared for their eventual arrival if signs begin to mount toward that reality. Any type of new processing capacity that can break parts of Bitcoin's encryption would be a major threat that requires an answer. And more broadly, it would be a threat to the entire internet and the entire existing banking system as well, since they all use similar types of encryption.

Third, a government could try to censor the network. The annual military budget of the United States is over $800 billion, and China's annual military budget is over $250 billion. It currently requires billions of dollars to attempt a sustained 51% censorship attack on the Bitcoin network, and these entities have the capital to do it if they were to try it. Such a proposal probably wouldn't go over well politically (imagine the negative publicity in the United States if it was known that the Pentagon was spending billions of taxpayer dollars, at a time of record fiscal deficits, to attack the Bitcoin network), and the network could respond to the threat with higher transaction fees to pay more miners to come online and un-censor it. But such an attack is not outside of the realm of possibility. Even just spending a few billion dollars to spam the network for years, making it harder and more costly to use, is something that a large government or military can do. Doing so, however, would enlarge and strengthen the bitcoin miners via higher transaction fee revenue, who can advocate for the network politically and through other means. High base-layer fees also tend to accelerate the adoption of second layer technologies to make more efficient use of block space.

Overall, we can imagine several risks occurring together to combine into a rather serious threat. Governments could ban or severely restrict usage of the Bitcoin network, force various financial institutions to sell their holdings to crash the price and drive the technology into the black market. From there, they could go after the supply chain and do their best to prevent the construction and distribution of new SHA-256 ASICs. If bitcoin's price remains low for a long time, many miners would become unprofitable and disconnect from the network until the difficulty adjustment reduced enough to find a new steady state. This would sharply reduce the cost of attempting a 51% censorship attack, and at that point perhaps some large government entity would spend the resources to do it, for the sake of eliminating the threat of stateless money entirely.

The bigger and more widely held the Bitcoin network is, the harder it is for governments to perform this type of multi-front attack. In the United States, for example, there are already senators and representatives that own bitcoin and that express approval of the Bitcoin network. However, as of this writing, bitcoin and cryptocurrencies in general are still only held by a minority of people, and therefore I see an ongoing window for governments to push back and slow down adoption of this technology. The Bitcoin network is very robust, but one of the reasons I write about it is to educate people about the nuances of how it works and how it may be helpful, so that it can be given as much breathing room as possible to survive and thrive while its surrounding ecosystem develops into maturity.

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CHAPTER 27

STABLECOINS AND CENTRAL BANK DIGITAL CURRENCIES

Blockchains and blockchain-like ledger networks allow fiat currencies to be deployed in more digitally native ways.

So far, this has taken two primary forms: private issuers of fiat-collateralized redeemable tokens (known as “stablecoins”) and digital versions of currencies issued directly by central banks (known as “central bank digital currencies” or “CBDCs” for short). This chapter explores the applications and risks associated with these technologies.

STABLECOIN APPLICATIONS AND RISKS

The first stablecoin was developed in 2014 and was deployed on a layer on top of the Bitcoin network. Since then, many stablecoins have emerged, and they have migrated to other blockchains.

The way that a fiat-collateralized stablecoin works is that someone wires currency (usually U.S. dollars) via the legacy banking system to the stablecoin issuer, and the stablecoin issuer generates new stablecoin tokens and sends them back to the person who wired in the dollars. The new stablecoin holder can then move these tokens on the blockchain they are interested in, and use them for savings, payments, trading, leveraging, or other applications, 24 hours per day, seven days per week, 365 days per year in custodial and non-custodial environments.

Someone who has stablecoins can redeem them in large amounts from the issuer, in a process that goes in reverse from how the stablecoins were generated in the first place. The stablecoin holder sends their tokens to the issuer, and the issuer deletes the stablecoins and wires them the currency amount that corresponds to the number of tokens they redeemed.

The issuer can freeze stablecoins associated with specific addresses in response to demands by law enforcement or similar reasons, which makes them inherently centralized. The issuer can make money via creation and redemption fees, and by earning interest on the collateral that they hold. From the issuer’s perspective, the stablecoin is a liability for them with an interest rate of zero, and they can invest their fiat collateral in U.S. Treasury securities or similar liquid investments and profit from that spread.

This technology offers some benefits compared to a typical bank account. Mainly, it turns a bank account into a bearer asset; stablecoins can be sent around to different people, and redeemed by someone who is different than the person who originally wired money to the stablecoin issuer. Stablecoins are like digital banknotes.

The original application of stablecoins was that they were used as a dollar unit of account in offshore cryptocurrency exchanges. They are also frequently used as a unit of account and source of leverage in decentralized finance (“DeFi”) applications. Outside of trading and leveraging, stablecoins have been used as savings by people who live in countries with major currency crises. For example, many Argentinians use stablecoins. The Argentinian government and banking system has a history of confiscating dollars deposited into the banks, and Argentinians must pay a big mark-up to get their hands on physical cash dollars. However, any Argentinian with a smartphone can access stablecoins, and there isn’t much that the Argentinian government can do about it, since the stablecoin issuers are outside of Argentina. The best they can do (and partially have done) is cut off cryptocurrency exchanges from the Argentinian banking system, thereby forcing Argentinians to use peer-to-peer methods or other methods to acquire them. In other words, although a stablecoin has a centralized issuer, the centralized issuer in this case is outside of the jurisdiction that is experiencing the currency crisis. There are many countries in the world where people who want dollars use stablecoins to access them for this reason. To put it simply, people around the world can use the internet and blockchains to partially access the U.S. banking system, and thus go around their local banking systems. Therefore, stablecoins in recent years have been serving as an offshore U.S. dollar bank account for middle-class people rather than just wealthy people.

At the same time, this technology comes with risks. All users of stablecoins must trust the stablecoin issuer to hold all the collateral that they say they do, or else the stablecoin could become unredeemable and collapse in price. This is similar to how we must trust banks — except in this case the stablecoin industry has been kept largely on the margins by regulators. Additionally, since over 99% of stablecoins are dollar-denominated, and are tied directly or indirectly to a bank in the United States, the U.S. federal government could shut down a stablecoin at any time by sanctioning it and telling the bank that it runs on to freeze the stablecoin issuer's assets. Alternatively, the government that runs the ledger that the stablecoin issuer relies on could tell the stablecoin issuer to freeze certain stablecoin addresses for any legal purpose, such as to target specific users or a specific region of users.

Overall, stablecoins have been increasingly relevant from a monetary perspective because they provide access to U.S. dollars for millions of people around the world who want them but who would otherwise have trouble accessing them. If it becomes easier for people to access any fiat currency they want (or any tokenized asset, more broadly) via their smartphone, then that represents a potential disruption to the current/legacy system of 160 different fiat currencies and capital markets.

CBDCS: OVERVIEW

The creation of the Bitcoin network, and then privately issued fiat-collateralized stablecoins, inevitably caused governments and their central banks to take notice. Paper banknotes and commercial bank reserves represent liabilities of a country's central bank, and therefore represent the "monetary base" of that country. Many central banks are interested in digitizing their physical banknotes, and thereby making the monetary base of their country an entirely digital ledger.

Agustin Carstens, head of the Switzerland-based Bank for International Settlements (which is owned by central banks around the world and provides them with banking services and regulatory frameworks as a supranational entity), had an interesting quote on central bank digital currencies in a 2020 panel discussion hosted by the IMF and World Bank titled “Cross-Border Payment — A Vision for the Future”:

> For our analysis on CBDC in particular for general use, we tend to establish the equivalence with cash, and there is a huge difference there. For example in cash, we don’t know for example who is using a hundred dollar bill today, we don’t know who is using a one thousand peso bill today. A key difference with a CBDC is that central bank will have absolute control on the rules and regulations that determine the use of that expression of central bank liability. And also, we will have the technology to enforce that. Those two issues are extremely important, and that makes a huge difference with respect to what cash is.[391]

In short, central bank digital currencies enhance a central bank’s ability to surveil and control the usage of the currency that it issues. This comes with substantial cross-border transaction improvements and more targeted forms of monetary policy, but also opens significant privacy and control issues for the public.

CBDCS: CROSS-BORDER SETTLEMENT

Cross-border payments remain somewhat of a friction point for the global banking system, despite having been interconnected by telecommunication infrastructure a century and a half ago. Banks have fundamentally used the same legacy international payment mechanisms (e.g., the SWIFT messaging system and transfers among correspondent banks) for half a century, although they’ve made various superficial technical upgrades over time. International transfers are often slow, expensive, and opaque.

In addition, much of the infrastructure goes through the U.S. banking system, which gives the U.S. considerable power to sanction countries for various reasons. Many governments around the world would like to transact in a more decentralized manner without going through systems controlled by a major hegemonic power that they might not have good relations with.

In autumn 2022, the Bank for International Settlements and several government agencies and central banks announced an international project to upgrade cross-border payment infrastructure. Their website described the project as follows:

> The payment system underpinning cross-border financial flows has not kept pace with rapid growth in global economic integration. The global network of correspondent banks that facilitates international payments is hindered by high costs, low speed and transparency, and operational complexities. Banks are also paring back their correspondent networks and services, leaving many participants (notably emerging market and developing economies) without sufficient or affordable access to the global financial system.

> Multiple CBDC (multi-CBDC) arrangements that directly connect jurisdictional digital currencies in a single common technical infrastructure offer significant potential to improve the current system and allow cross-border payments to be immediate, cheap and universally accessible with secure settlement.
>
> The BIS Innovation Hub Hong Kong Centre, the Hong Kong Monetary Authority, the Bank of Thailand, the Digital Currency Institute of the People's Bank of China and the Central Bank of the United Arab Emirates are working together to build such a multi-CBDC platform, known as mBridge.[392]

Central bank digital currency infrastructure can allow for more efficient methods of making cross-border payments and can route around the world in a complex web of connections that eliminates the ability for any single country to act as a system-wide bottleneck.

CBDCS: TARGETED MONETARY AND FISCAL POLICY

The United States is a country of 330 million people, and yet the Federal Reserve sets one baseline interest rate for the entire country. This same issue appears in other countries as well.

Critics of central banking generally view the active management of a currency system to be inherently problematic. From their perspective, rather than set interest rates, central banks should have little or no role, and the free market should determine baseline interest rates instead.

Proponents of central banking, including of course the central bankers themselves, are interested in technologies that give them a finer level of control over monetary policy. What if a central bank could adjust interest rates for different regions of the country, or different age groups? If there are certain industries that the central bank wants to expand and other industries that the central bank wants to diminish, the central bank could provide them with very different costs of capital. This could be done on a consumer level as well. Citizens could be given various quotas on various spending categories, and their spending could be automatically throttled back if they exceed those quotas. Stimulus payments could be handed out to targeted groups more quickly and precisely than current technology allows, and in a form of expiring money that incentivizes rapid spending.

This is one of those areas where we must differentiate between the issuer's perspective and the user's perspective with regards to what an "ideal currency" is. Users generally want their currency to be as free, private, and scarce as possible. Issuers generally want their currency to be surveilable, controllable, and to consistently devalue at a smooth pace over time. From the issuer's perspective, the finer tools that they have available to control the details of their currency, the better.

CBDCS: THE IMPOSITION OF NEGATIVE INTEREST RATES

During the global disinflationary bond bubble of the late 2010s, many monetary policymakers explored ways to set deeply negative interest rates. They generally view high levels of saving as "hoarding" and instead want that money to be spent faster, thereby boosting the economy in the short term. However, the availability of physical cash makes it hard to impose deeply negative interest rates, because people could withdraw money from their bank account and hold it as physical cash if the bank begins taking money away from them by charging deeply negative depositor interest rates.

A 2019 IMF article called "Cashing in: How to Make Negative Interest Rates Work" describes the issue well:

> In a cashless world, there would be no lower bound on interest rates. A central bank could reduce the policy rate from, say, 2 percent to minus 4 percent to counter a severe recession. The interest rate cut would transmit to bank deposits, loans, and bonds. Without cash, depositors would have to pay the negative interest rate to keep their money with the bank, making consumption and investment more attractive. This would jolt lending, boost demand, and stimulate the economy.
>
> When cash is available, however, cutting rates significantly into negative territory becomes impossible. Cash has the same purchasing power as bank deposits, but at zero nominal interest. Moreover, it can be obtained in unlimited quantities in exchange for bank money. Therefore, instead of paying negative interest, one can simply hold cash at zero interest. Cash is a free option on zero interest, and acts as an interest rate floor.
>
> Because of this floor, central banks have resorted to unconventional monetary policy measures. The euro area, Switzerland, Denmark, Sweden, and other economies have allowed interest rates to go slightly below zero, which has been possible because taking out cash in large quantities is inconvenient and costly (for example, storage and insurance fees). These policies have helped boost demand, but they cannot fully make up for lost policy space when interest rates are very low.
>
> One option to break through the zero lower bound would be to phase out cash.[393]

Due to the challenges of entirely phasing out cash, however, the authors of the IMF paper that this article was based on instead proposed keeping the monetary base in two parts, where physical cash would devalue vs cash stored in the financial system by a rate that is equivalent to the negative rates applied to deposited cash, so that negative rates are effectively applied to physical cash as well. There would be no escape from deeply nominal negative interest rates, in other words.

NBER Working Paper 25416, published in 2019 and featuring Larry Summers as a co-author, also discussed the issues that paper currency presents against substantially negative-rate policy:

> Second, if the deposit lower bound is overcome, our model predicts that negative policy rates should be an effective way to stimulate the economy. This could happen if banks over time become more willing to experiment with negative deposit rates, and depositors do not substitute to cash, or if there are institutional changes which affect the deposit lower bound. In Section 4 we consider under which conditions this could happen. An example of such policies is a direct tax on paper currency, as proposed first by Gesell (Gesell, 1916) and discussed in detail by Goodfriend (2000) and Buiter and Panigirtzoglou (2003) or actions that increase the storage cost of money, such as eliminating high denomination bills. Another possibility is abolishing paper currency altogether. These policies are discussed in, among others, Agarwal and Kimball (2015), Rogoff (2017a) and Rogoff (2017c), who also suggest more elaborate policy regimes to circumvent the zero lower bound.[394]

During the latter half of the 2010s decade, which was quite disinflationary for consumer prices, these types of proposals were common in financial academic circles. In an era of low inflation, many policymakers actively explored how to create deeply negative inflation-adjusted interest rates, which from their perspective entailed going ever-deeper into negative nominal interest rates if needed, while trying to eliminate the various escape valves such as physical cash that people could shift toward if those types of policies were to be enacted.[395] Policymakers, in other words, continued to explore ways to give themselves more and more control over the public ledger.

In the 2020s decade, as higher inflation and higher interest rates have made a comeback, discussions of deeply negative interest rates have so far become less common. However, these proposals may return in future periods of notable disinflation if they should occur, since the desire for greater control of the ledger by policymakers is a recurring theme.

CBDCS: LAW ENFORCEMENT AUTOMATION

In 2020, venture capitalist and analyst Nic Carter made the argument on social media that if physical cash was invented today, it would be made illegal. In other words, it's a method of private transactions that we view as normal due to its long-term usage, but one that government agencies and central banks don't really like. Governments have spent decades crafting ever-tighter ways to observe and freeze various bank accounts and transactions, and physical cash represents the largest workaround that people can still use for private transactions within the current financial system.

Central bank digital currencies offer a pathway for central banks to phase out physical cash, and therefore eliminate the last vestige of transaction privacy that their ledgers offer. CBDCs can be surveilled and controlled by the issuer with much better granularity than physical cash can. The same is true for stablecoins.

In 2021, China began testing a central bank digital currency that 1) can more easily track or block transactions, 2) can set up expiration dates on money to ensure it is spent rather than saved, and 3) can automatically deduct money from or freeze accounts associated with individual entities. An April 2021 *Wall Street Journal* article called “China Creates Its Own Digital Currency, a First for Major Economy” summarized the topic well:

> The money itself is programmable. Beijing has tested expiration dates to encourage users to spend it quickly, for times when the economy needs a jump start.
>
> It’s also trackable, adding another tool to China’s heavy state surveillance. The government deploys hundreds of millions of facial-recognition cameras to monitor its population, sometimes using them to levy fines for activities such as jaywalking. A digital currency would make it possible to both mete out and collect fines as soon as an infraction was detected.[396]

Since then, several other countries have deployed central bank digital currencies, with Nigeria (a country of over 200 million people) being among the most notable. In autumn 2021, Nigeria launched its central bank digital currency, the eNaira, but a year later it still had an adoption rate within the country below 1%. In late 2022, the central bank began sharply limiting the availability of physical cash. Haruna Musafa, the director of Banking Supervision at the Central Bank of Nigeria wrote that customers “should be encouraged to use alternative channels (internet banking, mobile banking apps, USSD cards/POS, eNaira, etc.) to conduct their banking transactions.”[397]

Bloomberg covered this topic in a December 2022 article called “Nigeria Caps ATM Cash Withdrawals at $45 Daily to Push Digital Payments”:

> The Central Bank of Nigeria capped the maximum customer withdrawal at 20,000 naira ($44.97) a day, down from the previous limit of 150,000 naira, according to a circular sent to lenders on Tuesday. Weekly cash withdrawals from banks are restricted to 100,000 naira for individuals and 500,000 naira for corporations, and any amount above that limit will attract a fee of 5% and 10%, respectively, the central bank said.
>
> The action is the latest in a string of central bank orders aimed at limiting the use of cash and expand digital currencies to help improve access to banking. In Nigeria’s largely informal economy, cash outside banks represents 85% of currency in circulation and almost 40 million adults are without a bank account.[398]

As this kind of thing shows, physical cash is something that many central banks would prefer to take back if they can, and central bank digital currencies along with various other digital payment rails, offer methods to make that a reality. However, Nigeria's case study thus far shows the difficulty of doing so if the public is not in alignment with the attempt to do so. As of this writing, over a year and a half after the introduction of the eNaira, far more Nigerians use cryptocurrencies than use the eNaira, even though Nigeria has long since severed its banking system from cryptocurrency exchanges. Nigerians, being unable to send money from a bank to a cryptocurrency exchange, instead trade peer-to-peer to get access to the cryptocurrencies or other assets that they want.

That doesn't stop more central banks from entering the CBDC market. In early 2023, Russian pranksters posed as Ukrainian president Volodymyr Zelensky and managed to convince Jerome Powell and Christine Lagarde to separately take video calls with them — which they then recorded and released online.[399] In the call with Lagarde, who currently runs the European Central Bank, they asked her about upcoming plans for central bank digital currency, and what her response is to the idea that people don't like to be controlled. She responded with the following:

> Now we have in Europe this threshold: above 1,000 euros you cannot pay cash. If you do, you're on the gray market. So, you take your risk. You get caught: you are fined or you go in jail. You know, the digital euro is going to have a limited amount of control. There will be control, you're right, you're completely right. We are considering whether for very small amounts, you know, anything that is around 300 [or] 400 euros, we could have a mechanism where there is zero control. But that could be dangerous. The terrorist attacks on France ten years ago were entirely financed by those very small anonymous credit cards that you can recharge in total anonymity.[400]

First, Lagarde mentioned France's existing limit for cash payments, which is part of their effort to reduce cash usage but is somewhat hard to enforce. Several countries have laws limiting the amounts of cash that businesses can accept, and France has one of the lowest limits. Second, Lagarde referred to a terrorist attack from nearly a decade ago as a potential reason to disallow citizens from having any uncontrolled anonymous transactions whatsoever. Over the past fifty years, less than 0.001% of the French population has been killed in terrorist attacks, and yet it's her go-to reason for the importance of top-down centralized surveillance and control of all transactions in the country.

Throughout this book, I continually return to the question of "who controls the ledger?" when examining various financial systems and technologies.

It's clear that money is moving into an increasingly digital form over time. The creation of Bitcoin ushered in a new era, and its aim was to decentralize money and give control of the ledger back to the users. On the other hand, fiat currency systems have adopted aspects of this technology and are being digitized as well, in the form of central bank digital currencies. In contrast to Bitcoin, CBDCs empower the controllers of the ledger at the expense of the users, and therefore give central banks and state agencies the ability to control their ledger with even finer precision than they historically have been able to do. The technology of central bank digital currencies potentially allows central banks to phase out physical cash, which represents the last vestiges of private and censorship-resistant transactions within existing fiat currency systems.

If we envision an ideal form of money, we envision very different things depending on who we are and what we aim to do. From the perspective of a central bank or government agency, the ideal money is one that they have absolute control over. They want it to gradually devalue over time, be easily surveilled and programmable by the issuer, and able to be frozen by the issuer at will for reasons that they consider to be justified. Central bank digital currencies are being and will continue to be advertised as systems that make financial services more accessible to people and that give enhanced tools to law enforcement personnel to catch criminal activity. However, the very technology that enables those features also gives governments and corporations an enhanced ability to crush public dissent and control the lives of their citizens, which is relevant in a world where over half of the global population lives under authoritarian or semi-authoritarian regimes and where there are 160 different currency monopolies. From the perspective of an individual user, the ideal money is one that is resistant to debasement, that can't be easily seized or controlled by third parties, that offers enhancements to transactional privacy, and that is globally portable and globally accepted.

This era represents a fork in the road. One direction provides a stepwise upgrade to those who wish to continue the multi-century trend of further and further centralization of the financial system. The other direction reverses that trend, fractures the existing forces of centralization, and gives more financial autonomy back to individual users who wish to take it. Part 6, the final part in this book, explores the ethics of these two different directions.

[391] Agustín Carstens, “Cross-Border Payments—A Vision for the Future,” (24:12–25:06).

[392] Bank for International Settlements, “Project mBridge: Connecting Economies Through CBDC.”

[393] Ruchir Agarwal and Signe Krogstrup, “Cashing In: How to Make Negative Interest Rates Work.”

[394] Gauti Eggertsson et al., “Negative Nominal Interest Rates and the Bank Lending Channel,” 6.

[395] The main treatment and overview of this topic is Kenneth Rogoff, *The Curse of Cash*.

[396] James Areddy, “China Creates Its Own Digital Currency, a First for Major Economy,” *Wall Street Journal*, April 5, 2021.

[397] Alys Key, “Nigeria Limits Cash Withdrawals to $45 per Day in CBDC, Digital Banking Push,” *Yahoo! Finance*, December 7, 2022.

[398] Emele Onu and Anthony Osae-Brown, “Nigeria Caps ATM Cash Withdrawals at $45 Daily to Push Digital Payments,” *Bloomberg*. December 6, 2022.

[399] Forkast.News, “ECB’s Lagarde gets pranked, reveals digital euro will have ‘limited’ control,” *Yahoo! Finance*, April 7, 2023.

[400] For *Rumble* video, see Real Truth Real News, “Vovan and Lexus’ Pretend to Be Zelensky”, *Rumble*, April 2023, (16:34–17:25).

PART SIX

FINANCIAL TECHNOLOGY AND HUMAN RIGHTS

"This nation was founded by men of many nations and backgrounds. It was founded on the principle that all men are created equal, and that the rights of every man are diminished when the rights of one man are threatened. Today, we are committed to a worldwide struggle to promote and protect the rights of all who wish to be free."[401]

-John F. Kennedy

[401] John F. Kennedy, "Radio and Television Report to the American People on Civil Rights, June 11, 1963."

CHAPTER 28

THE DEGRADATION OF PRIVACY

As this book has already illustrated, the right to privacy is increasingly being challenged in the digital age.

Privacy used to be expensive to violate. Prior to the widespread usage of the internet, smartphones, surveillance cameras, and other technologies, the only way to violate someone's privacy was to physically spy on them, search their person, or search their property. And because of this, the person who had their privacy violated had a good chance of knowing that it was violated.

In the digital age, it's increasingly easy and inexpensive for governments, corporations, or individuals to violate someone's privacy, and without that person knowing. For governments and corporations, a combination of public and private information on billions of people can be harvested automatically on all the major financial and communication platforms. That data, once collected, can be organized by various Big Data techniques including machine learning, and algorithmically monitored or made easily searchable to users of the database. Centralized treasure troves of this data are frequently hacked and made available on the dark web as well.

The Fourth Amendment to the U.S. Constitution, as part of the Bill of Rights that was ratified in 1791, provides protection against unreasonable searches and seizures:

> The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable

> searches and seizures, shall not be violated, and no Warrants shall issue, but upon probable cause, supported by Oath or affirmation, and particularly describing the place to be searched, and the persons or things to be seized.[402]

The Universal Declaration of Human Rights, put forth by the United Nations in 1948, also lists privacy as a human right in Article 12:

> No one shall be subjected to arbitrary interference with his privacy, family, home or correspondence, nor to attacks upon his honour and reputation. Everyone has the right to the protection of the law against such interference or attacks.[403]

In practice, these rights are regularly ignored in the United States and many other countries around the world.

Humans have an instinct to not want to be watched. We close our curtains at night. We are bothered if a stranger looks at us for too long in public. Our restrooms have doors on them; our voting booths have curtains on them. We are rightly concerned about our own cameras or microphones being hacked, allowing someone to watch us or listen to us when we are unaware.

This extends into the natural desire for privacy of our possessions and information as well. It’s not necessarily that we don’t want *anyone* to know about these things; it’s that we want only people who have a need to know, to know. We don’t necessarily want to tell a stranger what our salary is, what medications we take, or what our sexual lives are like. But of course, we may reveal our salary in a job interview, we will freely talk about our medical issues and medications with our doctor, and we share our sexual lives with our partners.

If our privacy needs to be violated by legitimate authorities, then as both the Bill of Rights and the Declaration of Human Rights suggest, it shouldn’t be arbitrary or universal, but rather should be with some degree of probable cause, for a specific reason, and within the bounds of the rule of law.

Privacy is important in a free society but is even more critical in an unfree society. In unfree countries, someone who has the “wrong” political opinions, sexual life, or religious affiliation may face persecution by the government or other members of society even if what they are saying, what they are doing, or what they believe causes no direct harm to others. There will always be people who believe they know what the best way to live is, and that they somehow have the right to force others to live that way.

Unfortunately, as surveillance technology becomes more powerful over time, people can’t realistically ask their governments or corporations for privacy. The answer will be “no” and the reasons for that keep changing over time. In the United States, during the 1970s and 1980s the reason for why privacy had to be systemically violated was the war on drugs. In the 2000s the reason shifted toward the war on terror. In the 2020s the reason shifted toward the war on trafficking and alignment with enemy nation states. There will always be a reason presented as to why nobody can have privacy, to ensure that a small percentage of people don’t abuse it for criminal purposes.

Instead, if people want privacy, they must build powerful counter-technologies that allow people to retain some of their own privacy and force the laws and activities to reshape themselves around that new technological reality. Just like people build physical walls around their persons and their physical possessions, which require expending energy and legal effort to bypass, they must build digital walls around their digital data for the same purpose.

TRANSACTIONAL PRIVACY

The right to privacy naturally includes transactional privacy. If a government, corporation, or individual acquires a full history of your transactions, then they learn pretty much all they could possibly want to know about you. And if someone can track your transactions in real time, then by extension they can generally track your physical location in real time.

When we look back at the types of money described in this book, several of them offered their users decent levels of transactional privacy, and that has generally been the norm for thousands of years. Bearer asset money in the form of precious metal coins and physical banknotes are quite naturally private. They were (and for banknotes still are) used for physical exchange between parties in a transaction, with no third party or observer able to keep track of the changes in the ledger. The “state of the ledger” of these bearer assets is maintained by possession, and no single entity (including the issuer, in the case of banknotes) can observe the full ongoing state of the ledger.

However, with the rise of telecommunication systems and the regular use of bank deposits for savings, the default state of financial privacy decreased substantially. The administrator of a bank ledger can easily keep track of how much money you have, where you are sending it to, and where you are receiving it from. And as a natural consequence of this, governments can ask the banks to hand over that data on a regular basis. Plus, a monetary policy that promotes persistent inflation encourages people to seek out interest to keep up with that inflation, which means it inherently disincentives the holding of physical cash and incentivizes the use of fractionally reserved and highly surveilled bank deposits.

The 1970 Bank Secrecy Act, enacted into law by the U.S. government and still in effect, compels banks to file reports with the government if a customer's daily transactions exceed $10,000.

When this law was enacted in 1970, the median American annual income was less than $10,000. Therefore, the law only covered rather large sums of money moving within a day — worth well over $80,000 in today's weaker dollars. However, there was no inflation adjustment embedded into the law. As the value of the dollar eroded over time, banks effectively had to file reports regarding smaller and smaller levels of transactions, since $10,000 worth of transactions occurring in a day became more and more commonplace. Every year, the government effectively lowered the threshold regarding its financial surveillance, simply through inflation, without passing further legislation.

Over the next fifty years, if the rate of inflation averages the same amount it has over the past fifty years, then the reporting threshold will shrink by another 8x or so in terms of purchasing power. When the law was enacted, the government granted itself the ability to keep tabs on house-sized transactions. Over time, inflation enhanced the law so that they can keep track of transactions the size of used cars. If this keeps up, it will enable them to keep track of transactions the size of lawnmowers or bicycles.

Similar reporting requirements exist in other countries as well. And as described in later sections of this chapter, intelligence agencies can and do investigate all manner of information even below these types of thresholds, with or without probable cause. And realistically, small transactions are already monitored at a very granular scale by the banks themselves.

Governments also do their best to apply these restrictions to other ledgers as well. Starting on the first day of January 2020, for example, Germany's government lowered the threshold on how much physical precious metals may be purchased by an individual without doing an identity check from 10,000 euros to only 2,000 euros worth of gold — ostensibly to combat money laundering. Germans can buy all sorts of things for over 2,000 euros without showing identification, but not gold. In late 2019, leading up to this change, there were long lines of people queuing at bullion shops to purchase precious metals with privacy before the tighter identification thresholds went into effect.

Similarly, during the past decade France banned cash transactions over 1,000 euros. The stated goal was to combat terrorist financing and money laundering. Several other countries have similar restrictions on cash.

THE 1980S PAGER SAGA

Criminals naturally make use of emerging technologies when available to them. In the 1980s for example, drug dealers began making extensive use of pagers to evade law enforcement. Pagers, however, were of course also used legitimately by doctors, lawyers, journalists, delivery workers, and others. A 1988 *Washington Post* article called "Message is Out on Beepers" opened with the following description:

> When a drug dealer is in trouble, he sometimes dials 911. But he isn't trying to reach the police.
>
> Instead, this message is sent to a drug courier wearing a beeper that displays messages dialed from a phone: 911 means the police are closing in.
>
> Although paging devices, or beepers, have grown in popularity throughout the labor force — doctors, delivery people and journalists often use them — they also have become a staple in the drug business, posing fresh problems for law enforcement and threatening to tarnish the image of a booming high-tech industry.[404]

The article went on to describe various techniques that were used to try to filter out illicit use of pagers. Credit checks were extensively used on purchasers of pagers, even when paying in cash, to try to reduce them getting into the hands of criminals. It also described how the American Civil Liberties Union pushed back on the potential for overreach by authorities in their attempt to determine who can access pagers and who cannot.

It seems quaint today, given how far technology has progressed since then, but this is an example of how any technology can be used for good or ill, especially when it is new. Public debates then begin to occur regarding how access to the technology may be restricted to maintain its benefits while reducing the instances of it falling into the wrong hands. The outcome, time and time again, is that it's very hard to globally and permanently suppress the proliferation of new technology, and most powerful technologies can be used for both good and evil.

Today, as most of us have mobile access to the internet, the idea of limiting pager use seems silly. It's such a low level of technology compared to what is accessible for 90% of the world today.

SURVEILLANCE CAPITALISM

A big trend throughout the 2000s and 2010s decades involved monetizing user data. Various companies would offer “free” services to users, but the real cost for that service was that they would collect and then either directly use or sell user data. The primary purpose of this business model is to target ads toward a person based on their online activity, which is very lucrative. A user gained various services, but the hidden cost was the loss of most of their privacy to large corporations.

Alphabet’s data collection capabilities are particularly noteworthy. With their main Google website, by far the most-used search engine in the world, they can track your search history. With Chrome, the most-used browser in the world, they can track where you go online. If you upload a document to their cloud, they can scan it and determine if it violates their terms of service. If you use Gmail, they can scan your email history and real-time communications. If you have an Android-based phone, especially if you don’t have certain privacy settings enabled, they can track your location, your app usage, and other fine details. Imagine the amount of information that people have given to one corporation — the ability to read their emails, documents, search history, what websites they go to, their app usage, and perhaps their real-time physical location.[405]

Nearly a decade ago when all of this was newer, I remember when I happened to be looking at my neighborhood on Google Maps and was surprised to see a note on a building saying that I had a dentist appointment there next week. I thought for a moment and realized that Google’s software must have read (and understood) my dentist’s email confirmation and then shared that information across their platforms.

In addition to monetizing data of free users, many products use data to try to be more convenient. Alexa and Siri, for example, listen to your voice to help you. But by extension, it means you’ve literally wiretapped your home for Amazon and Apple, which are among the largest corporations in the world. People trust their security systems as well. They install various outward-facing cameras, and often have cameras on their inside keypad. This information generally goes into a cloud service and runs through servers maintained by the largest corporations in the world.

If you merely walk down the street, chances are you are appearing on multiple cameras, with the data being uploaded to the cloud in real time. In a residential area, it will consist of a lot of doorbell cameras and other outward-facing cameras. In an urban area, it will also consist of various crime-prevention surveillance systems.

COUNTLESS DATA BREACHES

Unfortunately, data breaches occur all the time these days, against governments, corporations, and individuals. Ultimately, most of this ends up affecting individuals. People who trust government and corporate servers to safely store their data are very likely to be let down.

In 2013, three billion Yahoo email accounts were exposed to a data breach, and it went unknown to most people for years. In addition to the hackers being able to access the email accounts of people, other forms of information including names, dates of birth, phone numbers, security questions, and passwords of many accounts were leaked.

In 2014, eBay was breached, resulting in the public dissemination of information on 145 million people. The breached information included names, email addresses, physical addresses, phone numbers, and dates of birth.

In 2015, the U.S. Office of Personal Management experienced one of the biggest data breaches in U.S. federal government history. Over 22 million individuals, most of whom were government employees, contractors, or who had applied to those types of jobs, had personally sensitive information leaked including social security numbers, names, dates and places of birth, salary histories, health insurance information, and home addresses. For millions of them, this went further into background checks for security clearances, including full psychological profiles, information on family members and friends, and fingerprints.

In 2016, the adult social networking site, Adult Friend Finder, experienced a data breach involving 412 million accounts across several different databases (since they owned several other adult content sites as well). This data included deleted accounts and stretched back through two decades of account history. It included names, emails, and passwords, as well as the simple fact that the leaked people had accounts at these types of adult sites.

In 2017, one of the three main U.S. credit bureaus, Equifax, experienced a data breach that affected 148 million Americans plus several million Britons. The information included names, social security numbers, physical addresses, and in some cases driver’s license numbers. Most users didn’t opt in or otherwise use Equifax as a service; Equifax and other credit bureaus collect information on people whether they want them to or not. Most people can’t even name the three credit bureaus (Equifax, Experian, and TransUnion) and yet those organizations maintain massive personal and financial databases on people anyway. Our financial system with ever-devaluing currency revolves almost entirely around access to credit, and these oligopolistic entities sit near the heart of the system gathering as much information as possible for that system to function.

In 2018, India’s Aadhaar database was breached. This is one of the largest identification databases in the world, with information on more than one billion individuals. The information included names, photos, physical addresses, phone numbers, email addresses, iris scans, fingerprints, and even certain bank account information.

Also in 2018, the database of Marriott and their broad range of hotel brands was breached. Marriott is the largest hotel corporation in the world, and they own many hotel chains that don’t even carry the Marriott name. The information for millions of people included names, physical addresses, phone numbers, email addresses, passport numbers, dates of birth, reservation history, and credit card information.

In 2019, Capital One was breached by a former Amazon employee, who leaked the information online. With data related to customer accounts and credit card applications stretching back to 2005, approximately 100 million people had their data leaked, including names, physical addresses, email addresses, credit scores, account balances, and social security numbers.

In 2021, a Brazilian database was breached, resulting in a leak of personal information for virtually everyone in Brazil (well over 200 million people). The information included names, tax identification numbers, physical addresses, email addresses, phone numbers, credit scores, facial images, salary information, and more.

These data breaches are just the tip of the iceberg, and just happen to be some of the more notable ones. Most large corporations, ranging from Home Depot, to Microsoft, to J.P. Morgan Chase, to Meta Platforms, and others have experienced significant data breaches regarding user data at some point in their history. Most readers of this book have likely been the victim of numerous data breaches over the past decade, including several that they aren't even aware of.

THE SNOWDEN REVELATION

In 2013, a now well-known U.S. National Security Agency contractor named Edward Snowden leaked information to journalists that revealed that the NSA's surveillance capabilities extended far beyond what was previously known to the public. Specifically, the NSA was revealed to be able to directly tap into the systems of major telecommunication providers and large corporate software platforms to harvest information. In one of the original reports, the *Guardian* revealed:

> A chart prepared by the NSA, contained within the top-secret document obtained by the Guardian, underscores the breadth of the data it is able to obtain: email, video and voice chat, videos, photos, voice-over-IP (Skype, for example) chats, file transfers, social networking details, and more.
>
> The document is recent, dating to April 2013. Such a leak is extremely rare in the history of the NSA, which prides itself on maintaining a high level of secrecy.
>
> The Prism program allows the NSA, the world's largest surveillance organisation, to obtain targeted communications without having to request them from the service providers and without having to obtain individual court orders.
>
> With this program, the NSA is able to reach directly into the servers of the participating companies and obtain both stored communications as well as perform real-time collection on targeted users.[406]

The secretive set of programs had certain theoretical legal limitations (e.g., they were "supposed" to only target foreign individuals), but there was essentially no significant protection of American users. Legal decisions for the program were made in secret courts and were not previously known to the public, which prior to the leak gave the public virtually no way to push back or question the nature of these programs. A decade later here in 2023, these types of programs continue to exist in myriad forms in the United States and around the world.

THE PROLIFERATION OF CLIENT-SIDE SURVEILLANCE

In 2016, a sophisticated suite of mobile phone spyware called Pegasus was discovered. Ahmed Mansoor, an Emirati human rights activist was sent a text message about secrets regarding torture in UAE prisons. Rather than clicking on the link, he sent it for analysis to the University of Toronto's Citizen Lab, and they determined that if he had clicked the link, it would have infected his phone with this spyware.[407]

Mansoor had at the time been a public human rights activist for many years, critical of UAE heads of state. He had faced numerous attempts to silence him including arrest. Later in 2017, he was indeed arrested again for his ongoing peaceful protests for supposedly spreading false information, harming the reputation of the UAE heads of state, and inciting strife. For this activism, he was sentenced to a decade in prison. During this time, he has gone on numerous hunger strikes to protest years of solitary confinement, lack of medical support, and poor physical treatment.[408]

Pegasus is spyware that can be covertly installed on phones and used to spy on a target. Rather than making use of one exploit, it makes use of many different exploits, and can affect different phones in different ways. It is capable of one-click downloads (e.g., by tricking someone to click on a single malicious link) or even zero-click downloads in some cases, where the target doesn't even have to click something malicious for the software to be remotely downloaded and installed onto their phone. Once installed, the spyware can look through contacts, call logs, text messages, photos, browsing history, location data, and various apps including email and various messengers. It is also capable of tapping into the phone's microphone and camera without the user knowing.

The spyware was developed by an Israeli cyber-intelligence firm called NSO Group with the supposed use-case of monitoring terrorists and other criminals. However, it has been widely and repeatedly documented by global media for its extensive use by authoritarian governments on journalists and human rights activists.

For example, in 2021, Citizen Lab reported that nine Bahraini activists had been successfully exploited by Pegasus software, including three members of the Bahrain Center for Human Rights and two exiled dissidents.[409]

Freedom House, a nonprofit organization that advocates for democracy around the world, ranks Bahrain near the bottom of their country list in terms of freedom rankings. Their summary regarding the state of human rights in Bahrain is as follows:

> Bahrain's Sunni-led monarchy dominates state institutions, and elections for the lower house of parliament are neither competitive nor inclusive. Since violently crushing a popular prodemocracy protest movement in 2011, the authorities have systematically eliminated a broad range of political

> rights and civil liberties, dismantled the political opposition, and cracked down on persistent dissent concentrated among the Shiite population.[410]

In 2022, Citizen Lab reported that over thirty Thai activists, lawyers, and academics, many of whom were involved in pro-democracy movements, had their phones infected by Pegasus.[411]

Freedom House ranks Thailand relatively low on its freedom rankings, and summarizes:

> Following five years of military dictatorship, Thailand transitioned to a military-dominated, semielected government in 2019. The combination of democratic deterioration and frustrations over the role of the monarchy in Thailand's governance has since triggered massive demonstrations. In response, the regime continues to employ authoritarian tactics, including arbitrary arrests, intimidation, lèse-majesté charges, and harassment of activists. Press freedom is constrained, due process is not guaranteed, and there is impunity for crimes committed against activists.[412]

Citizen Lab also reported that Pegasus was extensively used against El Salvadorian journalists, including many who had been critical of the country's presidential administration.[413]

In 2021, journalist investigations found evidence of widespread usage of Pegasus by Hungary's government on its domestic opposition. They also reported that Hungary had fallen from 23rd to 92nd in the World Press Freedom Index during the period of 2010 (when Viktor Orbán became prime minister) through 2021.[414]

Pegasus has also been found on the phones of activists in Uganda, Rwanda, Panama, Morocco, and people in dozens of other countries that are too exhaustive to list here. It is frequently deployed against political opposition, pro-democracy advocates, human rights advocates, and as a foreign espionage tool against politicians of other countries. While it has been deployed against actual criminals as well, these examples show how surveillance and control technologies that are ostensibly meant for use against dangerous individuals or groups can easily be turned toward peaceful individuals or groups by state actors that find such opposition or activism to be inconvenient.

Concerningly, this spyware has also been deployed by governments in relatively free countries as well. A joint investigation by the *Guardian* and *El País* in 2020 found extensive use of Pegasus by Spanish intelligence on Catalonian separatists, including the active president of the Catalonian regional parliament at the time.[415]

Freedom House assigns quite high rankings to Spain:

> Spain's parliamentary system features competitive multiparty elections and peaceful transfers of power between rival parties. The rule of law prevails, and civil liberties are generally respected. Although political corruption remains a concern, high-ranking politicians and other powerful figures have been successfully prosecuted. Restrictive legislation adopted or enforced in recent years poses a threat to otherwise robust freedoms of expression and assembly. A persistent separatist movement in Catalonia represents the leading challenge to the country's constitutional system and territorial integrity.[416]

In late 2021, it was reported across major media outlets that Pegasus had been used by the Polish government, under the leadership of the Law and Justice Party, against their political opponents.[417]

Freedom House assigns moderately high rankings to Poland, and summarizes:

> Poland's democratic institutions took root at the start of its transition from communist rule in 1989. Rapid economic growth and other societal changes have benefited some segments of the population more than others, contributing to a deep divide between liberal, pro-European parties and those purporting to defend national interests and "traditional" Polish Catholic values. Since taking power in 2015, a coalition led by the populist, socially conservative Law and Justice (PiS) party has exerted significant political influence over state institutions and damaged Poland's democratic progress. Recent years have seen an increase in nationalist and discriminatory rhetoric.[418]

A 2021 Associated Press report titled "Probe: Journalists, Activists Among Firm's Spyware Targets" summarized the scale of Pegasus use:

> An investigation by a global media consortium based on leaked targeting data provides further evidence that military-grade malware from Israel-based NSO Group, the world's most infamous hacker-for-hire outfit, is being used to spy on journalists, human rights activists and political dissidents.[419]

The AP's report went on to describe the extent of surveillance that was found from a rather small sample of phone numbers:

> From a list of more than 50,000 cellphone numbers obtained by the Paris-based journalism nonprofit Forbidden Stories and the human rights group Amnesty International and shared with 16 news organizations, journalists were able to identify more than 1,000 individuals in 50 countries who were allegedly selected by NSO clients for potential surveillance.
>
> They include 189 journalists, more than 600 politicians and government officials, at least 65 business executives, 85 human rights activists and several heads of state, according to The Washington Post, a consortium member. The journalists work for organizations including The Associated Press, Reuters, CNN, The Wall Street Journal, Le Monde and The Financial Times.
>
> Amnesty also reported that its forensic researchers had determined that NSO Group's flagship Pegasus spyware was successfully installed on the phone of Post journalist Jamal Khashoggi's fiancee, Hatice Cengiz, just four days after he was killed in the Saudi Consulate in Istanbul in 2018. The company had previously been implicated in other spying on Khashoggi.[420]

CHINA'S SURVEILLANCE EXPORTATION

In 2013, China launched the Belt and Road Initiative, which is a global infrastructure development strategy that China is using to place their economy at the heart of a vast trade network.

In many ways, they are replicating some of the same neocolonialist monetary practices that the United States, the United Kingdom, France, and prior world powers have been doing throughout the developing world since the mid-20th century. China provides loans to developing countries and helps them build out their infrastructure, but at the cost of giving the Chinese government considerable political and economic influence over them.

In addition to being rather prolific in their infrastructure projects, Chinese companies are competitive producers of electronic systems and artificial intelligence, and this is a central feature of their Belt and Road Initiative. Domestically, China is well-known for having an extensive authoritarian surveillance and control apparatus, including facial recognition systems, various restrictions on movement via QR codes, an extensive social credit system, and the capability of performing automatic bank account freezes. However, as part of the Belt and Road initiative, China has also become the world's largest exporter of surveillance equipment and systems, surpassing the United States in that regard.

This is concerning, considering that this is how Freedom House summarized China's state of freedom in 2023:

> China's authoritarian regime has become increasingly repressive in recent years. The ruling Chinese Communist Party (CCP) continues to tighten control over all aspects of life and governance, including the state bureaucracy, the media, online speech, religious practice, universities, businesses, and civil society associations. The CCP leader and state president, Xi Jinping, secured a third term as party leader in October 2022, further consolidating personal power to a degree not seen in China for decades. Following a multiyear crackdown on political dissent, independent nongovernmental organizations (NGOs), and human rights defenders, China's civil society has been largely decimated.[421]

In 2019, Steven Feldstein of the Carnegie Endowment for International Peace published a paper titled "The Global Expansion of AI Surveillance." Among many other points, the report described the world's increasing usage of AI-powered surveillance technology, led by Chinese development:

> AI surveillance technology is spreading at a faster rate to a wider range of countries than experts have commonly understood. At least seventy-five out of 176 countries globally are actively using AI technologies for surveillance purposes. This includes: smart city/safe city platforms (fifty-six

> countries), facial recognition systems (sixty-four countries), and smart policing (fifty-two countries).
>
> China is a major driver of AI surveillance worldwide. Technology linked to Chinese companies—particularly Huawei, Hikvision, Dahua, and ZTE—supply AI surveillance technology in sixty-three countries, thirty-six of which have signed onto China's Belt and Road Initiative (BRI). Huawei alone is responsible for providing AI surveillance technology to at least fifty countries worldwide.[422]

The numbers are likely much larger now as of this writing, given how quickly this technology has been improving. The paper described that the technology is extensively used by both democratic and authoritarian countries, but that authoritarian countries tend to abuse the usage of the data more. It also described how China finances or subsidizes the use of the equipment for many countries that would otherwise have difficulty affording it. As the paper put it:

> Chinese product pitches are often accompanied by soft loans to encourage governments to purchase their equipment. These tactics are particularly relevant in countries like Kenya, Laos, Mongolia, Uganda, and Uzbekistan—which otherwise might not access this technology. This raises troubling questions about the extent to which the Chinese government is subsidizing the purchase of advanced repressive technology.[423]

In 2022, a report by Bulelani Jili of the Atlantic Council titled "China's Surveillance Ecosystem & the Global Spread of its Tools" explored the topic in similar detail. As the report's executive summary described:

> This paper seeks to offer insights into how China's domestic surveillance market and cyber capability ecosystem operate, especially given the limited number of systematic studies that have analyzed its industry objectives. For the Chinese government, investment in surveillance technologies advances both its ambitions of becoming a global technology leader as well as its means of domestic social control. These developments also foster further collaboration between state security actors and private tech firms. Accordingly, the tech firms that support state cyber capabilities range from small cyber research startups to leading global tech enterprises. The state promotes surveillance technology and practices abroad through diplomatic exchanges, law enforcement cooperation, and training programs. These efforts encourage the dissemination of surveillance devices, but also support the government's goals concerning international norm-making in multilateral and regional institutions.
>
> The proliferation of Chinese surveillance technology and cyber tools and the associated linkages between both state and private Chinese entities with those in other states, especially in the Global South, is a valuable component of Chinese state efforts to expand and strengthen their political and economic influence worldwide. Although individual governments purchasing Chinese digital tools have their local ambitions in mind, Beijing's export and promotion of domestic surveillance technologies shape the adoption of these tools in the Global South. As such, investigating how Chinese actors leverage demand factors for their own aims, does not undercut the ability of other countries to detect and determine outcomes. Rather it demonstrates an interplay between Chinese state strategy and local political environments.[424]

This technology tends to spread very efficiently because countries don't have to re-create the technology on their own; a handful of major technology exporters and trading partners including China, the United States, and a few others can supply all of them. It is “surveillance as a service.”

THE SURVEILLANCE AND CONTROL MINDSET

Extensive government surveillance, especially when used in automatic and ubiquitous ways rather than targeted ways based on probable cause, is implicitly based on the premise that everyone must give up most or all their privacy to central authorities to ensure that nothing bad happens. Because people are generally not very quantitative in nature, and instead tend to be more responsive to emotional arguments, most people go along with such intrusions.

For example, over the past several decades less than 0.05% of global deaths have been from terrorism.[425] In most countries outside of the Middle East and Africa, the percentage is lower than 0.01%. That means fewer than one in ten thousand people die from terrorism in most countries. And yet, countless laws are shaped around granting governments additional powers to prevent terrorism.

The 2001 Patriot Act was an example of legislation that gave more power for government surveillance and control techniques to prevent terrorism, and it was received well at the time because it came shortly after the infamous 9/11 terrorist attacks. With this type of legislation, people hand over a part of their privacy, indefinitely, during the peak of an emotional response to a recent event. Decade after decade, event after event, this centralizing tendency chips away at individual rights to privacy and begins to shape culture to align with the idea that people who want privacy must be up to something bad.

In a free and open society, there is generally debate and pushback around priorities, and an arms race between criminals and law enforcement. Naturally, we want terrorists, human traffickers, violent street criminals, mob members, murderers, thieves, fraudsters, and other dangerous individuals to be caught and prosecuted, and therefore most people happily provide resources to law enforcement to achieve those ends. However, the procedures and technologies used by law enforcement to catch dangerous criminals can also be used by governments to suppress speech, surveil human rights activists and pro-democracy activists and political opponents, and maintain authoritarian control over their subjects — which is why it’s important to have limitations on their powers. As previously described, military-grade spyware that is ostensibly meant for use against terrorists and dangerous criminals is also heavily used against human rights activists, pro-democracy activists, and political opposition by authoritarian (and even non-authoritarian) governments.

Whenever given the opportunity, governments around the world frequently grant themselves crisis powers, and then extend some, or all, of those powers indefinitely. Only in countries with a deep culture of respecting individual liberty, democracy, and government accountability, has there generally been enough societal pushback to elect leaders that dismantle prior powers and actively decrease government overreach.

PUTTING IT ALL TOGETHER

In the modern era, people should assume that virtually all information about them is collected into corporate databases, that their government can access the databases, and that the databases are vulnerable to external breaches by non-state or foreign-state hackers or inside leakers. It is most likely the case that your sensitive personal data has been leaked multiple times on the dark web, and that your personal data is easily accessible to intelligence analysts as part of their surveillance apparatus.

With additional time and financing, as well as advancements in processing power and software development, surveillance technology deployed by governments and corporations is likely to become even more commonplace, and with ever-greater abilities to gather and organize data from digital and physical environments. Even now, journalists, peaceful activists, and anyone considered a nuisance by their government, should be cautious by assuming that their phone and computer have already been infiltrated by military-grade spyware such as Pegasus.

In addition, as a prior chapter on central bank digital currencies discussed, governments can give themselves increasing levels of programmability for their national currencies. With CBDCs they could tailor different monetary policies for different groups, automatically freeze accounts associated with certain people, and could program someone’s money to shut off for certain categories or in certain geographies.

With or without CBDCs specifically, the combination of widespread surveillance hardware, machine learning systems connected to massive amounts of collected data, and controllable bank accounts and currency, means that protestors in a crowd can automatically have their faces recognized and their financial accounts frozen if authorities want to, for example.

When everything is put together, it can lead to a rather Orwellian outcome. What may sound like a dystopian science fiction movie could become an increasing reality in many jurisdictions, especially jurisdictions of the more authoritarian variety. In a handful of jurisdictions such as China, there are already elements of this in place currently. Imagine getting automated messages like these:

> "Due to your concerning online activity over the past month, your social credit score has dropped below the minimally acceptable threshold. Until further notice, your transactional ability has been reduced to within five miles of your residence, and only for essential goods and services."

> "Your monthly C02 quota has been reached. Until the end of the month, your transactional ability to purchase meat, airplane tickets, or other carbon-intensive goods and services will be declined. Here is a website with helpful guidance on how to reduce your carbon footprint so that you may ration it more appropriately next month."

> "Due to recent disruptive protests in your region, all bank accounts and payment methods of those who have been surveilled or suspected to be involved will be suspended for the next 72 hours. Please return to your home and await further instructions."

> "Our enemies are attacking our currency. It is in all citizens' interest to support the currency and national banking system. Therefore, all purchases of foreign currency, precious metals, cryptocurrencies, and similar assets will be automatically blocked until further notice."

These quotes may seem far-fetched to readers in liberal democracies, but the loss of privacy in the digital age combined with the gradual rise of autocracies globally and the fine-tuned programmability of central bank digital currencies and bank accounts generally, is a concerning development that is hard to overstate. Whether one is on the right or left on the political spectrum, one merely must imagine one of their least favorite politicians gaining control over these types of systems. What is first applied to the fringes can easily be applied to the masses. Even jurisdictions with the strongest rules of law and property rights may buckle under these pressures (and indeed already have done so to varying degrees) while jurisdictions with the weakest rules of law and property rights can be entirely captured.

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CHAPTER 29

ASYMMETRIC DEFENSE

The prior chapter discussed the risks associated with the reduction or elimination of social and financial privacy. Corporations and governments alike can collect user data into massive databases, which can be abused by them and are also ripe for hacking. The combination of automated data collection, machine learning, and government control of the financial system is very centralizing in terms of power structures and can allow governments to deploy various social control techniques on their populations.

This chapter discusses some of the defenses or pushbacks on that type of intrusion, mainly in the form of encryption.

Some technologies are inherently centralizing, while others are inherently decentralizing. An example of a decentralizing technology was the printing press. It was a necessary ingredient for the Protestant Reformation, the American Revolution, the French Revolution, and all sorts of major changes to society. It enabled large countries to shift their governance models from theocracy and monarchy toward democracy, since it enabled the inexpensive distribution of information and ideas over long distances.

Prior to the invention of the printing press, books had to be copied by hand. It was a labor-intensive (and therefore expensive) process. Written information was expensive, literacy rates were low, and therefore information was highly centralized. In terms of Christianity, people were not expected to have their own

Bibles or interpret the contents for themselves; the church priests had the expensive Bibles and interpreted them for their churchgoers. After the invention of the printing press, it became much cheaper to reproduce books, pamphlets, and other writings. A person could more easily own or access a copy of the Bible, interpret it for themselves, and then mass-produce and distribute pamphlets articulating their views. Similarly, a person could more easily spread political pamphlets against rulers in charge of their society and organize the public around a set of new ideas or grievances. Or a person could write and distribute stories that inspire new ideas and shape the culture around them.[426]

Encryption is a newer decentralizing force and an asymmetric defense because it is cheap to deploy but expensive to attack. The top encryption methods today cannot be broken even by the best supercomputers. No matter how many billions of dollars that governments and corporations use to try to break strong encryption, they can’t do it. And as computers get stronger at breaking earlier encryption methods, new and more powerful encryption methods arise. A physical analogy for this is that encryption is like a bunker that can’t be destroyed by any bomb currently in existence, no matter how powerful.

Instead, authorities must go around encryption. If people are sending encrypted messages to each other or transferring encrypted value to each other, and the government wants to stop or surveil that, it must be done by spyware on the device before it is encrypted, or by physical force on the person, and both of those are expensive to do on an individual level and able to be defended against in various ways. Encryption, therefore, is a method of making it expensive to violate someone’s privacy in the digital age, like it used to be expensive to violate someone’s privacy in the physical age.

A CYPHERPUNK’S MANIFESTO

Dystopian science fiction books have been written and read for the better part of the past century. With the rise of the internet in the 1980s and 1990s, along with the digitization of money, many technology-focused people began to raise concerns regarding how this technology could be used in oppressive ways and how tools need to be developed to push back on those types of oppressive technologies. These individuals, often known as “cypherpunks,” specifically advocate the usage of encryption as one of the main tools toward these ends.

Eric Hughes began his famous 1993 essay “A Cypherpunk’s Manifesto” with a statement on how privacy differs from secrecy:

> Privacy is necessary for an open society in the electronic age. Privacy is not secrecy. A private matter is something one doesn't want the whole world to know, but a secret matter is something one doesn't want anybody to know. Privacy is the power to selectively reveal oneself to the world.[427]

Further in the essay, he went on to elaborate about how private transactions are necessary, and how encrypted digital messages are critical:

> Since we desire privacy, we must ensure that each party to a transaction have knowledge only of that which is directly necessary for that transaction. Since any information can be spoken of, we must ensure that we reveal as little as possible. In most cases personal identity is not salient. When I purchase a magazine at a store and hand cash to the clerk, there is no need to know who I am. When I ask my electronic mail provider to send and receive messages, my provider need not know to whom I am speaking or what I am saying or what others are saying to me; my provider only need know how to get the message there and how much I owe them in fees. When my identity is revealed by the underlying mechanism of the transaction, I have no privacy. I cannot here selectively reveal myself; I must always reveal myself.
>
> Therefore, privacy in an open society requires anonymous transaction systems. Until now, cash has been the primary such system. An anonymous transaction system is not a secret transaction system. An anonymous system empowers individuals to reveal their identity when desired and only when desired; this is the essence of privacy.
>
> Privacy in an open society also requires cryptography. If I say something, I want it heard only by those for whom I intend it. If the content of my speech is available to the world, I have no privacy. To encrypt is to indicate the desire for privacy, and to encrypt with weak cryptography is to indicate not too much desire for privacy. Furthermore, to reveal one's identity with assurance when the default is anonymity requires the cryptographic signature.

In another segment of the essay, he correctly predicted that governments and corporations would not freely offer or advance the nature of privacy. If people want privacy, they need to build and deploy privacy-focused systems:

> We cannot expect governments, corporations, or other large, faceless organizations to grant us privacy out of their beneficence. It is to their advantage to speak of us, and we should expect that they will speak. To try to prevent their speech is to fight against the realities of information. Information does not just want to be free, it longs to be free. Information expands to fill the available storage space. Information is Rumor's younger, stronger cousin; Information is fleeter of foot, has more eyes, knows more, and understands less than Rumor.
>
> We must defend our own privacy if we expect to have any. We must come together and create systems which allow anonymous transactions to take place. People have been defending their own privacy for centuries with whispers, darkness, envelopes, closed doors, secret handshakes, and couriers. The technologies of the past did not allow for strong privacy, but electronic technologies do.
>
> We the Cypherpunks are dedicated to building anonymous systems. We are defending our privacy with cryptography, with anonymous mail forwarding systems, with digital signatures, and with electronic money.
>
> Cypherpunks write code. We know that someone has to write software to defend privacy, and since we can't get privacy unless we all do, we're going to write it. We publish our code so that our fellow

> Cypherpunks may practice and play with it. Our code is free for all to use, worldwide. We don't much care if you don't approve of the software we write. We know that software can't be destroyed and that a widely dispersed system can't be shut down.
>
> Cypherpunks deplore regulations on cryptography, for encryption is fundamentally a private act. The act of encryption, in fact, removes information from the public realm. Even laws against cryptography reach only so far as a nation's border and the arm of its violence. Cryptography will ineluctably spread over the whole globe, and with it the anonymous transactions systems that it makes possible.[428]

The full essay was short and powerful and remains as relevant in the 2020s as it was in the 1990s. The open-source cryptographic creation of natively digital methods in 2008 to transfer value, fifteen years after the essay was written, in many ways revitalizes its contents and makes it worth reading and contemplating all over again.

One way to conceptualize this is to realize the importance of real-world institutions and then see why protocols serve the role of digital institutions. What allows some countries to persist as democracies and others to repeatedly degrade into autocracies, is the presence of independent institutions and checks on power, or the lack thereof.

In the United States, for example, we have a constitution at the base layer and then three branches of government with defined rules on how they interact with each other. It's not a perfect system, but it has done reasonably well and lasted for centuries through all types of different presidents and technological eras. If democracy relies on always having the right people in power, then it's destined to fail quickly. Institutions such as separate branches of government and founding documents that are held higher than any individual are what give the democratic system a degree of staying power. Strong and independent institutions make it so that for democracy to be lost, it requires a long period of chipping away at it rather than just one bad election.

Similarly, protocols that enhance the sharing of speech or value can be described as digital institutions. They provide a check on centralized power, or an information backbone that, while not invincible, provides a degree of persistence beyond what one powerful entity says things should be like at the time.

THE LEGAL PRECEDENT FOR CODE AS SPEECH

In 1991, a computer scientist and cryptographer named Phil Zimmermann created a program called "Pretty Good Privacy" or PGP for short. He published the open-source code, and it became the first widely available implementation of public-key cryptography that could be used by the public for ensuring that online messages were private between the sender and the receiver.

In 1993, the U.S. federal government began a criminal investigation against Zimmermann for allegedly violating the Arms Export Control Act. The government considered software encryption to be a form of munitions, and they considered Zimmermann's code being shared freely to be a form of munitions export.

In 1995, Zimmermann responded by publishing a book via MIT Press called *PGP Source Code and Internals*, which contained the full source code of his program. The reasoning was that although his code could supposedly be suppressed via the Arms Export Control Act as a munition, if he publishes it in a book then it is protected by the First Amendment to the U.S. Constitution, which grants freedom of speech and overrides lesser laws that would interfere with freedom of speech. Software code is merely a collection of words and numbers, and in this case, it was a defensive technology rather than one that could directly harm others.

Similar techniques were used for other types of encryption proponents. People would even put encryption-related code on t-shirts and wear them around, with warnings displayed on the shirts indicating that these shirts are classified as munitions and may not be exported. These sorts of protests 1) used some of the more foundational laws like the First Amendment in their favor, and 2) generally showed the absurdity of restricting information by taking such restrictions on information to their logical conclusions, since they imply the existence of so-called dangerous t-shirts. Some technologies, especially ones that consist entirely of software that can be written in a book or on a t-shirt, spread easily and are therefore inherently hard to suppress.[429]

In 1996, the U.S. federal government dropped their charges against Zimmermann. They also went on to liberalize their munitions export restrictions around cryptography. End-to-end encryption subsequently played a very large role in enabling safe e-commerce from the late 1990s to the present day, as people share payment details online while trying to protect their payment details from bad actors. Sometimes, David does beat Goliath.

In the decades that followed, however, the U.S. federal government and other governments have repeatedly attempted takebacks against end-to-end encryption, to restrict its usage. In the U.S., various legislation has been put forth by members of the House or Senate that would restrict or ban the usage of end-to-end encryption, but they haven't passed. In the European Union, there have been proposals to mandate that corporations regularly scan every electronic device for illegal content, including so-called encrypted content.

One of the highest-profile incidences regarding this ongoing debate involved Apple, the largest U.S. company in this era. Starting in 2015 or earlier, law enforcement considered it unacceptable that, even with a warrant, they couldn't necessarily access certain password protected phones. This brought up questions such as:

"Should Apple or a similar company be allowed to build a phone that even they can't access?"

"Should all corporations be forced to build backdoors into their products for the government?"

"What about free open-source software? What if some random individuals create end-to-end encryption techniques that other individuals freely use? Can this be outlawed, and if so, can such a law actually be enforced?"

As we go down that list from top to bottom, the existence of encryption becomes increasingly hard for a government to prevent. With enough legislative consensus, a government can of course force domestic corporations to do whatever it wants them to do. However, they can't prevent foreign corporations from making or using end-to-end encryption available for use, and it's hard for them to realistically prevent individual software developers, domestically or internationally, from creating and distributing free open-source code that makes end-to-end encryption available for use.

ATTEMPTS TO REGULATE CRYPTOCURRENCIES LIKE BANKS

When the automobile was introduced in the late 19th century, there were various public safety concerns (justifiably so) and competitive concerns about them. Executives in the horse-and-buggy industry were threatened by them, since automobiles represented superior technology compared to what they had to offer, and some of them were politically well-connected. Public opinion could be influenced with scare tactics, and policymakers naturally wanted to limit seemingly dangerous new technologies in public spaces, especially when pressured and financed by people in legacy industries.

This resulted in very restrictive laws being passed in the United States and United Kingdom for a period. These included limitations on automobile speed that were slower than human walking speed, the requirement for automobiles to yield to horse-drawn carriages, and the requirement of a person to literally walk in front of the automobile with a flag, which basically rendered the vehicle useless.[430] These laws didn't last long since they were obviously untenable; they were attempts to restrict automobiles from the perspective of people with a horse-and-buggy mindset.

Similarly, the introduction of peer-to-peer monetary software represents a confusing and difficult-to-regulate situation for policymakers, and currently threatens some of their biggest financiers in the legacy banking system. Prior to the invention of Bitcoin, people had to go through the banking system if they wanted to transfer significant value over long distances. Governments could therefore impose various transaction restrictions by targeting the banks themselves, who then could restrict user transactions as needed. The peer-to-peer nature of Bitcoin, however, allows for global value transfer without going through a centralized third party, assuming no malicious entity can gain and maintain over 50% of network-wide processing power.

Additionally, as of this writing, smartphone adoption has surpassed bank account adoption on a global basis. Banks had centuries of a head start, but in a couple short decades, smartphones caught up and surpassed banks in terms of reaching more people. And with smartphones, people can store and transfer encrypted value via cryptocurrencies.

Various public debates and laws have therefore popped up among multiple governments when it comes to the regulation of cryptocurrencies, especially when it comes to self-custodying them or using various privacy techniques with them. The ability for people to store value self-custodially, send it to and receive from others, and use various privacy techniques to make those transactions harder to track, threatens government control over the financial system. Governments and banks want people to use their domestic centralized ledgers, not a global decentralized ledger. And they want ledgers to be able to be constantly surveilled, rather than to be private.

And as such, governments have tried to impose the full suite of bank-type restrictions on cryptocurrencies. What makes it hard, however, is that such laws must be enforced on the individual level (with millions of enforcement points) rather than just the bank level (which only has thousands of tightly regulated institutional enforcement points).

People don't just use privacy techniques to evade the government; they use privacy techniques to evade corporations that do their best to monetize their data and track their every move. Especially for a cryptocurrency which is a public ledger, many users want to use anonymization techniques to make it harder for corporations to track their spending. As it stands now, if you buy and withdraw bitcoin from a cryptocurrency exchange, and then spend that bitcoin on various goods and services, that exchange operator can track each expenditure that you make. The merchants you gave bitcoin to are also able to look at your address and see how much bitcoin you have, and perhaps trace it back through various earlier transactions. Therefore, people often anonymize their coins to create probabilistic obfuscation, which prevents corporations and merchants from tracking their transactions and wealth.

With these anonymization technologies, privacy is limited by liquidity. It's easier to make private Bitcoin transactions with small amounts than it is to make private transactions with large amounts. The volume of coinjoins, mixers, Lightning channels, privacy-themed cryptocurrencies, Chaumian mints, and other privacy techniques is still rather limited. In other words, as of this writing a normal tech-savvy individual can gain privacy with these technologies for an amount of money that is meaningful to them, but there isn't enough liquidity for a Russian oligarch or other billionaire to gain privacy with an amount of money that is meaningful to them.

The Digital Asset Anti-Money Laundering Act was proposed by two U.S. senators in 2022, and as of this writing is unlikely to pass. However, like many prior legislative attempts at curtailing encryption usage and overall privacy, it shows the direction that a significant subset of lawmakers would prefer to go in. The key text of the bill makes several businesses into money services businesses for regulatory purposes:

> MONEY SERVICE BUSINESS DESIGNATION.—The Financial Crimes Enforcement Network shall promulgate a rule classifying custodial and unhosted wallet providers, cryptocurrency miners, validators, or other nodes who may act to validate or secure third-party transactions, independent network participants, including MEV searchers, and other validators with control over network protocols as money service businesses.

Money service businesses are a subset of financial institutions, which is relevant for a later section of the bill that adds new rules for what financial institutions are prohibited from doing:

> The Secretary of the Treasury shall promulgate a rule that prohibits financial institutions from (1) handling, using, or transacting business with digital asset mixers, privacy coins, and other anonymity-enhancing technologies, as specified by the Secretary; and (2) handling, using, or transacting business with digital assets that have been anonymized by the technologies described in paragraph (1).[431]

When asked if they are against money laundering, most people, including myself, say yes. Obviously, we don't want terrorists, human traffickers, malevolent dictators, or various violent criminals moving around money if we can help it. However, we must ask ourselves three questions. The first is: What should we all have to give up to ensure that the tiny fraction of the population that is engaged in those activities is prevented from doing them? For example, should governments around the world (including authoritarian ones) be able to automatically look into every possible transaction for the sake of preventing crime? The second question is: Can a government even enforce what they want to do in this area? For example, governments were able to shut down Napster (a centralized file-sharing platform) but couldn't shut down BitTorrent (a *de*centralized file-sharing method). Satoshi Nakamoto purposely built the Bitcoin network to be more like the latter. The third question is: How honest are governments and/or central banks about their motivations regarding these trade-offs? In 2022 and 2023, Argentina's central bank banned banks and then payment apps in the country from offering digital assets as they had been doing. At the time of the ban, Argentina was dealing with over 100% annual price inflation and uncontrolled money supply growth with its own fiat currency, while Argentinians were rapidly adopting bitcoin and other cryptocurrencies as an escape route, and banks were increasingly offering them to their customers. The monetary authorities conveniently cited the usual risks around volatility and money laundering, but of course it really had to do with trying to protect their own failing currency.[432]

When we look at the U.S. Digital Asset Anti-Money Laundering Act (and I'm just using it as an example for illustrative purposes; there are many like it), we can see an immediate problem around "unhosted wallet providers." An unhosted wallet provider is merely a hardware device or software program that allows a user to control and interact with their own cryptocurrency keys — which are just large numbers. Due to this proposed bill, therefore, a single developer of open-source software could be classified as a money service business and a financial institution. From there, as a financial institution, they are barred from handling or using digital asset mixers, privacy coins, or anonymization methods.

Therefore, if this were to be enacted into law as written, it would be illegal for an individual to create an open-source wallet software or cryptocurrency that uses privacy techniques. In other words, it's a form of control on the usage of math. Referring to the Zimmermann precedent, what if they publish the code in a book, and let the user do it themselves? What if they put the code on a t-shirt?

The challenge with such enforcement is that anyone in the world can generate a private key by flipping a coin 256 times, and anyone in the world can create open-source code that offers anonymization methods. If laws trying to prevent the existence and usage of these technologies are going to be enforced, they must be enforced on the individual level. The government must come and say, "you're not allowed to write that code" or "you're not allowed to run that non-malicious open-source software on your own laptop" along with some argument for how it goes against the public interest. The only chance a government has if they want to be somewhat successful in this effort would be to convince most of the public to go along with draconian anti-privacy and anti-open-source laws and harsh enforcement — likely by equating the desire for privacy with inherent illegality.

These types of debates and battles are already being waged across various jurisdictions and are likely to become more intense over the next decade. There is an arms race between bottom-up developers creating increasingly ubiquitous and easy-to-use encryption and privacy techniques, and top-down governments and corporations creating increasingly ubiquitous surveillance and control techniques.

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CHAPTER 30

A WORLD OF OPENNESS OR A WORLD OF CONTROL

In May 2022, I found myself in a place I hadn't expected or planned to be: inside Norway's Parliament building in Oslo. I was talking to several Norwegian MPs as part of a twelve-person group sent by members of the Human Rights Foundation.

The goal of the Human Rights Foundation is to help provide basic rights for people in authoritarian or semi-authoritarian regimes. They reference the United Nation's International Covenant on Civil and Political Rights for their list of values, which was ratified by 173 countries in 1976 and includes:[433]

- freedom of speech and expression
- the right to equal treatment and due process under law
- freedom from slavery and torture
- freedom of association
- the right to leave and enter their countries
- freedom from interference and coercion in matters of conscience
- the right to acquire and dispose of property
- freedom from arbitrary detainment or exile
- the right to worship in the manner of their choosing
- the right to participate in the government of their country

The context for my unusual situation was that several members of Norway's parliament were proposing to ban bitcoin mining in the country. The Human Rights Foundation, which was holding its annual Oslo Freedom Forum just down the street from the Parliament building at that time, had been making use of bitcoin and stablecoins as tools for human rights in places where authoritarian financial censorship is commonly used against human rights advocates. So, the Human Rights Foundation was invited to send a group of forum speakers over to Parliament to discuss this fact. Most of the members of the twelve-person group were human rights activists, and a few others such as me were brought along as subject matter experts that were able to answer questions in detail that might come up about how or why the Bitcoin network uses energy.

A few human rights activists in the group were from Nigeria, and they described to the members of Parliament how, when their bank accounts were frozen for protesting excessive violence by police in their country, they turned to using bitcoin for donations instead. The same had been true for Vladimir Putin's domestic political opposition, Alexei Navalny, as well. Faced with frequent bank account freezes, Navalny's organization in Russia had made use of bitcoin to collect and move funds to support their legitimate political opposition against Putin's dictatorial behavior. Others in the group talked about the problem of people being underbanked in many parts of the world, and how some of these technologies make storing and transmitting value far more efficient and accessible, which can connect people in some of the most impoverished areas to the global economy. When it came to me, I kept my part short and described how the Bitcoin network tends to use cheap and stranded energy, while being useful for its unique type of demand flexibility. Norway's electrical grid consists of over 90% clean hydro power, and especially in the northern part of the country they have plenty of stranded resources to help support such a valuable network. Private companies were already happily doing it, and my view was that there was no reason for the government to step in and stop them from doing so.

Several months prior to that meeting, across the ocean in Canada, there was a large trucker convoy protest, which had gathered people across the country into the nation's capital to protest COVID-19 vaccine mandates and mobility restrictions. In 2021, Canada had enacted increasingly strict policies around mobility. People could not ride trains or planes without proof of vaccination, meaning they were restricted from moving within the country and, importantly, had no realistic way to even leave the country if they were not vaccinated, since they could not fly and could not cross the U.S. land border. In early 2022, Canada further tightened this by requiring truckers entering Canada to show proof of vaccination as well. International covenants do allow for temporary suspensions of certain rights during emergencies (e.g., mobility restrictions), but this was happening years into the pandemic when the vaccine was increasingly understood by that point to be temporary, and with limitations regarding its ability to prevent transmission.

Any large protest has extremist characters associated with it, but by and large the protest was a peaceful and economic one. The Canadian protests disrupted local businesses and put pressure on the government by blocking traffic, but on the other hand, they were supported by many regular people who felt boxed into a corner. The whole purpose of protests is to create awareness through disruptions, and it requires ongoing cost of time and/or money by the protestors to maintain it, which naturally limits the duration and magnitude of the disruption of the protest depending on the severity of what they are protesting for and how committed they are to it.[434]

Donations began to pour in to support the protestors, with both fiat currency and bitcoin. Benjamin Tyler Perrin, a well-known educator regarding Bitcoin-related technologies, helped put together a donation portal for people to send bitcoin to support the truckers. Perrin, who had previously voted for Prime Minister Justin Trudeau's party but who had later opposed their imposition of vaccine mandates and mobility restrictions, thought the donations would be small and uncontested by the government. However, as numerous donation portals such as GoFundMe were told to shut down their services without funds being delivered, the Bitcoin network became one of the only ways for donations to make it to the intended recipients.

The government of Canada subsequently enacted emergency powers and began telling banks to freeze bank accounts of certain protesters, as well as certain individuals that had merely donated to protesters. Many of these were without court orders, and the line between government and bank actions became blurred.[435]

However, self-custodial bitcoin holdings could not be frozen. Domestic cryptocurrency exchanges could blacklist certain known addresses, making it less convenient to exchange bitcoin for Canadian dollars through those specific portals, but other than that, there were limits to what the government could do automatically and remotely. There are plenty of ways to spend bitcoin or exchange bitcoin. If authorities wanted someone's bitcoin, they needed to show up at their door, literally or figuratively, with a warrant or threat of some kind. In other words, the usage of bitcoins added a considerable cost to enact financial censorship. Unlike most other donations that were blocked entirely, two-thirds of bitcoin donations made it to their intended recipients, and only the remaining third was confiscated with the use of targeted enforcement.

In February 2022, during the protest, I wrote on social media about this nuance, while purposely avoiding the subject of vaccines or Canadian political partisanship directly. My conclusion was that technologies that make it harder to freeze money are not about avoiding legitimate laws, but rather, are about ensuring that governments themselves follow their own laws. As I wrote at the time:

> Custodial financial services allow governments to freeze accounts first, and then sort out who is guilty or innocent later. Self-custodial financial services force governments to actually charge people with a crime before they can use pressure to freeze their accounts.
>
> Custodial money often can't be withdrawn from a jurisdiction if for whatever reason rule of law breaks down there. Self-custodial money can be withdrawn from a jurisdiction if the individual is able to move their self elsewhere (and sometimes, even if they can't).
>
> It's not a "right or left" issue, because one merely needs to imagine their least-favorite politician winning the next election, or two or three elections from now. Most people are in favor of rule of law, but the questions are "which law?" and "in which order?"
>
> Thus, bitcoin and cryptocurrencies aren't really about "avoiding the law" but rather are about putting the onus on governments to act within the law, and giving individuals more mobility options when governments begin to change the law in a way that trends away from liberty.[436]

I personally took the pandemic seriously as it emerged and supported efforts to produce vaccines and distribute them when they became available to those that wanted them. However, due to the temporary effectiveness of the coronavirus vaccines and some of the other nuances involved, I did not support government mandates for the general public to get vaccinated, nor did I support placing significant top-down mobility or employment restrictions on people based on their vaccination status. This touches on an age-old political debate between individualist and collectivist policies, but my point here is to highlight the right to protest rather than to highlight the subject of the protest itself, which for any given protest I might agree or disagree with.

A similar concept applies to the broad practice of civil forfeitures. In the United States, billions of dollars per year in cash, jewelry, and other valuables are taken from people by police without charging them with a crime. If someone travels through an airport with cash or valuables or gets pulled over while carrying a lot of cash or valuables, in many jurisdictions the police can simply take the cash or valuables despite not charging the person with violating any law. The person then must go through time-consuming and expensive proceedings if they have any hope of getting their assets back, which is a bigger hurdle for regular people to do than wealthy people.[437] This practice occurs on a global scale, to varying degrees, and puts the burden of proof on the person to get their assets back rather than on the authority that seized the asset in the first place.

I met Benjamin Tyler Perrin at the Oslo Freedom Forum in May 2022, months after his involvement in the donation portal. He is by no means an extremist or hyper-partisan person. In a public interview with Peter McCormack, he described that when the government began cracking down on bank accounts and donation portals associated with the protest, he was concerned for the safety of himself and his family. He has also publicly said that had he known ahead of time that the political environment would have become so adversarial, he could have constructed the donation portal using more private, unstoppable means. As he has described, it didn't occur to him at the time that the government would step in and attempt to prevent the disbursement of protest-related donations, and so he did not emphasize privacy when setting up the donation portal. And yet it still succeeded more than GoFundMe and other similar centralized donation portals.[438]

Financial censorship against protestors or political opposition is a common tool in authoritarian and semi-authoritarian regimes, but shades of it occasionally pop up in democracies as well, usually around wars or other extreme events. When choosing to support or oppose the usage of such tools in a given context, one must keep in mind that any power the government has can be used in the reverse context as well. For real freedom to exist, it must be held above any specific interest, rather than something that is easy to take away from groups that we may not like. In other words, due process should occur for the most virtuous groups and the most odious groups alike.

The Bitcoin network was built and initially adopted by people of the cypherpunk movement, which, as previously mentioned, refers to those advocating widespread use of cryptography and privacy-enhancing technologies as a route to social and political change. From that base, a broader subset of libertarianminded people became enthusiastic supporters of the network as well.[439] As of this writing, there are more politicians associated with the Republican Party in the United States who embrace Bitcoin compared to politicians associated with the Democratic Party, although there are some of both.

From its inception Bitcoin has always had somewhat of a political element to it. As of this writing, it's the world's largest and most successful attempt at a stateless digital currency, and that fact carries some political weight to it. Encryption initially allowed for the private sharing of information, and now encryption also allows for the private sharing of value. Information and value are the two components needed for individuals to conduct trade.

But what *exactly* is the political nature of the network? Is it only for cypherpunks and libertarians? What if someone has a favorable view of their country's government? Is Bitcoin not for them? Can we determine someone's political views based on their opinion of digital assets?

Some of the most-cited books by libertarians and critics of government in general are *Animal Farm* and *Nineteen Eighty-Four*, written by George Orwell. To this day, these remain some of the most powerful novels that emphasize anti-authoritarian themes. But what many people don't realize in the context of today is that George Orwell was a democratic socialist. He favored large government, but only if that government was of the transparent and democratically elected variety. Anti-authoritarianism doesn't exclusively belong to the political right or the political left. It just gets expressed by those sides in different ways. And arguably the most well-known anti-authoritarian writer happens to have been on the left on the political spectrum.

After the 2008 global financial crisis and bank bailouts by the U.S. federal government, there were Tea Party protests by people mainly on the political right and Occupy Wall Street protests mainly by people on the political left. Both groups were protesting aspects of the same underlying problem: When the financial system broke in 2008, those who were at the helm of the intertwined government-corporate power structure could use the flexible public ledger to selectively bail out who they wanted — and they prioritized bailing out those who were already rich and powerful.

Today, Bitcoin as a network collects members from both types of groups, and partially organizes them in an emergent way by giving them something to use and build on, so that they don't have to only rely only on protesting. It offers them a way to potentially opt out of the existing financial system that they view as being heavily corrupted, and to build a parallel peer-to-peer financial system instead. It is for this reason that many proponents of the Bitcoin network describe their activities as a peaceful revolution. So, while the technology does have political implications, it's not inherently partisan.

In 2022, there was a significant rise in the visibility of Bitcoin proponents who identified as progressives, referring to people that generally lean to the left in terms of political persuasion both socially and fiscally. Many of them had been active in the ecosystem for a while, but during the period between 2021 and 2022 many of them connected with each other and were given more significant stages to speak on. One of the largest Bitcoin-focused podcasters, Peter McCormack, specifically dedicated the year to featuring more Bitcoin proponents from the political left on his show (such as Jason Maier, author of *A Progressive's Case for Bitcoin*) to counterbalance what he viewed as a broadly conservative or libertarian culture within the Bitcoin podcasting and media circuit. Their presence at events increased rapidly from there. I personally know many Bitcoin proponents from across the political spectrum and from around the world.

A theme that many left-leaning Bitcoin proponents have in common is that they view the Bitcoin network as a tool to curtail the overreach of corporations and crony capitalism, in similar ways that many right-leaning Bitcoin proponents view the Bitcoin network as a tool to curtail the overreach of the state. This is not contradictory because, in the broadest sense, the Bitcoin network is a tool (among many other tools) that provides a check on many forms of consolidated power, including both the corporate and government varieties. At the highest levels of power, governments and corporations become intertwined anyway, with Big Defense, Big Food, Big Agriculture, Big Pharma, Big Tech, Big Oil, and so forth all having considerable influence over spending-related legislation. With such a flexible public ledger, governments can favor any corporation they want, and corporations can use their financial scale to help ensure that their preferred government officials get in power and stay in power so that they can further favor them as a corporation. There's a revolving door between the regulators and the regulated, and Bitcoin was designed to take back part of that public ledger.

In other words, as demonstrated by George Orwell's famous works, anti-authoritarian viewpoints come from multiple political perspectives. People can disagree with each other on various political topics — including what the precise tax rate should be and which services government should provide — and still have a strong appreciation of freedom of expression, property rights, ease of doing business, the right to move within or out of a country, the right to privacy, the ability to transact, and the freedom to use tools to avoid the debasement of their hard-earned savings. To the extent that people disagree about what the government should spend money on, most people at least agree that the money should be spent transparently. It was people on the political left more so than the political right, for example, who from the beginning protested the United States' War on Iraq, which cost trillions of dollars, ended an uncountable number of lives, and was financed primarily by opaque methods through the long-term debasement of the currency and greatly benefited large corporate defense contractors.

In his 1961 farewell address, President Eisenhower warned against the rise of the military industrial complex. During Eisenhower's lifetime, the United States had gone from a country that only raised significant military forces in response to a threat, to one that now needed to maintain a large military at all times. While he viewed this as necessary, he warned against the dangers that it could cause:

> A vital element in keeping the peace is our military establishment. Our arms must be mighty, ready for instant action, so that no potential aggressor may be tempted to risk his own destruction.
>
> Our military organization today bears little relation to that known by any of my predecessors in peace time, or indeed by the fighting men of World War II or Korea.
>
> Until the latest of our world conflicts, the United States had no armaments industry. American makers of plowshares could, with time and as required, make swords as well. But now we can no longer risk emergency improvisation of national defense; we have been compelled to create a permanent armaments industry of vast proportions. Added to this, three and a half million men and women are directly engaged in the defense establishment. We annually spend on military security more than the net income of all United State corporations.
>
> This conjunction of an immense military establishment and a large arms industry is new in the American experience. The total influence-economic, political, even spiritual-is felt in every city, every state house, every office of the Federal government. We recognize the imperative need for this development. Yet we must not fail to comprehend its grave implications. Our toil, resources and livelihood are all involved; so is the very structure of our society.
>
> In the councils of government, we must guard against the acquisition of unwarranted influence, whether sought or unsought, by the military-industrial complex. The potential for the disastrous rise of misplaced power exists and will persist.
>
> We must never let the weight of this combination endanger our liberties or democratic processes. We should take nothing for granted only an alert and knowledgeable citizenry can compel the proper meshing of the huge industrial and military machinery of defense with our peaceful methods and goals, so that security and liberty may prosper together.[440]

In his speech, he also talked about the dangers of the centralization of power and the financial tendency to sacrifice the future to enhance the ease and convenience of the present:

> The prospect of domination of the nation's scholars by Federal employment, project allocations, and the power of money is ever present and is gravely to be regarded.
>
> Yet, in holding scientific research and discovery in respect, as we should, we must also be alert to the equal and opposite danger that public policy could itself become the captive of a scientific-technological elite.
>
> It is the task of statesmanship to mold, to balance, and to integrate these and other forces, new and old, within the principles of our democratic system—ever aiming toward the supreme goals of our free society.
>
> Another factor in maintaining balance involves the element of time. As we peer into society's future, we—you and I, and our government—must avoid the impulse to live only for today, plundering, for our own ease and convenience, the precious resources of tomorrow. We cannot mortgage the material assets of our grandchildren without risking the loss also of their political and spiritual heritage. We want democracy to survive for all generations to come, not to become the insolvent phantom of tomorrow.

Unfortunately, these things have generally increased after Eisenhower left office. Defense contractors, large banks, large multinational corporations, and their armies of lobbyists have firmly intertwined themselves with politicians. Public debts have been accumulated, the economy has become hollowed-out and financialized, and the United States' political establishment focuses heavily on pseudo-imperial ambitions (via hundreds of foreign military bases, trillions of dollars spent on non-defensive wars, billions of dollars spent on covert operations to change political regimes in dozens of countries) — all while manufacturing capabilities and logistics infrastructure stagnate in the homeland, leading to rising political polarization and populism among the citizenry.

Bitcoin developers and educators are often not the "white crypto bros" or "shadowy super-coders" that politicians and media make them out to be.[441] There are people of many different backgrounds across the political spectrum and around the world who, for a variety of reasons, have found the idea of an open-source ledger that gives power to individuals to be an important thing to dedicate their work toward. While there is a lot of fraud and grift in the broad cryptocurrency ecosystem (it has been enticing and lucrative for developers and venture capitalists to create unregistered security tokens out of thin air and dump them on retail investors), people working in the Bitcoin-only space have tended to be doing what they do for ethical and pragmatic reasons.

Obi Nwosu is a British entrepreneur of Nigerian descent who founded the United

Kingdom’s longest-running bitcoin exchange, and then founded a company called Fedi that serves as a bitcoin wallet aimed at decentralizing and distributing bitcoin custody as much as possible. Fedi implements the open-source Fedimint protocol to allow local communities around the world to easily build their own private community banks, with an emphasis on users in developing countries. From there, the community banks can provide other services to their users as well, such as data storage, processing, and a variety of sub-applications.

Anita Posch is an Austrian woman who frequently travels to African countries to teach people how to use the Bitcoin network. She is supported by donations, and she reports on what she finds in her published works. Her focus is on human rights, and specifically on helping people access the ability to save and spend money in areas where the local financial system is broken. She has written about the problematic state of freedom globally, including from her own perspective as a lesbian woman who feels fortunate to have been born in Europe, and so her goal has been to help make the world a fairer place.

Troy Cross is a philosophy professor at a liberal arts college, and an environmentalist who focuses on Bitcoin’s unique ability to make productive use of stranded energy in a way that he views as being beneficial for human rights. As he has described publicly, he was originally concerned about Bitcoin’s environmental impact, but after researching it in detail, he changed his mind and became a strong advocate for it. Cross now regularly educates people about the topic, combats disinformation, and promotes methods to make bitcoin mining as sustainable as possible.

Alex Gladstein is the Chief Strategic Officer of the Human Rights Foundation, and wrote a book called *Check Your Financial Privilege* that extensively catalogued the use of bitcoin and stablecoins by people in inflationary and authoritarian jurisdictions around the world. Alex and the Human Rights Foundation have hosted several private retreats where human rights activists from authoritarian countries, software developers, and venture capitalists meet to discuss technologies that would be useful for human rights activists and their communities if they were to be developed, and for people to learn about some of the latest technologies that have recently been developed.

Elizabeth Stark and Olaoluwa Osuntoken, the co-founders and leaders of Lightning Labs since 2016, led the deployment of the most widely used

Lightning node implementation to this day. Stark, who has a J.D. from Harvard Law School, regularly speaks around the world on the topic of bringing open-source monetary technology to billions of people in developing countries. Osuntoken, a computer scientist and applied cryptographer, co-authored *Mastering the Lightning Network*, which is the primary technical book regarding Bitcoin's Lightning Network.

Farida Nabourema is a democracy advocate from the authoritarian country of Togo, and currently lives in exile. In her country, she saw firsthand how authorities used financial surveillance and the freezing of bank accounts to suppress democracy advocates. In addition to advocating for democracy, she has been a vocal critic of French monetary neocolonialism in Africa, and a vocal proponent of the Bitcoin network since she sees it as a tool for freedom. In late 2022, she and others put together the Africa Bitcoin Conference in Ghana, where people from around the world came to speak and gather.

Paco de la India, a runner from India, was challenged by his friend in 2021 to travel the world using bitcoin, and was gifted a book on the subject by him. Paco subsequently decided to blend his existing passion with running with his newfound obsession with Bitcoin, to run in 40 countries in 400 days, while using bitcoin as a transaction medium wherever possible. From Kenya to Sudan to Sri Lanka to South Africa to Cuba and elsewhere, he has visited dozens of countries (mostly developing ones) to educate people with workshops about Bitcoin in person.

Yan Pritzker is the co-founder and chief technical officer of Swan.com. When he was a child, he and his family left the Soviet Union, and like most others, they were only allowed to take $100 with them. He has described bitcoin as a tool for empowerment that allows refugees from authoritarian countries and failed states, if they are able to physically escape, to bring savings with them. Capital naturally wants to flow from unfree places to free places, wherever possible.

Renata Rodrigues, originally from Brazil, has spent the past several years developing peer-to-peer Bitcoin communities in developing countries, including in places where banks have shut themselves off from cryptocurrency exchanges. While many critics in developed markets view bitcoin as a mere tool for speculation, mainly just a number to trade on a computer screen, she has a boots-on-the-ground approach to help build Bitcoin-based communities in regions with inflating currencies and low banking access.

I think these people are justified in seeing things this way, and doing the work that they do. According to Freedom House's methodology, global freedom has been on the decline since 2005, with 17 consecutive years of more countries dropping in their ranking than rising in their ranking. The 1980s, 1990s, and early 2000s were characterized by increasing freedom and openness in the world. In particular, the economic liberalization of China and the collapse of the Soviet Union partially freed up large portions of the world in various ways, both socially and economically. However, the late 2000s, 2010s, and 2020s have been characterized by decreasing economic openness, heightened forms of surveillance, and a reduction in personal liberty.[442]

Russia has pulled back its level of freedom under the leadership of Vladimir Putin, and the same is true for China under Xi Jinping. Several countries in their spheres of influence have done the same, ranging from Türkiye to Thailand to Hungary. Many governments around the world have turned to populist strongmen leaders who have pressured journalists and have blamed religious minorities or sexual minorities or political minorities or vague outsiders for many of their country's economic woes. Meanwhile, Freedom House's score for the United States still categorizes it as "free," but at a lower value than it used to be at its height. The 2001 Patriot Act, various corruptions within the criminal justice system, and other issues have chipped away at freedom in the United States around the margins.

There are multiple factors that have contributed to this, but I contend that the malfunctioning global financial system has played a large role. As I discussed in Part 3 and Part 4 of this book, the global financial system tends to be reconstructed every several decades, in part because geopolitics and technological capabilities change over time, and in part because problems associated with the long-term debt cycle and misaligned policymaker incentives build up in the financial system and its associated institutions. Over the past two centuries, the world went from free banking and bimetallic coinage, to a central bank gold standard, to the Bretton Woods system, and then to the Eurodollar/Petrodollar system. Each system eventually became antiquated and strained, and ultimately fell apart under its own entropy, until it was reconstructed toward something new. Today, many signs suggest that the current version of the global financial system is breaking down once again. The combination of large sovereign debts after decades of deficit spending, increasing wealth concentration, and a shift from a unipolar to a multipolar world order, is putting a lot of pressure on various fiat currency systems.[443] As wealth concentrates toward the top and as people begin to feel that the economic system is no longer working well for them, people tend to turn toward populism. It’s a cycle as old as civilization.

Populism comes in many flavors, but the far sides of the political spectrum contain several extremist elements. In an increasingly chaotic world, people often want order at any cost, even if it includes giving up some liberty. They want to be told by a seemingly strong leader what the problem is and what the plan will be to fix it. Sadly, what the strong leader proposes the problem to be usually ends up being a cruel misdiagnosis that sacrifices the most vulnerable in society in favor of the cultural majority, or that breaks down the economic incentives that create the efficient production of goods and services in the first place.

This book repeatedly explored the question of “who controls the ledger?” and the answer to that question has shifted over time. In early history, the answer was that local communities and nature (for commodity money) controlled the ledger. As some civilizations gained large technological advantages over others, their technology gave those advanced civilizations a way to basically control the ledgers of the less advanced civilizations they encountered by producing a lot of certain types of commodity money that those less advanced civilizations thought was rare. With the rise of banking and central banking in a telecommunication-enhanced world, where gold was too slow to serve as money anymore, the ledger became increasingly centralized and controlled by nation states. Governments and their central banks essentially acquired a monopoly on fast, long-distance money transmission, which gave them more flexibility to devalue the savings of people within their borders and channel that value toward their goals in opaque ways. Going forward, bottom-up digital monies such as bitcoin attempt to give the ledger back to the people, while top-down digital monies such as central bank digital currencies give nation states even more control over the ledger that people use.

When it comes to control of the ledger, there are two main parts. The first question is, “Who can surveil and censor the transactions of others, or freeze their funds?” The second question is, “Who can create money nearly for free and devalue the savings and wages of others?”

If some group can create money at a cost that is significantly below the current market value, then they have gained the power of seigniorage, and therefore control the ledger entirely or in part. In contrast, if nobody can create money for free, such as in a world of collectible commodity proto-monies between tribes of similar technical proficiency, then nobody has the power of seigniorage, and nature alone controls the ledger. If one group gains a sufficient degree of technical superiority over another culture, and becomes able to cheaply create the glass beads, shell necklaces, rai stones, cocoa beans, or other such stores of value that the group with less technology stores their wealth in, then they have gained the power of seigniorage — at least until people identify the problem and stop using that type of corrupted money.

In fiat currency systems, sovereign governments and central banks can create money nearly for free, which everyone else is supposed to treat as valuable within a jurisdiction, even as it is continually diluted. Many countries mismanage their ledgers dramatically, resulting in massive increases in the money supply and aggregate prices. When people try to flee from it toward other ledgers or assets to protect their savings, authorities rarely take responsibility for the problem and instead tend to blame speculators and outside forces, and therefore often try to block the exits.

Gold has long been turned to as a form of defense and savings, but it's not a useful transactional money in the digital age. The Bitcoin network presents a newer and faster alternative, where nobody can create bitcoin for free, and thus nobody has the power of seigniorage. Similarly, nobody can censor transactions unless they control over 50% of the network's active processing power. And it can move globally without the need for central banks as bottlenecks. However, the network is still in its relative infancy, and it remains to be seen how robust it will be in the face of bigger attacks from large governments that may try to protect their own centralized monetary systems as they become destabilized from their own entropy over time.

In Part 3 of this book, I quoted John Maynard Keynes about how those who control the public ledger can redirect value from one group to another, without people really knowing about it:

> By a continuing process of inflation, governments can confiscate, secretly and unobserved, an important part of the wealth of their citizens. By this method they not only confiscate, but they confiscate arbitrarily; and, while the process impoverishes many, it actually enriches some.[444]

The idea of separating money and state is not about eliminating the state.

Instead, the idea is about creating a decentralized monetary technology that, if it were to be widely adopted and resistant to attacks, would put the state more on a level playing field with everyone else. Governments would need to be more transparent with their actions in a world where fast, portable, self-custodial, globally transmissible, debasement-proof peer-to-peer money is widely held, since it gives people more options. With 160 fiat currencies in the world, and over half of the world's population living under various shades of authoritarianism, this is no small objective. Open-source money in the form of bitcoin may eventually become large enough to compete with the U.S. dollar more directly, but the low-hanging fruit for now is that the technology offers an alternative to billions of people who use failing currencies in any number of jurisdictions that many people rarely think about. It also allows for much faster innovation in money and opens entirely new applications that are not possible with existing technology.

If politics in many parts of the world continue to shift away from freedom and toward varying levels of authoritarianism as they have in the past two decades, then control of the public ledger may become even more important than it has been in recent decades. In less free parts of the world, the user of a centrally controlled currency has decreasing control and decreasing transparency into how the public ledger is being managed. At the same time, governments and corporations have increasing control and insight into everyone's small allocation of the ledger, including how much they have and how they are allowed to use it.

While politics can impact how we interact with money locally and temporarily, it's technology that impacts how we interact with money globally and permanently. As new technologies come into existence, certain types of ledgers become obsolete and go extinct while new types of ledgers are born and become necessary. That's why new forms of money tend to be adopted everywhere rather than just locally. As the world became increasingly industrialized, gold won out over every other commodity. And then as the world became increasingly connected by telecommunication systems, fiat currencies displaced gold in every country. Now that digital scarcity and digital settlement exist as new forms of technology, there is an opening for a new monetary era yet again.

Throughout history, most updates to monetary technology have been centralizing, and have consolidated power into a smaller number of hands in exchange for greater efficiency. Now, there's a real window of opportunity to decentralize some of that power and disperse it more broadly. Additionally, the ever-greater speed gap between transactions and settlements has resulted in ever-greater levels of financialization and abstraction. Now, with the acceleration of settlements and the subsequent closing of that speed gap, there's the possibility to move toward a period of financial simplification and greater robustness.

We cannot know the future. The best that we can do is analyze the present, envision what we think the future should be like, and then play our individual roles to move toward that vision. In my view, open-source decentralized money that empowers individuals, that is permissionless to use, and that allows for a more borderless flow of value, is both powerful and ethical. The concept presents an improvement to the current financial system in many ways and provides a check on excessive power, which makes it worth exploring and supporting.

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