GRADUALLY, THEN SUDDENLY

By Parker Lewis*

*Views are expressly those of Parker Lewis and not those of Unchained Capital or his colleagues. Special thanks to Will Cole, Phil Geiger, Adam Tzagournis, and Ethan Packard who have reviewed past and present releases of *Gradually, Then Suddenly* and provided valuable feedback. Also thanks to Saifedean Ammous, Yan Pritzker, and Andreas Antonopolous for their books, which are incredible resources.

TABLE OF CONTENTS

GRADUALLY, THEN SUDDENLY - JULY 26, 2019

Introduction

This is the first of a weekly series that I've decided to write on the subject of bitcoin, inspired by my friends Marty Bent and Saifedean Ammous. Education is such a critical aspect of bitcoin and I hope that, by distilling my own thoughts, I can help others accelerate their path in understanding a complex subject. I've titled the series *Gradually, Then Suddenly*. As Hemingway penned the process of going bankrupt, it's also the way that government-backed currencies hyper-inflate and often how people come to understand bitcoin (gradually, then suddenly). Writings will generally stick to bitcoin but will also include the Fed and monetary economics as these stories are deeply intertwined. Because I'll be trying to keep concise, the series will communicate my principal conclusions and opinions rather than setting out to present every detail that led to them; my intention is to provide insight into my thought process and to provide a roadmap if others are interested in learning more. My hope is to reach a broader audience (beyond those that have been formative in my own journey) and to help folks on the periphery gain a better understanding of why many of us are so focused on bitcoin as a subject matter. Views presented are expressly my own and not those of either Unchained Capital or my colleagues. Hope you enjoy & please provide feedback.

Bitcoin is money

Or rather, Bitcoin has become money (to me). It was a slow process that involved unlocking a number of mental blocks along the way but it began with asking the question, what is money? That is the beginning of the real rabbit hole. And not the speculative, I'm looking for a lottery ticket blockchain-is-going-to-change-the-world kind of rabbit hole. At the root level, it's the rabbit hole that attempts to answer the question, "why is the dollar in my pocket money?" Why do hundreds of millions of people exchange their hard-earned, real-world value every day for this piece of paper (or digital representation)? It's both a difficult question to ask and a harder one

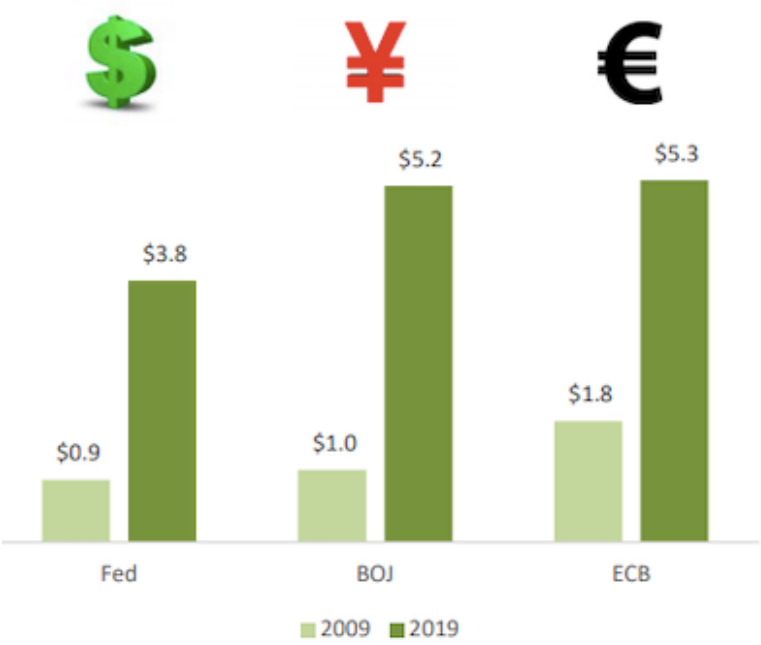
to answer, something I realized everyone has to approach in their own way, on their own timeline and guided by their own life experiences. People have to be interested in that question in order to even begin to understand bitcoin.

> "What is money? That is the beginning of the real rabbit hole."

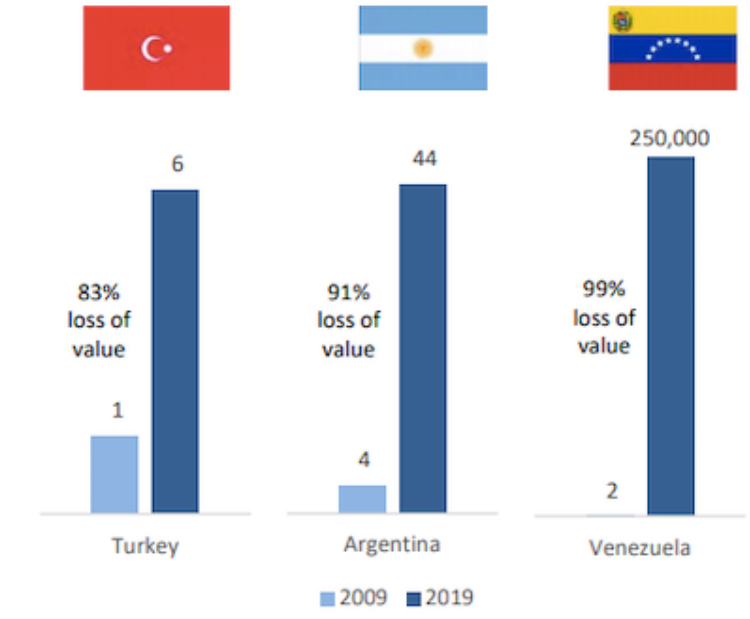
For me, the path involved first understanding why gold was money. That involved understanding the unique properties which made something a better or worse form of money and what differentiated money as a unique economic good compared to most other types of economic goods. The Bitcoin Standard was formative for me in exploring the questions, not as a gospel but rather, as a foundation to think about the problem statement. When I applied that foundation to my own life experiences and to my own understanding of the existing financial system, and its flaws, only then did it begin to become intuitive. And that's something that may be evident (that bitcoin is intuitive as money) to those that have spent years thinking about it relative to monetary principles but it's also true that bitcoin is not intuitive. It's extremely not intuitive until it becomes intuitive and then over time it becomes hyper intuitive.

As part of my process, I found it helpful to consider bitcoin relative to two tangible guide posts: gold and the dollar financial system. Does A (bitcoin) share the properties of B (either gold or the dollar, respectively). Is A better than B? Because what makes something money is not an absolutism; it is a choice between storing value in one medium vs. another, always involving trade-offs. Without understanding the flaws of the existing financial system (whether the dollar, euro, yen, bolivar, peso, etc., respectively), I could have never arrived at bitcoin being money in a vacuum.

Central Bank Balance Sheets ($ in tn, 2009 vs. 2019)



EM Currencies vs. USD (2009 vs. 2019)



While I worked at Deutsche Bank during the financial crisis, I had no baseline to understand what was actually happening. Ten years later, and after having worked in the restructuring world and at a macro hedge fund, only then did I start to develop a more clear understanding of what had really transpired in 2008 and 2009. Through my own research of the great financial crisis, the Fed and specifically the impact of quantitative easing (see here), I came to the principal conclusion that the root problem was that the financial system had been leveraged approximately 150-to-1 (too much debt and too few dollars) and that the insane degree of leverage was only made possible as a function of Fed policy which had consistently prevented system-wide deleveraging over the course of the three decades leading up to the crisis. Further, it became apparent that the solution (quantitative easing) merely caused an unsustainable credit system to metastasize over the subsequent ten years, making future QE an inevitability. I became convinced that, whether bitcoin survives or not, the existing financial system is working on borrowed time and that one way or another, something other than the status quo will be the inevitable path forward.

> "It became apparent that the solution (quantitative easing) merely caused an unsustainable credit system to metastasize over the subsequent ten years, making future QE an inevitability."

Then I figured out that bitcoin has a fixed supply. Developing an understanding of how and why that is possible is the basis of understanding bitcoin as money. Doing so requires significant personal investment in understanding how economic incentives are woven together with bitcoin's technical architecture and why bitcoin can't be "faked" or copied (or rather, why the incentives are so strong to cooperate and why the opportunity cost is too high to defect). It's a long road but will ultimately lead one to an understanding that a global network of rational economic actors, operating within a voluntary, opt-in currency system would not collectively and overwhelmingly form a consensus to debase the currency which they

have all independently and voluntarily determined to use as a store of wealth. This reality (or belief system) then underpins and reinforces bitcoin's economic incentives, technical architecture and network effect.

So it's not simply that software code dictates that there will only ever be 21 million bitcoin; it's understanding why that monetary policy is credible and resilient and how bitcoin achieves verifiable scarcity. That can't happen overnight for any individual. It can't be explained to someone at a cocktail party. It is a reality that is reinforced and strengthened over time only by experiencing the incentive structure and seeing it work time and time again, every 10 minutes (on average). When then compared to how the dollar system works or even the underpinnings of gold, bitcoin as money becomes more intuitive.

> "Bitcoin exists as a solution to the money problem that is global QE"

In summary, when trying to understand bitcoin as money, start with gold, the dollar, the Fed, quantitative easing and why bitcoin's supply is fixed. Money is not simply a collective hallucination or a belief system; there is rhyme and reason. Bitcoin exists as a solution to the money problem that is global QE and if you believe the deterioration of local currencies in Turkey, Argentina or Venezuela could never happen to the U.S. dollar or to a developed economy, we are merely at a different point on the same curve. Bitcoin represents a fundamentally different structure and a more resilient path forward but you have to understand where we've been and how we got here to know where we're going.

Hayek writes about the price mechanism as the greatest distribution system of knowledge in the world (The Use of Knowledge in Society). When the money supply is manipulated, it distorts global pricing mechanisms which then communicates "bad" information throughout the economic system. When that manipulation is sustained

over 30-40 years, massive imbalances in underlying economic activity are created which is where we find ourselves today. Ultimately, gold's failure was the dollar and the dollar's failure is the economic distortion which led to, and which has been exacerbated by, QE. Bitcoin's promise is the solution to both. Because bitcoin's supply is fixed and cannot be manipulated, it will eventually become the most reliable pricing mechanism in the world and consequently, the greatest distribution system of knowledge. The volatility witnessed today is nothing more than the logical path of price discovery as adoption increases by orders of magnitude and as we advance toward that future state of full adoption.

> "Establishment economists deride the fact that bitcoin is volatile as if you can go from something that didn't exist to a stable form of money overnight, it's completely ludicrous." – Vijay Boyapati on SLP

BITCOIN CAN'T BE COPIED - AUGUST 2, 2019

As kids, we all learn that money doesn't grow on trees. As a society on the other hand, we have become conditioned to believe that it's not only possible but that it's a normal, necessary and productive function of our economy. Before bitcoin, this privilege was reserved to global central banks (see here for example). Post bitcoin, every Tom, Dick & Harry seems to think that they can create money too. At a root level, this is the audacity of everyone that attempts to create a copy of bitcoin. Whether by hard-forking out of consensus (bitcoin cash), cloning bitcoin (litecoin) or creating a new protocol with "better" features (ethereum), each is an attempt to create a new form of money. If bitcoin could do it, why can't we?

We sit here, in 2019, witnessing the monetization event of an economic good (bitcoin) on the free market for the first time in thousands of years (h/t gold). Rather than stopping to contemplate the weight of that reality or to understand how or why that is possible, many people skip right past it to focus on some derivative or some way to improve upon a problem they didn't see in the first place. Everyone wants to get rich quick, and so long as there is money, there will also be alchemists. Those that attempt to copy bitcoin are our modern day alchemists.

> "Everyone wants to get rich quick, and so long as there is money, there will also be alchemists."

They tell us that bitcoin is too slow so they create a copy that is "faster". Or they tell us that bitcoin does not have the capacity to handle the number of transactions required by the global economy so they create a copy that has "greater" scale. Then they tell us that bitcoin is too volatile to be a currency so they create a "more stable" version. It goes on and on. Next it's that bitcoin is too rigid and that it needs to be more programmable so they create a copy that is "more flexible". They often even tell us that their creation is not money but

instead, it's a vehicle for "payments" or a "utility" or maybe a "global computer fueled by gas". They also try to convince us of a world that has hundreds, if not thousands, of currencies. But make no mistake, in each case, it is their own attempt to create money.

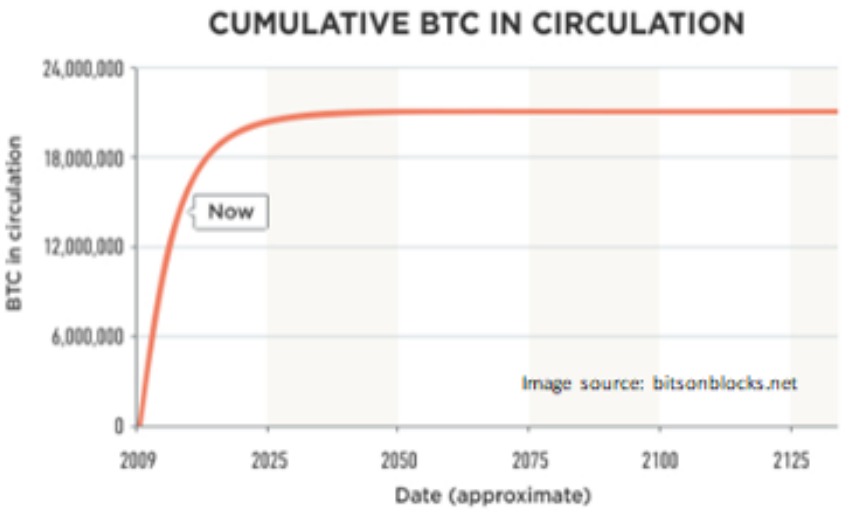
Bitcoin's Value Function

If an asset's primary (if not sole) utility is the exchange for other goods and services and if it does not have a claim on the income stream of a productive asset (such as a stock or bond), it must compete as a form of money and will only store value if it possesses credible monetary properties. With each "feature" change, those that attempt to copy bitcoin signal a failure to understand the properties that make bitcoin valuable or viable as money. When bitcoin's software code was released, it wasn't money. To this day, **bitcoin's software code is not money**. You can copy the code tomorrow or create your own variant with a new feature and no one that has adopted bitcoin as money will treat it as such. Bitcoin has become money over time only as the bitcoin network developed emergent properties that did not exist at inception and which are next to impossible to replicate now that bitcoin exists.

> "Those that attempt to copy bitcoin signal a failure to understand the properties that make bitcoin valuable or viable as money."

These properties emerged organically and spontaneously as individual economic actors all over the world evaluated bitcoin and determined to store a portion of their wealth in it. As bitcoin's value increased, it became decentralized and as it became decentralized, it also became increasingly difficult to alter the network's consensus rules or to invalidate, or prevent, otherwise valid transactions (often referred to as censorship-resistance). There remains reasonable debate as to whether bitcoin is sufficiently decentralized or sufficiently censorship-resistant, but while this may be the case, there are other considerations less subject to debate:

1. Bitcoin represents, by far, the most decentralized and most censorship-resistant monetary system in the world today, whether compared to traditional currencies, other digital currencies or commodity monies like gold.
2. Bitcoin derives its value because it is decentralized and because it is censorship-resistant; it is these properties which secure and reinforce the credibility of bitcoin's fixed 21 million supply (i.e. why it is an effective store of value).
3. Bitcoin becomes increasingly decentralized and increasingly censorship-resistant as its value increases and as it scales at all levels of the network.
4. Repeat.



Monetary Systems Tend to One

Every other fiat currency, commodity money or cryptocurrency is competing for the exact same use case as bitcoin whether it is understood or not and monetary systems tend to a single medium because their utility is liquidity rather than consumption or production. When evaluating monetary networks, it would be irrational to store value in a smaller, less liquid and less secure network if a larger, more liquid and more secure network existed as an attainable option.

Apply a common sense test. If you worked for two weeks and your employer offered to pay you in a form of currency accepted by 1 billion people all over the world or a currency accepted by 1 million people, which would you take? Would you request 99.9% of one and 0.1% of the other, or would you take your chances with your billion friends? If you are a U.S. resident but travel to Europe one week a year, do you request your employer pay you 1/52nd in euros each week or do you take your chances with dollars? The practical reality is that almost all individuals store value in a single monetary asset,

not because others do not exist but rather because it is the most liquid asset within their market economy.

Anyone with Venezuelan bolivars or Argentine pesos would opt into the dollar system if they could. And similarly, anyone choosing to speculate in a copy of bitcoin is making the irrational decision to voluntarily opt-in to a less liquid, less secure monetary network. While certain monetary networks are larger and more liquid than bitcoin today (e.g. the dollar, euro, yen), individuals choosing to store a percentage of their wealth in bitcoin are doing so, on average, because of the belief that it is more secure (decentralized → censorship-resistant → fixed supply → store of value). And, because of the expectation that others (e.g. a billion soon-to-be friends) will also opt-in, increasing liquidity and trading partners.

> "Anyone choosing to speculate in a copy of bitcoin is making the irrational decision to voluntarily opt-in to a less liquid, less secure monetary network."

Why Bitcoin Can't Be Copied

Many individuals creating digital currencies neither accept or admit that what they are creating has to be money to succeed; others that are speculating in these assets fail to understand that monetary systems tend to one medium or naively believe that their currency can out-compete bitcoin. None of them can explain how their digital currency of choice becomes more decentralized, more censorship-resistant or develops more liquidity than bitcoin. To take that further, no other digital currency will likely ever achieve the minimum level of decentralization or censorship-resistance required to have a credibly enforced monetary policy. And to literally steal a page from The Bitcoin Standard:

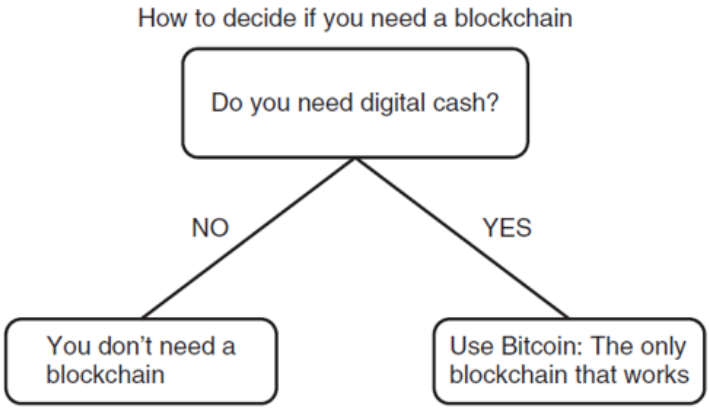


Figure 22 Blockchain decision chart.

Bitcoin is valuable, not because of a particular feature, but instead, because it achieved finite, digital scarcity, through which it derives its store of value property. The credibility of bitcoin's scarcity (and monetary policy) only exists because it is decentralized and censorship-resistant, which in itself has very little to do with software. In aggregate, this drives incremental adoption and liquidity which reinforces and strengthens the value of the bitcoin network. As part of this process, individuals are, at the same time, opting out of inferior monetary networks. This is fundamentally why the emergent properties in bitcoin are next to impossible to replicate and why bitcoin cannot be copied or out-competed: because bitcoin already exists as an option and its monetary properties become stronger over time (and with greater scale), while also at the direct expense of inferior monetary networks.

One would likely never come to this conclusion without first developing their own understanding of the following: i) that bitcoin is finitely scarce (how/why); ii) that bitcoin is valuable because it is scarce; and iii) that monetary networks tend to one medium. You may come to different conclusions, but this is the appropriate framework to consider when contemplating whether it is possible to copy (or out-

compete) bitcoin rather than a framework based on any particular feature set. It's also important to recognize that any individual's conclusions, including your own or my own, has very little bearing in the equation. Instead, what matters is what the market consensus believes and what it converges on as the most credible long-term store of value.

The empirical evidence (price mechanism & value) demonstrates that the market continues to determine why bitcoin is different, despite a significant amount of noise. Before speculating, try to understand why bitcoin works and why it's unique. When someone inevitably tells you about a better bitcoin or some differentiating feature, remember that the market, which has come to this same crossroad over the last decade before you, has considered those trade-offs and chosen bitcoin over the field for very rational reasons.

The Minority Rule

Nassim Taleb writes about how a very small intransigent minority can force its preference on the majority, referring to it as the minority rule and explaining why The Most Intolerant Wins. Bitcoin (and monetary systems) are a perfect example of this phenomenon. If a very small minority converges on the belief that bitcoin has superior monetary properties and will not accept your form of digital (or traditional) currency as money, while less convicted market participants accept both bitcoin and other currencies, the intolerant minority wins. This is exactly what is happening in the global competition for digital currency supremacy. A small minority of market participants has determined that only bitcoin is viable, rejecting the monetary properties of all other digital currencies, while the majority is willing to accept bitcoin along with the field. Because of its intransigence, the minority is slowly forcing its preference on the majority. In the world of digital currencies, diversifying by picking the field is the equivalent of letting the crowd (or the intolerant minority) choose what your future money will be, while resigning yourself to only a fraction of what you otherwise would have saved. Evaluate the trade-offs and

consider the minority rule before trading in your hard-earned value for a flyer. Money doesn't grow on trees.

> "Bitcoin is a remarkable cryptographic achievement, and the ability to create something that is not duplicable in the digital world has enormous value."
> – Eric Schmidt (Former Google CEO)

BITCOIN IS NOT TOO VOLATILE - AUGUST 9, 2019

Has anyone you respect ever told you that bitcoin doesn't make any sense? Maybe you've seen the price of bitcoin rise exponentially and then seen it crash. You write it off, believe your friend was right, don't hear about it for a while and think bitcoin must have died. But then you wake up a few years later, bitcoin hasn't died and somehow its value is a lot higher again. And you start thinking maybe your skeptical friend wasn't right?

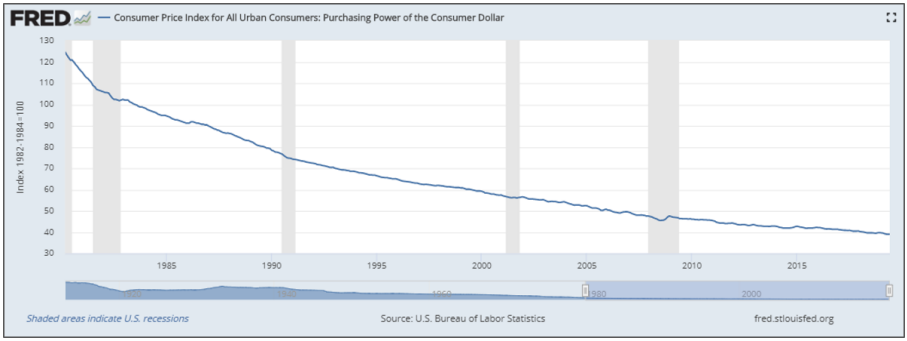
The list of bitcoin skeptics is long and distinguished (see here), but the noise contributes directly to the antifragile nature of bitcoin. People that store wealth in bitcoin are forced to think through first principles in order to understand characteristics of bitcoin which otherwise seem, on the surface, to contradict an establishment view of money, which ultimately hardens convictions. Bitcoin volatility is one of these oft-criticized characteristics. A common refrain among skeptics, including central bankers, is that bitcoin is too volatile to be a store of value, medium of exchange or unit of account. Given its volatility, why would anyone hold bitcoin as a savings mechanism? And, how could bitcoin be effective as a transactional currency for payments if its value could reasonably drop tomorrow?

The principal use case for bitcoin today is not as a payments rail but instead as a store of value, and the time horizon for those that store wealth in bitcoin is not a day, week, quarter or even a year. Bitcoin is a long-term savings mechanism and stability in the value of bitcoin will only be realized over time as mass adoption occurs. In the interim, volatility is the natural function of price discovery as bitcoin advances down the path of its monetization event and toward full adoption. Separately, bitcoin does not exist in a vacuum; most individuals or businesses are not singularly exposed to bitcoin and exposure to multiple assets, like any portfolio, mutes volatility of any single asset.

Not Volatile ≠ Store of Value

It is fair to say that volatility and store of value are often confused as mutually exclusive. However, they most certainly are not. If an asset is volatile, it does not mean that asset will be an ineffective store of value. The opposite is also true; if an asset is not volatile, it will not necessarily be an effective store of value. The dollar is a prime example: not volatile (today at least), bad store of value.

> "Volatile things are not necessarily risky, and the reverse is also true." Nassim Taleb (Skin in the Game)



The Fed has been highly effective in very slowly devaluing the dollar, but always remember, *gradually, then suddenly*. And, not volatile ≠ store of value. This is a critical mental block that many people experience when thinking about bitcoin as a currency, and it is largely a function of time horizon. While central bankers all over the world point to bitcoin as a poor store of value and not functional as a currency because of volatility, they think in days, weeks, months and quarters while the rest of us plan for the long-term: years, decades and generations.

Despite the logical explanations, volatility is one area that particularly confounds the experts. Bank of England Governor, Mark Carney

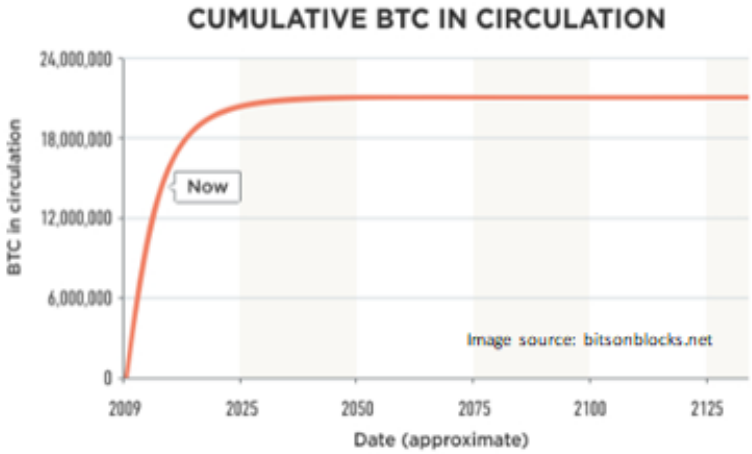
recently commented that bitcoin "has pretty much failed thus far on […] the traditional aspects of money. It is not a store of value because it is all over the map. Nobody uses it as a medium of exchange," (see here). The European Central Bank (ECB) has also mused on Twitter that bitcoin is "not a currency", noting that it is "very volatile" while at the same time reassuring everyone that it can "create" money to buy assets, the very function by which its currency actually loses value and why it's a poor store of value.

The lack of self-awareness is not lost on anyone here but Mark Carney and the ECB are not alone. From former Fed Chairs, Bernanke and Yellen, to current Treasury Secretary Mnuchin to the President himself. All have, at times, trumpeted the idea that bitcoin is flawed as a currency (or as a store of value) because of its volatility. None seem to fully appreciate, or at least admit, that bitcoin is a direct response to the systemic problem of governments creating money via central banks or that bitcoin volatility is a necessary and healthy function of price discovery.

But luckily for all of us, bitcoin is not too volatile to be a currency and often the experts are not experts at all. Setting logic aside, the empirical evidence shows that bitcoin has proven to be an exceptional store of value over any extended time horizon despite its volatility. So how could an asset such as bitcoin be both highly volatile and an effective store of value?

Bitcoin Value Function Revisited

Consider why there is fundamental demand for bitcoin and why bitcoin is naturally volatile. Bitcoin is valuable because it has a fixed supply and it is also volatile for the same reason. The fundamental demand driver for bitcoin is in its scarcity. To revisit bitcoin's value function from a previous edition, decentralization and censorship-resistance reinforce the credibility of bitcoin's scarcity (and fixed supply schedule) which is the basis of bitcoin's store of value property:



While demand is increasing by orders of magnitude, there is no supply response because bitcoin's supply schedule is fixed. The disparity in the rate of increase in demand (variable) vs. supply (fixed) combined with imperfect knowledge amongst market participants causes volatility as a function of price discovery. As Nassim Taleb writes in The Black Swan of Cairo: *"Variation is information. When there is no variation, there is no information."* As bitcoin's value increases, it communicates information despite the volatility; the variation is the information. Higher value (dependent on variation) causes bitcoin to become relevant to new pools of capital and new entrants which then stokes an adoption wave.

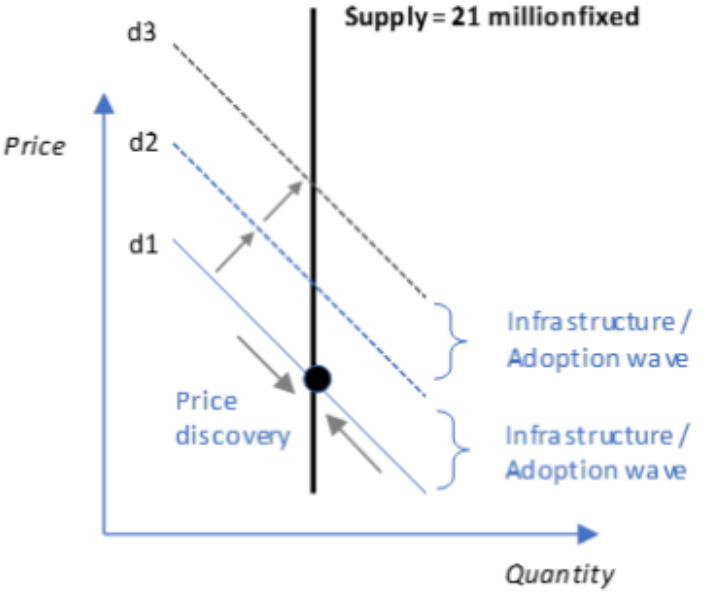
Adoption Waves & Volatility

Knowledge distribution and infrastructure fuel adoption waves and vice versa. It is a virtuous feedback loop and a function of both time and value. As value rises, bitcoin captures the attention and mindshare of a much wider audience of potential adopters, which then begin to learn about the fundamentals of bitcoin. Similarly, an appreciating asset base attracts additional capital not only as a store of wealth but also to build incremental infrastructure (e.g. more on-ramps & off-ramps, custody solutions, payments layers, hardware, mining, etc.).

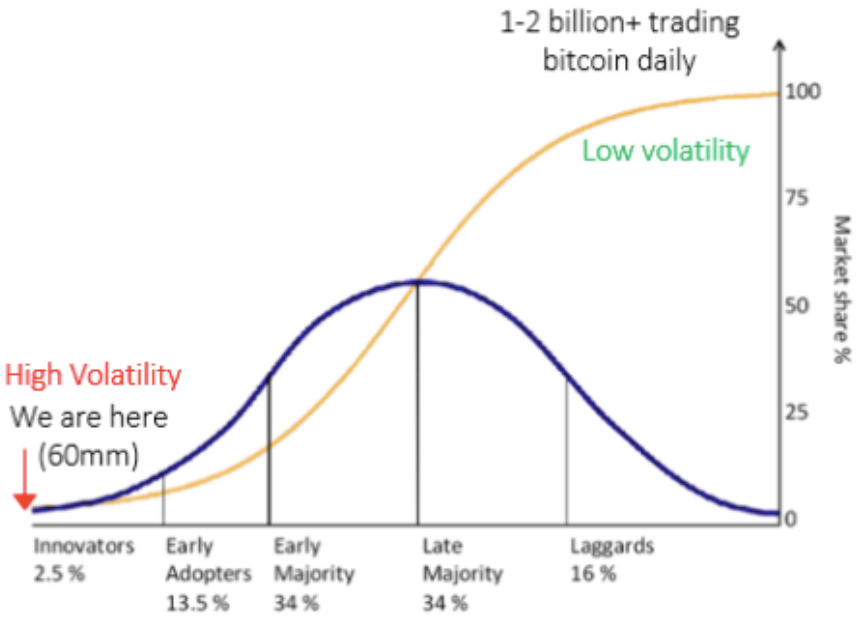
Developing an understanding of bitcoin is a slow process, as is building infrastructure, but both fuel adoption which then further distributes knowledge and justifies additional infrastructure.

Knowledge → *Infrastructure* → *Adoption* → *Value* → *Knowledge* → *Infrastructure*

Fixed Supply vs. Expanding Demand



Stages of Technology Adoption (S-Curve)

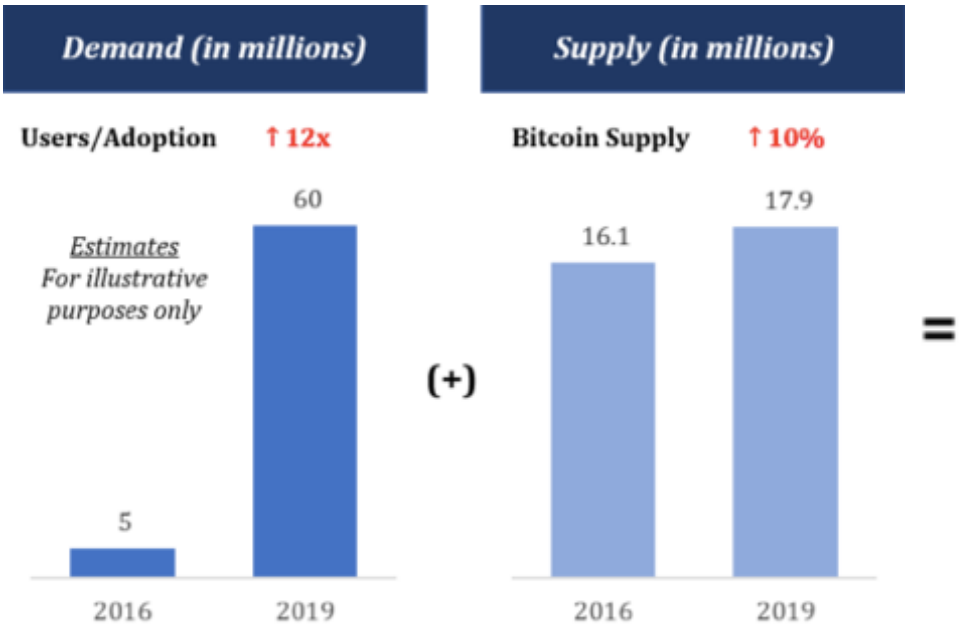


Today, bitcoin is still nascent and current adoption likely represents <1% of terminal adoption. As a billion people adopt bitcoin, new adoption will represent orders of magnitude for any foreseeable future period which will continue to drive significant volatility; however, with each new adoption wave, the value of bitcoin will also reset higher because of higher base demand. Bitcoin volatility will only decline as the holder base reaches maturity and as the rate of new adoption stabilizes. Said another way, for a billion people to be using bitcoin, adoption will have had to increase by ~20x, but the subsequent 100 million adopters will only represent an additional 10% of the base. All while the supply of bitcoin remains on a fixed schedule. So long as adoption represents orders of magnitude, volatility is unavoidable, but on that path, volatility will naturally and gradually decline.

As Vijay Boyapati explained on Stephan Livera's podcast, "establishment economists deride the fact that bitcoin is volatile, as if you can go from something that didn't exist to a stable form of money overnight; it's completely ludicrous." What happens between adoption waves is the natural function of price discovery as the market converges on a new equilibrium, which is never static. In bitcoin hype cycles, the rise, fall, stabilization and rise again is almost rhythmic. It is also naturally explained by speculative fear, followed by accumulation of fundamental knowledge and the addition of incremental infrastructure. Rome wasn't built in a day; in bitcoin, volatility and price discovery are core to the process.

Historical Adoption Wave

For a more tangible explanation of the relationship between volatility and value, it is helpful to think about the most recent adoption wave from the end of 2016 to present (2019).



While adoption can never really be quantified, a rough but fair estimate would be that bitcoin adoption increased from ~5 million people to ~60 million (an increase in demand of ~12 times) from 2016 to present, yet the supply of bitcoin only increased by approximately 10% over the same period. And naturally, the information and capital possessed by market participants varies significantly. As a massive adoption wave occurred, it was met by bitcoin's fixed supply schedule. What would one expect to happen when demand increases by an order of magnitude but supply only increases by 10%? And what would happen if the knowledge and capital of the new entrants naturally varies greatly?

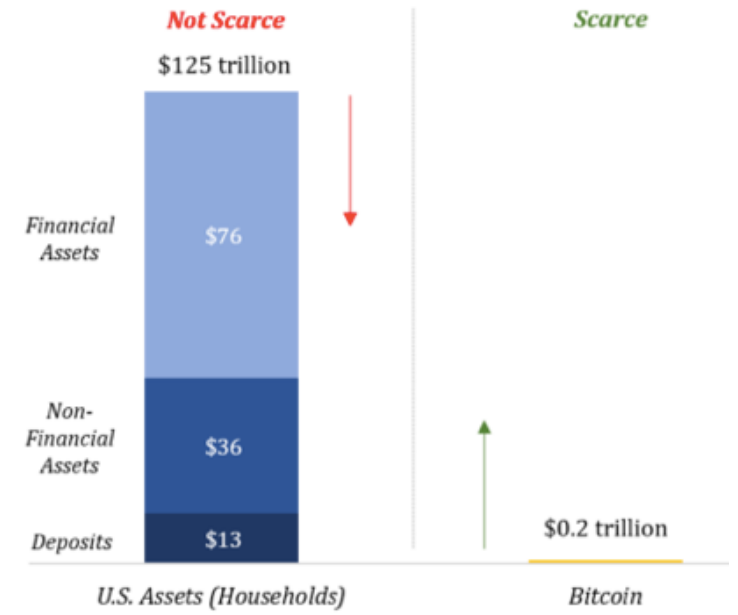
The very logical end result is higher volatility and a higher terminal value, if even a small percentage of new entrants convert to long-term holders (which is exactly what happened). New adopters who initially purchased bitcoin in its astronomical rise, slowly accumulate knowledge and convert to long-term holders, stabilizing base demand at a far higher terminal value compared to the prior adoption cycle.

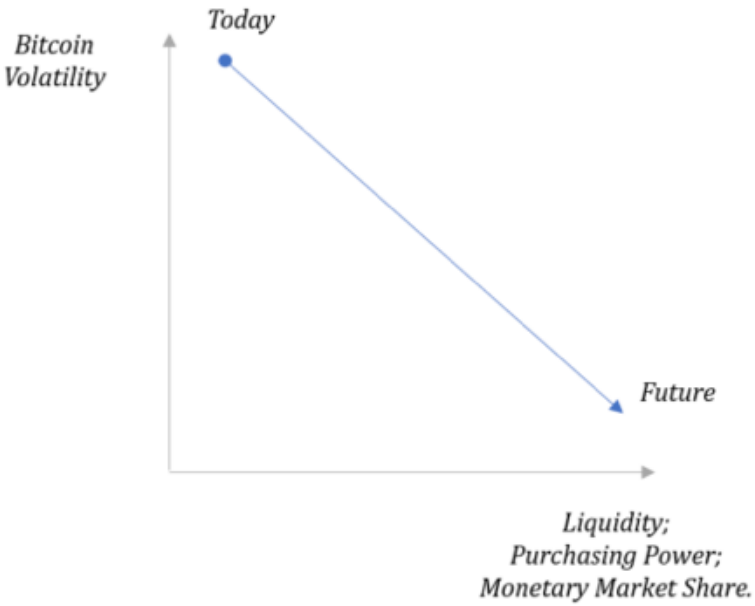
Because bitcoin is nascent, the aggregate wealth stored in bitcoin on a relative basis is still very small (~$200 billion) which allows for the rate of change between marginal buyers and sellers (price discovery) to represent a significant percentage of the base demand (volatility). As base demand increases, the rate of change will begin to represent a smaller and smaller percentage of the base, reducing volatility over time and only after several more adoption cycles.

Managing Volatility

If we can accept that bitcoin volatility is both natural and healthy, why doesn't current volatility prevent the adoption required to transition bitcoin to a stable form of money? Very simply: diversification, portfolio allocation theory and time horizon. There exists a global network (bitcoin) through which you can transfer value over a communication channel to anyone in the world, and it is currently valued, in total, at less than $200 billion. Facebook alone, on the other hand, is worth in excess of $500 billion. For further frame of reference, U.S. household assets are estimated to be valued at $125 trillion (see here, page 138).

In a theoretical world, bitcoin volatility would be an issue if it existed in a vacuum. In the real world, it doesn't. Diversification comes in the form of real productive assets as well as other monetary and financial assets, which mutes the impact of bitcoin's present volatility. Separately, information asymmetry exists and those that understand bitcoin also understand that, in time, the cavalry is coming. These concepts are obvious to those that have exposure to bitcoin and actively account for its volatility in short and long-term planning, but it's apparently less obvious to the skeptics, who struggle to grasp that bitcoin adoption is not an all or nothing proposition.


Not Scarce
Scarce
$125 trillion
Financial Assets
$76
Non-Financial Assets
$36
Deposits
$13
$0.2 trillion
U.S. Assets (Households)
Bitcoin


Today
Bitcoin Volatility
Future
Liquidity;
Purchasing Power;
Monetary Market Share.

While bitcoin will continue to steal share in the global competition for store of value because of its superior monetary properties, the function of an economy is to **accumulate capital** that actually makes our lives better, **not money**. Money is merely the economic good that allows for coordination to accumulate that capital. Because bitcoin is a fundamentally better form of money, it will gain purchasing power relative to inferior monetary assets (and monetary substitutes) and increasingly take market share in the economic coordination function, despite being less functional as a transactional currency today.

Bitcoin will also likely induce the de-financialization of the global economy, but it will neither eliminate financial assets nor real assets. During its monetization, these assets will continue to represent the diversification which will mute the impact of bitcoin's day-to-day volatility. See example here which highlights the risk/return of a 1% bitcoin + 99% dollar portfolio compared to gold, U.S. treasuries and the S&P 500 (@100trillionUSD). Also see The Case for a Small Allocation to Bitcoin by Xapo CEO Wences Casares. Both provide a look through into how volatility and risk can be managed should bitcoin experience a significant drawdown or even fail (which is still a possibility).

While failure is a possibility and significant drawdowns are an inevitability, each day that bitcoin doesn't fail, its survival becomes more and more likely (Lindy Effect). And over time, as bitcoin's value and liquidity increase due to its fundamental strengths, its purchasing power will also increase in terms of real goods, but as its purchasing power represents a larger and larger share of the economy, its volatility relative to other assets will proportionally decrease.

The End Game

Bitcoin will become a transactional currency over time but in the interim, it would be far more logical to spend a depreciating asset (dollars, euro, yen, gold) and save an appreciating asset (bitcoin). Establishment economists and central bankers really struggle with this

one; but I digress. On bitcoin's path to full monetization, store of value must come as a logical first order and bitcoin has proven to be an incredible store of value despite its volatility. As adoption matures, volatility will naturally fall, and bitcoin will increasingly become a medium of direct exchange.

Consider the person or business that would demand bitcoin in direct exchange for goods and services. This person or business collectively represent those that have first determined that bitcoin will hold its value over a particular time horizon. If one did not believe in the fundamental demand case for bitcoin as a store of value, why would they trade real-world goods and services in return? Bitcoin will transition to a transactional currency only as its liquidity gradually shifts from other monetary asset to goods and services which will occur along the path to mass adoption. It will not be a flash cut or a binary process. On a more standard path, adoption fuels infrastructure and infrastructure fuels adoption. Transactional infrastructure is already being built but more material investment will only be prioritized as a sufficient number of individuals first adopt bitcoin as a store of wealth.

Ultimately, bitcoin's lack of a price stability mandate and fixed supply will continue to result in near-term volatility but will drive long-term price stability. It is the literal opposite model pursued by Mark Carney of the BOE, the ECB (and its twitter account), the Federal Reserve and the Bank of Japan. And, it is why bitcoin is antifragile; there are no bailouts and it's a market devoid of moral hazard, which drives maximum accountability and long-term efficiency. Central banks manage currencies to mute short-term volatility, which creates the instability that leads to long-term volatility. Volatility in bitcoin is the natural function of monetary adoption and this volatility ultimately strengthens the resilience of the bitcoin network, driving long-term stability. Variation is information.

Nassim Taleb & Mark Blyth (Black Swan of Cairo)

"Complex systems that have artificially suppressed volatility tend to become extremely fragile, while at the same time exhibiting no visible risks."

"This is one of life's packages: there is no freedom without noise —and no stability without volatility."

Ben Bernanke, Chairman of the Federal Reserve (during the Great Financial Crisis)

"The Federal Reserve is not currently forecasting a recession." – January 10, 2008

"The risk that the economy has entered a substantial downturn appears to have diminished over the past month or so." – June 9, 2008

BITCOIN DOES NOT WASTE ENERGY - AUGUST 16, 2019

How many times have you heard the safety instructions before a standard commercial flight? You probably know them by heart, but every time, prior to takeoff, flight attendants instruct passengers traveling with children to put their oxygen mask on first and then tend to the children. Instinctively, it's counterintuitive. Logically, it makes all the sense in the world. Make sure you can breathe, so that the child dependent on you can breathe too. The same principle applies to the coordination function of money in an economy and the resources required to protect that function. In a more philosophical safety warning, the flight attendant may say, "please make sure the money supply is secure so that we can continue to coordinate the activity of millions of people to build these hyper complex planes that afford you the opportunity to even contemplate the problem I'm about to explain."

We will come back to this, but you will never hope to understand the justification for the amount of energy bitcoin consumes without first developing an appreciation for the fundamental role money plays in coordinating economic activity. What is money? How does it work? How should it work? What is its function in society? If you haven't stopped to ask these questions, you can't begin to grasp the weight of the problem bitcoin intends to solve. And without an appreciation for the problem, the cost to secure the solution will never seem justified.

Any number of concerned onlookers raise the red flag about the amount of energy consumed by the bitcoin network. This concern stems from the idea that the energy consumed by the bitcoin network could otherwise be utilized for more productive functions, or that it is just plain bad for the environment. Both ignore the fundamental magnitude of how critical bitcoin's energy consumption actually is. In the long-game, there may be no greater, more important use of energy than that which is deployed to secure the integrity of a monetary network and constructively, in this case, the bitcoin network. But, that

doesn't stop those that do not understand the problem statement from raising concerns.

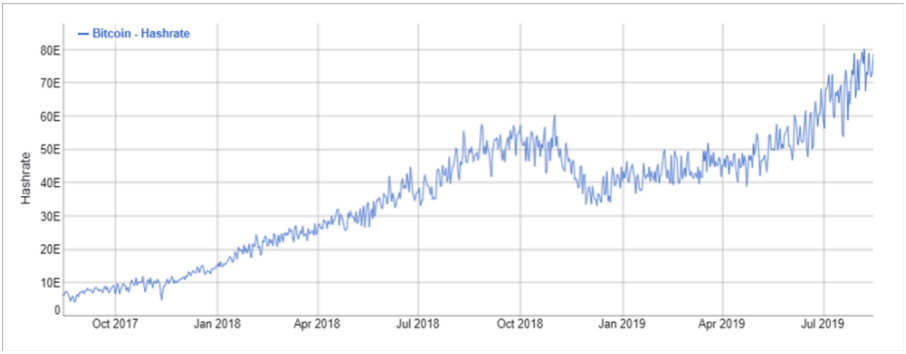
> "The fundamentally wasteful nature of bitcoin mining means there's no easy technological solution coming."
> – the Guardian

> "In the context of climate change, raging wildfires, and record-breaking hurricanes, it's worth asking ourselves hard questions about Bitcoin's environmental impact."
> – Vice Media

Bitcoin Energy Consumption

For background, bitcoin is secured by a decentralized network of nodes (computers running the bitcoin protocol). Economic nodes within the network generate, validate and relay transactions as well as validate and relay bitcoin blocks (time sequenced groups of transactions). Mining nodes perform similar functions but also perform bitcoin's proof of work function to generate, solve and transmit blocks to the rest of the network. By performing this work, miners validate history and provide a "clearing" function for current transactions, which all other nodes then check for validity. Think the clearing function of the New York Fed but on a completely decentralized basis every ten minutes (on average).

The work performed requires massive amounts of processing power contributed by miners all over the world, running 24 hours a day, 7 days a week. This processing power requires energy. For context, at 75 exahashes per second, the bitcoin network currently consumes approximately 7-8 gigawatts of power, which translates to ~$9 million per day (or ~$3.3 billion per year) of energy at a marginal cost of 5 cents per kWh (rough estimates). Based on national averages in the U.S., the bitcoin network consumes as much power as approximately 6 million homes. Yeah, it is definitely a lot of power, but it is also what secures and backs the bitcoin network.



How could this much energy be justified? And what will bitcoin consume when a billion people are using it? The dollar works just fine, right? Well that's just the thing, it doesn't. These resources are being devoted to fix a problem most don't understand exists, which makes justifying a derivative cost challenging. To help ease the pain of environmentalists and social justice warriors, we often point out a number of countervailing narratives to make it seem more palatable:

- A significant portion of bitcoin's energy consumption is generated from renewable resources.
- Bitcoin will spur innovation in the development of renewable energy technology & resources.
- Bitcoin consumes energy that is otherwise wasted, if not, flared into the atmosphere.
- Bitcoin consumes only the energy that the free market will bear at a free market rate.
- Bitcoin consumes energy resources that would otherwise not be economic to develop.
- The nature of bitcoin energy demand will improve the efficiency of energy grids.

These considerations help enumerate why a simple view that bitcoin's energy consumption is necessarily wasteful or necessarily bad for the environment fails the proverbial test. However, without an appreciation for the enormity of the monetary problem bitcoin intends to solve, the marginal cost could never be justified. Bitcoin represents

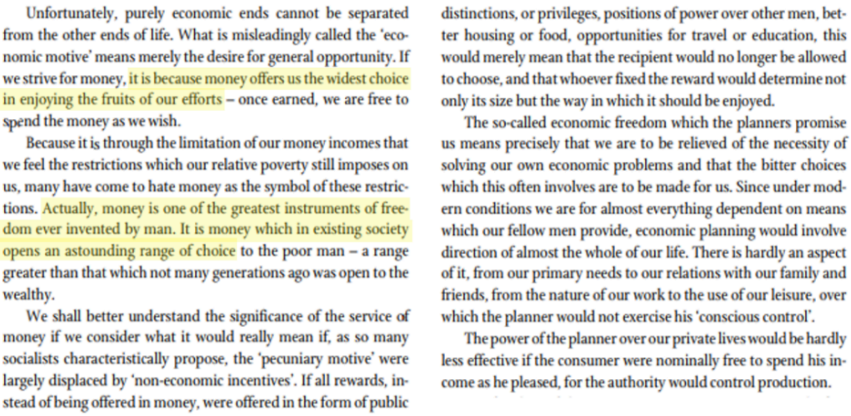
a solution to the systemic issues that exist within our legacy monetary framework and it relies on energy consumption to function. Economic stability depends on the function of money and bitcoin provides a more sound monetary framework which is why there is no more important long-term use of energy than securing the bitcoin network. So rather than expand on the many individual counterpoints to the mainstream narrative, there is no better place to focus than the first principle problem itself: the money problem or the global QE (quantitative easing) problem, see here.

The Function of Money

The problem of money is enormous, though most people do not recognize it. Most can feel it in their daily lives but cannot identify the root cause. Working harder, longer hours, going into debt and still barely getting by. There has to be a better way, but in order to identify a solution, one has to first see and understand the problem. The problem that exists is with our money and the impact it has on society is pervasive.

Without getting into the details of what money is (read the Bitcoin Standard or Nick Szabo's Shelling Out), we can more easily describe its function in society. Money is the good that facilitates economic coordination between parties that otherwise would not have a basis to cooperate. Put simply, it is the good that allows society to function, and it allows us to accumulate the capital that makes our lives better, which takes different forms for different people. There is a saying that money is the root of all evil, but as Hayek more appropriately describes it in the Road to Serfdom, money is an agent of freedom.

> "Money is one of the greatest instruments of freedom ever invented by man."
> - F.A. Hayek, The Road to Serfdom (Reader's Digest Condensed Version)



Unfortunately, purely economic ends cannot be separated from the other ends of life. What is misleadingly called the 'economic motive' means merely the desire for general opportunity. If we strive for money, it is because money offers us the widest choice in enjoying the fruits of our efforts – once earned, we are free to spend the money as we wish.

Because it is through the limitation of our money incomes that we feel the restrictions which our relative poverty still imposes on us, many have come to hate money as the symbol of these restrictions. Actually, money is one of the greatest instruments of freedom ever invented by man. It is money which in existing society opens an astounding range of choice to the poor man – a range greater than that which not many generations ago was open to the wealthy.

We shall better understand the significance of the service of money if we consider what it would really mean if, as so many socialists characteristically propose, the 'pecuniary motive' were largely displaced by 'non-economic incentives'. If all rewards, instead of being offered in money, were offered in the form of public distinctions, or privileges, positions of power over other men, better housing or food, opportunities for travel or education, this would merely mean that the recipient would no longer be allowed to choose, and that whoever fixed the reward would determine not only its size but the way in which it should be enjoyed.

The so-called economic freedom which the planners promise us means precisely that we are to be relieved of the necessity of solving our own economic problems and that the bitter choices which this often involves are to be made for us. Since under modern conditions we are for almost everything dependent on means which our fellow men provide, economic planning would involve direction of almost the whole of our life. There is hardly an aspect of it, from our primary needs to our relations with our family and friends, from the nature of our work to the use of our leisure, over which the planner would not exercise his 'conscious control'.

The power of the planner over our private lives would be hardly less effective if the consumer were nominally free to spend his income as he pleased, for the authority would control production.

More specifically, money is the good that allows for specialization and the division of labor. It allows individuals to pursue their own interests; it is how individuals communicate their preferences to the world, whether in work or in leisure, and it is what creates the "range of choice" we all take for granted. Our modern economy is built on the foundation of freedom that money provides, but the end result is a highly complex and specialized system.

To simplify the concept, Milton Friedman explains the complexity of a pencil (see here), detailing how no one individual is capable of producing a standard lead pencil. He details the wood required, the saw to cut the wood, the steel to make the saw, the iron ore to make the steel, the lead, the rubber for the eraser, the brass ring, the yellow paint, the glue, etc. He explains how making a single pencil requires the coordination and cooperation of thousands of people, including people who don't speak the same language, who likely practice different religions and who may even hate each other if they were ever to meet in person. And he explains that the ability to cooperate is a function of the price system and the economic good we call money.

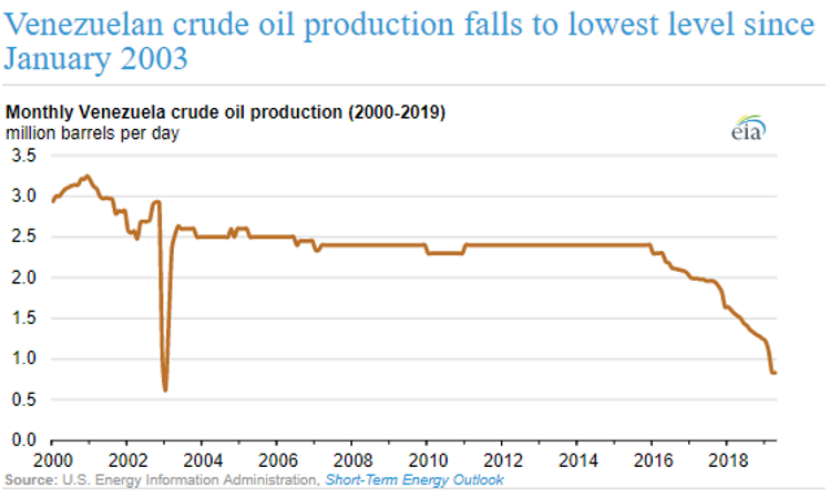
Abstracting from the pencil, now consider the complexity of our modern economy. From cars to airplanes to the internet to mobile phones, even to your local grocery store. Modern supply chains are so

complex and so specialized that they require the coordination of millions of people to deliver any of these basic functions. The orchestration of all this activity which fuels global trade is only made possible by the function of money.

A Living Example: Venezuela

Venezuela provides a tangible macro and micro example of the vital role money plays in economic coordination and the dysfunction that follows when a monetary good fails. Venezuela is one of the most oil rich countries in the world, but as an end game function of monetary debasement, Venezuela's currency has recently hyperinflated. As its currency has deteriorated, basic economic functions have broken down to the point where getting food at grocery stores or basic healthcare is no longer the baseline. It is a full-on humanitarian crisis, and at the root level, it is a function of Venezuela no longer having a stable currency to coordinate economic activity and to facilitate the production of the goods it needs to trade within the global economy.

How does this relate to bitcoin and energy consumption? Being an energy rich country, oil was (and is) Venezuela's primary export; or rather, the good it needs to produce in order to trade. Despite being one of the most energy rich countries in the world, Venezuela's oil production is plummeting.

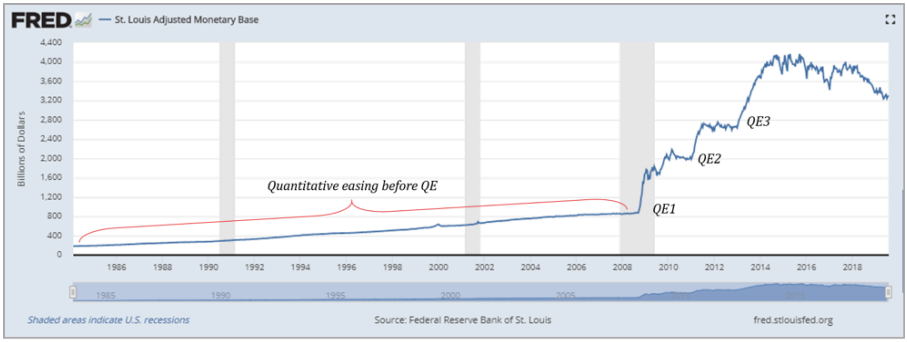


Venezuela can no longer import the technology or coordinate the resources it needs to extract its primary trading currency (oil). This has caused significant deterioration in its local economy, impairing its ability to produce the electricity needed to power its own energy grids, causing extended blackouts and preventing the delivery of basic services such as power, clean water or healthcare.

What is occurring in Venezuela is devastating, and it is a function of the economic deterioration caused by hyperinflation. Monetary debasement distorts the price mechanism of a currency, which then creates economic imbalances. As economic coordination deteriorates, complex supply chains become disrupted resulting in a decline in the supply of real goods (e.g. food on shelves, oil production, etc.) and an imbalance between supply and demand. As more money is created, real goods become relatively scarce compared to the supply of money, which causes the very function of money to breakdown. Individuals have a disincentive to hold currency as real goods become more and more scarce, instead choosing to sell currency as quickly possible, creating a run on basic necessities and causing the currency to hyperinflate. Economic deterioration by monetary manipulation 101.

The Developed World Application

Now, many sitting comfortably in the developed world will look at Venezuela and think, "it could never happen here," but that ignores all first principles. Whether it is well understood or not, the market structure of the Venezuelan bolivar or the Argentine peso is identical to that of the dollar, the euro or the yen. The Fed, the European Central Bank or the Bank of Japan may be better at managing stability (for now), but it does not change the fact that the underpinnings of all fiat currency systems are the same.



Note: The Adjusted Monetary Base is the sum of currency (including coin) in circulation outside Federal Reserve Banks and the U.S. Treasury, plus deposits held by depository institutions at Federal Reserve Banks. These data are adjusted for the effects of changes in statutory reserve requirements on the quantity of base money held by depositories.

To highlight the U.S. as an example, the Federal Reserve expanded the monetary base from $180 billion in 1984 to a peak of $4.2 trillion following QE3, an increase of 23x. Because of the nature of the Fed's credit-based economy, the economic distortion of this debasement occurred gradually (see here) until the financial crisis which occurred suddenly, and as a function of quantitative easing, we presently sit further out on the same ledge. If you believe the developed world is not in a precarious situation or not subject to a similar monetary foundation as Venezuela, I would respectfully point to patients zero: the Fed, the ECB and the Bank of Japan. Often, faith placed in these institutions is blind to both first principles and common sense, but consider the quote below from a resident Fed economist during the aftermath of the financial crisis and as the Fed was in the middle innings of creating $3.6 trillion new dollars as part of quantitative easing:

> "Also, I want to just emphasize that I think the gaps in our understanding of the interactions between the financial sector and the real sector are profound"
> David Wilcox – Fed Economist (August 2011)

An honest review of history demonstrates the ill-temperament of those put in charge of managing our economies from central command. While admitting profound gaps in their ability to understand the implications of actions taken on the real economy, the

response was to continue down the same path (but in a bigger way) while expecting a different result, the definition of insanity. Now, as we face the consequences of the response to the crisis, we have a choice between two great contrasts. A) a centrally-planned form of currency that is designed to lose its value; or B) a decentralized currency with a fixed supply. The latter comes with cost in the form of energy consumption, but the positive externality will be long-term economic stability.

Economic Stability via Energy Consumption

Future economic stability is fundamentally why there can be no more important source of demand for the consumption of energy than the security of bitcoin's monetary system, especially when the alternatives (fiat and gold) are structurally flawed. If we wait to see the signs of hyperinflation, we're already lost. But Venezuela is not just an example of what transpires as a result of hyperinflation, it is a living example of the importance of energy production to the functioning of society. Some energy input is required for everything that we consume in our daily lives. The coordination of those energy inputs is dependent on the reliability and stability of the money we use.

Ignore your morning coffee for a minute and think basics: clean water, sanitation, food, medicine, basic healthcare, etc. The coordination of resources to deliver these basic services is dependent on a functioning monetary system. When a monetary system breaks down, social coordination and even the social fabric begins to go with it. If the basis of all trade is energy, and if we need money to coordinate trade, the highest and best use of that energy should first be to protect the monetary system. Put your proverbial "oxygen mask" on first and then shift to dependents. Secure the foundation of trade and then focus on all of the derivatives.

Any and all concerns about the amount of energy bitcoin consumes or will consume is a red-herring. It is not that we should sacrifice electricity that could otherwise power homes; instead, it's that we will

never have the electricity to power those homes if we do not have a reliable monetary system to coordinate economic activity and marshal resources. In practice, bitcoin will not practically compete for the same energy resources that fuel the basic productive and consumptive functions of our economy (not zero sum); instead, bitcoin's function as a currency system will ensure that those very energy needs can continue to be fulfilled.

What would be bad for society is if more countries deteriorated into the economic and humanitarian disaster that is Venezuela, where basic health and human services cannot be reliably provided. And this is not to present a draconian vision or a dystopian future; instead, it is to articulate the importance and interconnectedness of both the money function and the energy function in complex, highly specialized economies.

> "If it prevents one instance of hyperinflation such as Venezuela from happening […], bitcoin's energy consumption would be the best bargain humanity ever got." – Saifedean Ammous, The Bitcoin Standard Research Bulletin

Bitcoin represents a backup switch to the current architecture of the global financial system and is soon to be its primary engine. Setting aside the systemic risks that currently plague our financial system, bitcoin is a fundamentally more sound monetary system from the ground up. And, it is one secured by the production and consumption of energy. You do not have to believe that the dollar's fate will be that of the Venezuelan bolivar to recognize the importance and interplay between the stability of a monetary function and the production of energy resources that provide basic economic necessities. And the risk inherent in even the possibility of hyperinflation is so negatively asymmetric that the price of bitcoin energy consumption is of small relative cost.

Bitcoin will consume any and all energy resources necessary to secure its monetary network, which is inherently driven by the base demand to hold it as a currency. The more people that value the long-term stability it provides, the more energy it will consume. In the end, this consumption will ensure all other derivatives of energy consumption will continue to be fulfilled, which is why there is no more important long-term use of energy than securing the bitcoin network. Put a price on economic stability and the economic freedom a stable monetary system provides; that is the true justification for the amount of energy bitcoin should and will consume. Everything else is a distraction.

BITCOIN IS NOT TOO SLOW - AUGUST 23, 2019

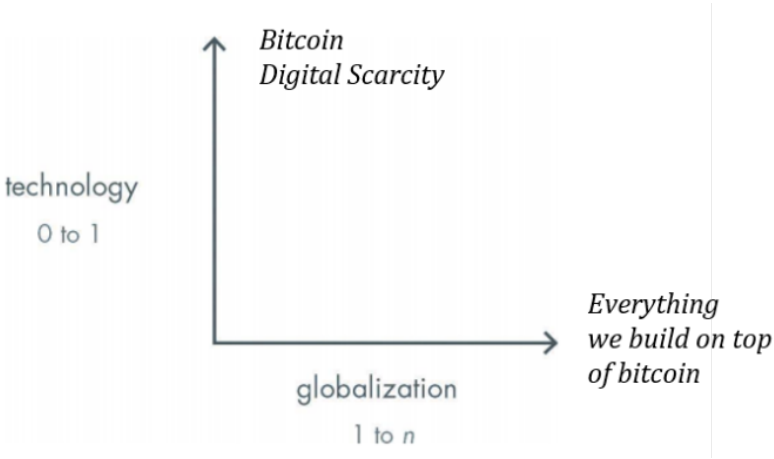
In Peter Thiel's Zero to One, he outlines the impact new technology has on building a non-zero sum future. While the book is focused on individuals and companies, bitcoin as a monetary system is the ultimate zero to one technology leap. For historical examples, Thiel highlights the advent of the steam engine as well as the shift from typewriters to computer processors among others. He also articulates a view that innovation has largely stagnated since the early 1970s, while noting that technological progress since then has been more 1 to n than 0 to 1. Bitcoin fixes this. Bitcoin's innovation is not only zero to one; it is fundamentally distinct from the class of innovation that is the focus of Thiel's book. Bitcoin is a monetary protocol built on digital scarcity, the impact of which will be far broader than steam engines and computer processors.

Bitcoin fixes this

There's a new meme floating around the internet; whatever the problem, bitcoin fixes this. Negative yielding debt? Bitcoin fixes this. Wealth inequality? Bitcoin fixes this. Endless global war? Bitcoin fixes this. Financial crises? Bitcoin fixes this. Rage culture? Bitcoin fixes this. We're not exactly sure how just yet, but it's an articulation of the balancing effect a sound and stable monetary system will have on every aspect of society. Money is the coordination function of society. It allows hundreds of millions of people to cooperate who otherwise would not have a basis to do so. And, bitcoin is the tool that will allow for more peaceable coordination because it is both unmanipulable and devoid of moral hazard. How it globalizes is the "1 to n" problem (not in the express sense as Thiel describes), but the solutions to scale bitcoin will naturally be incremental. The non-zero sum collective benefit that follows may not literally cure every ill in the world, but the invention of a step-function change monetary network is fundamentally different than any single product because money is the economic good that coordinates all other economic activity.

> "The problem is precisely how to extend the span of our utilization of resources beyond the span of the control of any one mind; and therefore how to dispense with the need of conscious control and how to provide inducements which will make the individuals do the desirable things without anyone having to tell them what to do." – F.A. Hayek, The Use of Knowledge in Society

Hayek writes about the invention of money and the price mechanism as the tool that allows society to dispense with the need of "conscious control." Bitcoin is the superior successor to this mechanism, and its zero to one innovation is digital scarcity, not payments or speed of transactions. While bitcoin's property of scarcity still needs further stress testing, it is a profound achievement and what makes bitcoin unique. Never before bitcoin has any asset, let alone a digital one, been finitely scarce; the end result of its innovation is the hardest form of money that has ever existed. That is the zero to one achievement and a phenomenon that almost certainly will not be repeated.



Every other problem that bitcoin will have to overcome is more pedestrian relative to scarcity. Digital payments? The idea that human ingenuity can create digital scarcity but that we then cannot layer on payments technology does not logically follow. Payments technology is just one of the many 1 to n innovations that will be built on top of bitcoin to globalize its adoption. Not only are payments easier to solve, it is also not a critical path that needs solving **today**. The primary use case for bitcoin today is as a savings mechanism, not payments. Over time, as adoption increases and as more infrastructure is built, bitcoin will evolve into a more transactional currency, but that process will occur gradually, not suddenly. And as the shift occurs, bitcoin adopters will continue to leverage legacy monetary systems and legacy payments rails.

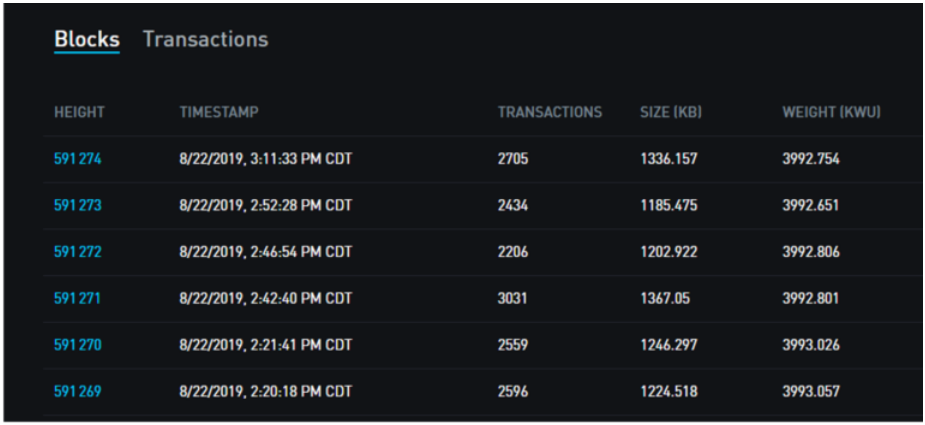
Not a Payments Rail

The bitcoin blockchain will never be a layer for mass payments, but there is a considerable amount of debate on this topic. Many hold the view that for bitcoin to be "successful" it needs to be a one-stop shop, combining the roles of currency issuer, settlement layer and payments rail. While bitcoin fulfills the first two functions beautifully (currency issuer + settlement layer), it is categorically not a payments rail. Both for reasons of speed and scale, bitcoin fails the payments test. The good news? We don't need the bitcoin network to be a payments rail.

Much of the confusion in the philosophical (rather than technical) debate stems from the opening salvo of the bitcoin whitepaper: "a Peer-to-Peer Electronic Cash System." Peer-to-peer has been interpreted by some to imply that bitcoin needs to be able to handle every last transaction in the world between any two peers. Separately, others believe that if bitcoin transactions cannot occur at the scale or speed of Visa or Mastercard, it is structurally flawed. Essentially, according to skeptics, if bitcoin cannot meet both of these standards, it fails on its promise. Thankfully it does not.

For additional background, bitcoin blocks are solved every 10 minutes on average; however, bitcoin blocks are not solved precisely

every 10 minutes on a fixed schedule. The next block may be solved in 1 minute or 20 minutes, 30 seconds or 36 minutes. The network adjusts such that blocks are solved on average every 10 minutes. How could a merchant or transaction processor live in a world either this slow or unpredictable? Separately, bitcoin blocks have a limited amount of space to include transactions. While there is not a fixed transaction capacity in bitcoin by count, each bitcoin transaction consumes a limited amount of block space; as a function of limited capacity, blocks include approximately 2,700 transactions on average. With ten-minute average block intervals, six blocks per hour, 24 hours per day, 365 days per year, that equates to a network capacity of approximately 145 million transactions per year which is the equivalent of approximately 4.6 transactions per second. Visa on the other hand processes 124 billion transactions per year at a rate of ~4,000 transactions per second (see here).



Blocks Transactions

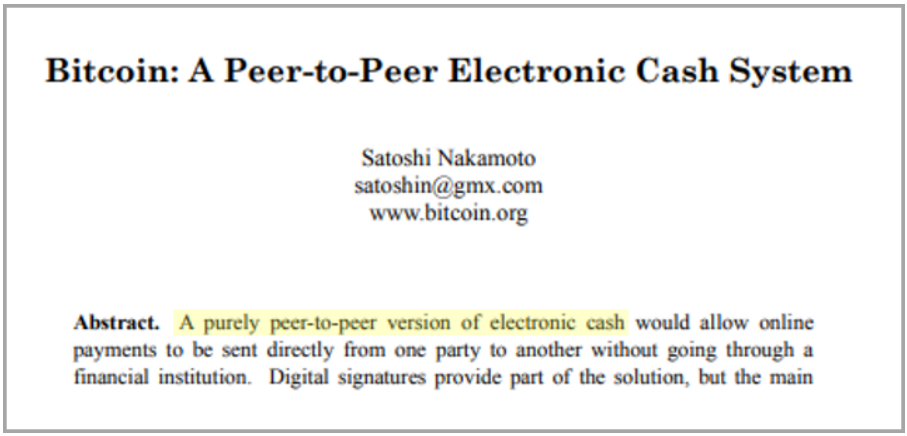
HEIGHT	TIMESTAMP	TRANSACTIONS	SIZE (KB)	WEIGHT (KWU)
591 274	8/22/2019, 3:11:33 PM CDT	2705	1336.157	3992.754
591 273	8/22/2019, 2:52:28 PM CDT	2434	1185.475	3992.651
591 272	8/22/2019, 2:46:54 PM CDT	2206	1202.922	3992.806
591 271	8/22/2019, 2:42:40 PM CDT	3031	1367.05	3992.801
591 270	8/22/2019, 2:21:41 PM CDT	2559	1246.297	3993.026
591 269	8/22/2019, 2:20:18 PM CDT	2596	1224.518	3993.057

Source: blockstream.info

How can bitcoin be the purely peer to peer engine that powers the global financial system, if it operates at nearly one one-thousandth the scale and speed of Visa alone? The reality has always been that, if bitcoin were to have a non-zero value, the consequence would be a system so valuable that any base layer would not be able to handle all transactions without sacrificing decentralization or censorship

resistance. Without these properties, bitcoin would not be a zero to one innovation and its value function would break down. Ultimately, the bitcoin protocol layer provides the function of currency issuance and final settlement, but it is not capable of storing every small purchase, including your Starbucks, for the rest of time for everyone.

If it were the latter, all transactions by all people, no matter how big or how small, would have to be validated and stored by every other person on earth. Without a mechanism to align the interests of network participants, a tragedy of the commons problem would exist and the end result would be a less secure currency system subject to centralization. Instead, we accept a mechanism to limit transaction throughput at the base layer, shifting aspects of bitcoin's peer-to-peer transactional architecture to separate layers that integrate with bitcoin. These tradeoffs have been made in order to secure the foundation of bitcoin's monetary system (decentralization → censorship resistance → fixed supply).



Bitcoin: A Peer-to-Peer Electronic Cash System

Satoshi Nakamoto
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www.bitcoin.org

Abstract. 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

Many point to this text from the bitcoin whitepaper released by its pseudonymous founder as evidence that bitcoin was always intended to fulfill every payment by every possible network peer. It does say "purely peer-to-peer" after all. However, more important to bitcoin

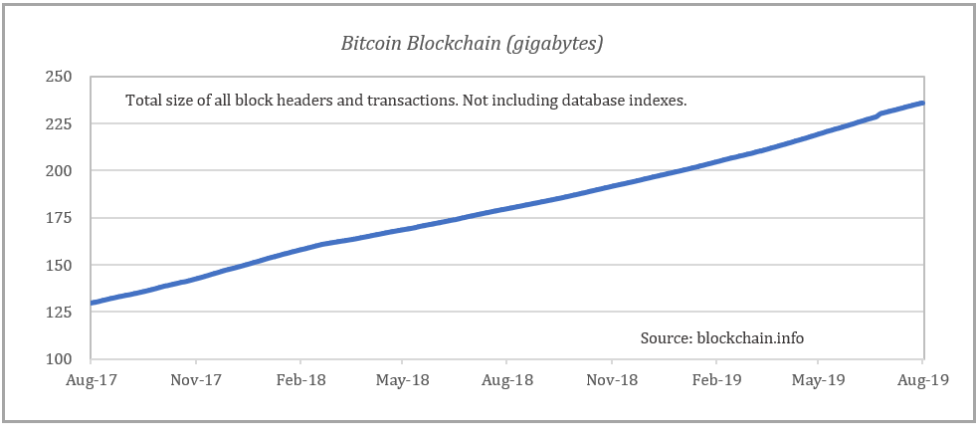
than anything written in this summary (or any interpretation) is bitcoin's consensus mechanism. Everything critical in bitcoin is enforced by a consensus of network participants, including its fixed supply and ultimately the capacity within each bitcoin block, which limits the number of transactions it can process. This is the fundamental difference between bitcoin and the legacy financial system: monetary policy by consensus rather than by fiat. Bitcoin's founder created a system that ultimately removed critical decisions from any central authority, instead deferring to the wisdom of market consensus. It is a system that is flexible enough to be adapted but rigid enough that any material change is very difficult. As a consequence, network peers have to decide, on a decentralized basis, how best to scale bitcoin. It is through this consensus mechanism that bitcoin dispenses of the need for "conscious control."

Security Trade-offs

Everything comes with trade-offs. In bitcoin, there are two holy grails: a fixed 21 million supply and preventing the currency from being spent multiple times (the double spend problem). The value of bitcoin is derived from its ability to secure both of these functions on a decentralized, trustless basis and both are inextricably linked to bitcoin's fixed network capacity. Think of the capacity within each bitcoin block as valuable digital real estate. All market participants seeking to clear bitcoin transactions have to compete for block capacity. Scarcity in network capacity is the function by which bitcoin's shared resource is optimized. Or, think of it as bitcoin's solution to the tragedy of the commons. Competition for this scarce resource ensures that the resource is used efficiently and that its value is maximized. Ultimately, scarcity causes market participants to compete with each other, bidding up the value of the network's capacity, rather than shifting negative externalities on to the rest of the network.

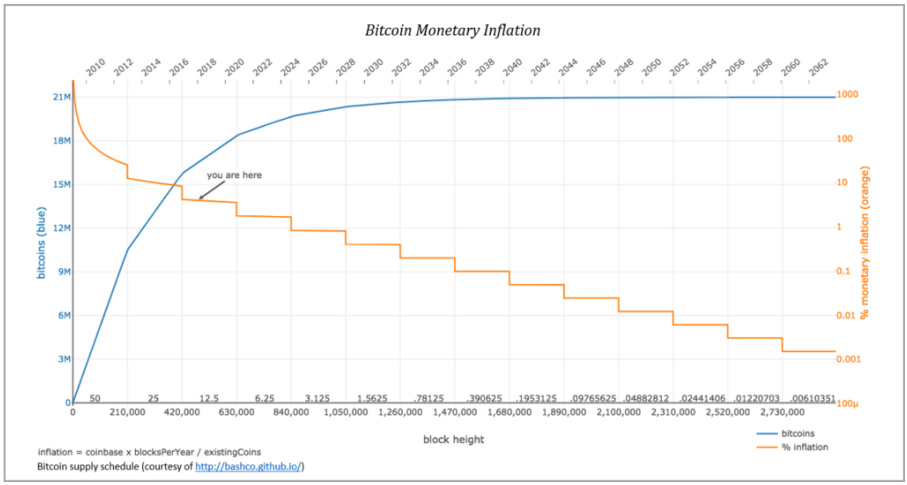
In bitcoin's free market, the highest value and most profitable transactions are prioritized. Without scarcity in transaction capacity, this value function would break down. It is less important that we

optimize for transaction capacity and more critical that scarcity exists. No one really knows the optimal amount of transaction capacity at any point in time, partly because demand is ever changing but also because it is generally growing over time. The critical piece is that capacity is known and scarce, which allows market participants to plan and ultimately, to compete. The commons is never depleted; instead participants compete and innovate to figure out how best to utilize a scarce asset. Scarcity ensures that the commons is not abused and creates a predictable rate of growth in the overall size of bitcoin's blockchain, which ultimately protects and promotes decentralization.



As discussed in a prior edition (see here), miners secure the bitcoin network by devoting real world energy resources to run cryptographic hashing functions and to solve bitcoin blocks. By solving blocks, miners validate history and clear current transactions which are then checked and validated by the rest of the network. In return, miners are paid in bitcoin. Devote resources to secure the network and get paid in the network's native currency (bitcoin). The actual compensation paid to miners comes in two forms: newly issued bitcoin and transaction fees. In order to devote resources today to secure the network, miners have to reliably expect that aggregate compensation will hold its value into the future.

Approximately every four years, the newly issued bitcoin paid to miners gets cut in half (the bitcoin "halvening"). Today, with each block, 12.5 new bitcoin are issued. In approximately eight months, when the next halvening event occurs (see here), that amount will be reduced to 6.25 new bitcoin per block. Approximately four years after that, 3.125 new bitcoin per block will be issued. This process will continue until we reach the smallest unit of bitcoin (1/100,000,000th) and thereafter no new bitcoin will be issued. This is the issuance function that governs bitcoin's fixed supply (21 million), and as a derivative function, it also shifts compensation to secure the network from (mostly) new bitcoin today to ultimately a system relying completely on transaction fees.



But how does this relate to Visa and transaction capacity? If it were not for the scarcity of capacity in each bitcoin block, there would not be a mechanism to create a transaction fee market. Scarcity in block space creates competition between market participants to clear transactions which causes them to bid up the value of real estate and to use it efficiently. Without a fee market, the only mechanism to pay miners to secure the network would be to alter bitcoin's fixed monetary policy and increase supply. But recall that scarcity in bitcoin's fixed supply (21 million) is the basis of its store of value

property, which is where the rubber meets the road. By creating scarcity in network capacity, we also ensure the integrity of bitcoin's fixed supply, which makes the whole value cycle function. Working within this reality, scarcity is a far more important property than either the speed or ultimate capacity of transaction throughput.

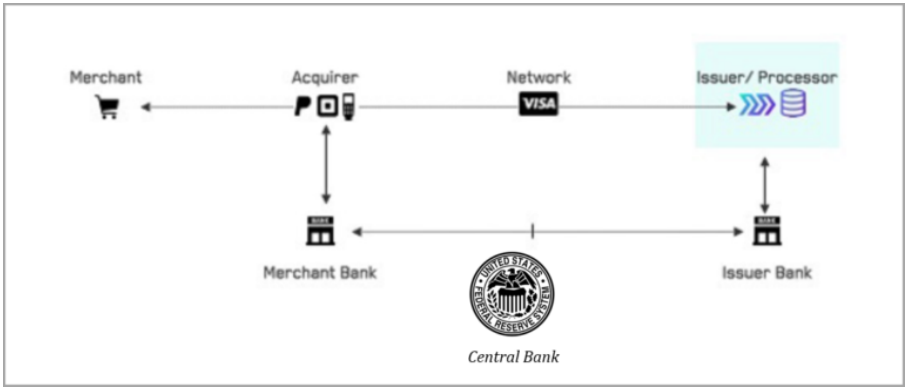
Fixed Network Capacity → Limited Transaction Capacity → Fee Market → Fixed Supply of Bitcoin

And because the real problem bitcoin is intending to solve is that of money and global QE (not payments), those that store wealth in bitcoin would much rather secure the money supply than sacrifice its long-term integrity and credibility for transaction throughput. In short, the future of bitcoin is far more secure in a world where all market participants can depend on it having a reliably fixed and scarce supply, while accepting lower transaction throughput or speed as trade-offs. What good is high transaction throughput and faster speeds if the fundamental value of the underlying currency is at risk? The existing financial system has already made the opposite trade-off for us. High transaction throughput and fast transactions by way of centralization but with the cost of an architecture susceptible to systemic monetary debasement. Bitcoin represents the alternative, and we are not about to make the same mistake twice.

Bitcoin ≠ Visa

Ultimately, bitcoin is not competing with Visa for supremacy in global payments. Instead, bitcoin is competing with the dollar, euro, yen and gold as money, and any comparison to Visa, its transaction volume or transaction speed is fundamentally flawed. Bitcoin fulfills the role of currency issuer and final settlement. As a result, the proper comparison would be between bitcoin and the Fed as currency issuer and as a clearing mechanism. No one makes the mistake of confusing the functions of Visa for that of the New York Fed, but for some reason, the comparison is often made between Visa and bitcoin.

While it would require time and investment, Visa's payment network could sit on top of the bitcoin network to fulfill payments much the same way it sits on top of the existing banking system. Rather than clearing the currency through a central bank, final settlement of transactions would clear through the bitcoin network. In the existing architecture, the payments layer (Visa) and the settlement layer (banking network/central banks) are separate and distinct. The principal problem bitcoin intends to solve has little to do with the former, but instead, with the mechanism by which currency is issued and cleared (think the Fed and QE). Visa helps move dollars but Visa is not the dollar. It is a technology company that provides a service; it has 17,000 employees. Bitcoin has none.



Whether credit or debit, Visa is an inherently trust-based credit system. While consumers generally associate swiping a Visa card (or the equivalent) at a point of sale terminal as payment, it really is not. Instead, balances are checked, transactions are authorized and settlement occurs later. Dollars are not actually cleared through a central bank or settled at the point of sale every time a transaction is processed. Individual transactions are also never really cleared. Instead, transactions are batched together, netted and settled at a later point in time; only then are accounts credited with proper balances. So when someone attempts to equate a Visa transaction with final settlement, that is just not the way the world works. But that is the

comparison that is implicitly being made when someone attempts to compare Visa with bitcoin.

Bitcoin vs. the Federal Reserve

When compared against its real competition (the Fed, ECB, BOJ, etc.), bitcoin begins to look like a Ferrari. Final global settlement approximately every 10 minutes, 24 hours per day, 7 days a week, 365 days a year on a permissionless basis. Compare this to the existing permissioned financial system, which is subject to multiple layers of bank and central bank intermediaries and only open during "business" hours. This is the great misnomer that exists within bitcoin. Those that believe bitcoin to be too slow or lacking in network capacity are comparing bitcoin to the wrong application. We could set up a network of banks on top of the bitcoin network and the payments system could function as it does today.

The push back on this point is the risk of centralization. If bitcoin were to just sit in centralized banks, it would increase the possibility that the bitcoin network could be co-opted and undermined by a network of banks and central banks, whether to force changes to network consensus rules or to censor end users. Ultimately, this was gold's failure as a monetary medium. It was susceptible to centralization, which then spawned fiat currencies, which have turned out to be easily manipulable. While this is unlikely (and hopefully not) how bitcoin scales, money and payments technology are distinct problems. The fundamental reason being that there are two sides to every value transfer; one side almost always involving money and the other as the fulfillment of goods and services. Payments layers help provide a bridge.

Because of the nature of trade, the two sides of a value transfer generally, and naturally, occur by different processes and at different points in time. Think about the settlement of currency on one side and the transfer of title to a home or car on the other. Or, payment for a good on Amazon and the fulfillment of that good two days later. Two different processes, occurring at two different times. And, it is

important to recognize that bitcoin has no knowledge of the outside world, whether identities or the second leg of a value transfer; all bitcoin knows how to do is issue and validate currency (whether a bitcoin is a bitcoin). This is really the function and limitation of any base currency system. Payments layers provide a bridge between currency settlement (the Fed or bitcoin) and the fulfillment of goods and services. Gold solved mass payments via bank centralization, the dollar, the Fed and large payments processors such as Visa. Bitcoin likely solves payments through a technologically superior mechanism, but we have time to solve what is a separate and distinct problem from that of money.

Scaling Bitcoin is 1 to n

If we solve the problem of money through digital scarcity first (zero to one), the technology advancements to scale transactions and ultimately solve payments are 1 to n. It is not credible to think that human ingenuity can solve the former but then fail on the incremental derivatives. It is not just a matter of hope and faith; instead, it is one of reason and logic, considering both the advancements in scaling solutions that are already being pursued and the challenges relative to the problem bitcoin has already solved. Permissionless innovation and the economic incentives inherent in bitcoin will coordinate and accelerate solutions to any number of future challenges. Market participants have an incentive to increase the value of the network and to innovate to scale the network, but the solutions will have to work within the network's consensus or garner sufficient consensus to change the rules.

Because of the nature of bitcoin's economic incentives, it is far more likely that scaling solutions work within existing consensus rules. One such example of an advancement to scale bitcoin within the network's consensus is the lightning network. The lightning network builds on top of bitcoin as a trust-minimized layer to scale transaction capacity, which still remains fundamentally distinct from payments fulfillment. However, if successful, lightning will be used to create bitcoin payment channels that enable far greater transaction throughput at far

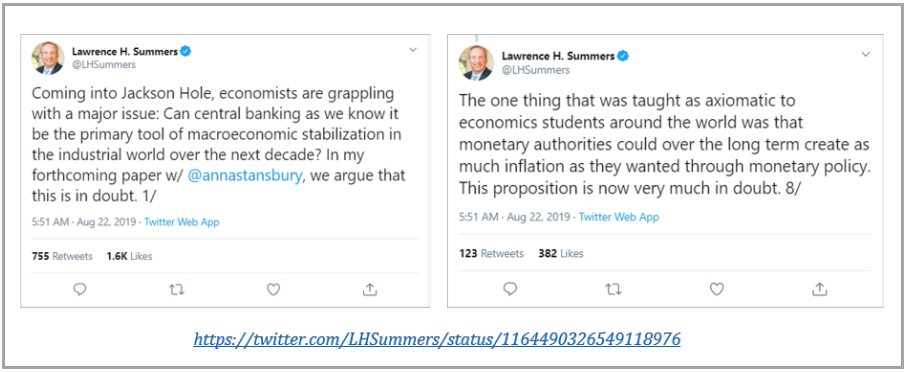
lower cost, the scale and speed of which would rival Visa. While it may not be the ultimate solution, it is an example of the innovation that bitcoin is fostering. Lightning is also only one of many solutions that are actively being developed, and competition will drive us toward the best scaling solutions, of which there may be a combination of many.

The approach to scaling bitcoin is a slow and conservative process. Bitcoin is too important to follow the Silicon Valley mantra of move fast and break things. Instead, it's move slowly and don't break anything. If a global financial system is to be built on a decentralized monetary system, the foundation must be protected at all cost. Ensure the security of the base monetary layer (bitcoin) first and then allow network participants to innovate on top of it in a permissionless manner. Remember that bitcoin is only ten years old; we are in the very inception of bitcoin's monetization event, and infrastructure is still being built to allow for the proliferation of this new technology.

It's a little ridiculous to contemplate the problem bitcoin has already solved and then immediately pivot to a "but why not mass payments today" line of thinking. Especially when considering that bitcoin, in its clearing function, is already faster and more reliable than comparable mechanisms for final settlement of dollars, euros, yen or gold. Then, when understanding that the fundamental use case for bitcoin today is as a long-term savings mechanism (not to fulfill payments), it becomes more clear that not only is the problem misdiagnosed but also that the desired solutions can wait. We will need the ability to fulfill payments in the future, but we have time before we get there. In due time, we're going to have our cake and eat it too.

BITCOIN FIXES THIS - AUGUST 30, 2019

This past week marked that time of year when global central bankers, establishment economists and CNBC, et al. descend on Jackson Hole, Wyoming to discuss the systemic issues that plague our economy. Never seeming to find an answer but constantly in search of it; it is the perennial Jackson Hole dilemma. There is always much fanfare and this year was no different. The whole spectacle may have been highlighted by Lawrence Summers, former U.S. Treasury Secretary and former President of Harvard University. In a 28-part twitter thread, Summers questioned a number of foundational assumptions made by the establishment economic mainstream, of which he is a resident member. In the game of Marco Polo, Summers is getting warmer but he's still on the wrong side of the pool. Identifying symptoms of the problem maybe, but as with most mainstream economists, the obvious question is never asked. Could the whole apparatus of central bank policy be the root cause of the problem rather than the ever-elusive solution?



https://twitter.com/LHSummers/status/1164490326549118976

The baseline question from Summers: can central banking as we know it be the primary tool of macroeconomic stabilization in the industrial world over the next decade? Summers doubts that it can, but what if the better question were: is central banking the primary cause of macroeconomic instability? Since the financial crisis,

quantitative easing has been the primary tool central banks have used in an attempt to stabilize the economy and to manufacture inflation. The playbook is as follows: increase the money supply, reduce interest rates and reflate asset values such that existing debt levels can be sustained and more debt can be created.

However, despite record low interest rates, the global economy has once again begun to deteriorate and the effectiveness of quantitative easing is naturally being questioned by many. As Summers notes, what has long been taught as axiomatic is now very much in doubt. Contrary to popular belief, the function of quantitative easing actually creates the instability it seeks to avoid. When understanding its base operation, it becomes clear that quantitative easing has always been a fool's errand. As Nassim Taleb writes in the foreword to The Bitcoin Standard, the macroeconomic experts are not only not experts, they don't know it either.

> Let us follow the logic of things from the beginning. Or, rather, from the end: modern times. We are, as I am writing these lines, witnessing a complete riot against some class of experts, in domains that are too difficult for us to understand, such as macroeconomic reality, and in which not only is the expert not an expert, but he doesn't know it. That previous Federal Reserve bosses Greenspan and Bernanke, had little grasp of empirical reality is something we only discovered too late: one can macroBS longer than microBS, which is why we need to be careful of whom to endow with centralized macro decisions.
>
> What makes it worse is that all central banks operated under the same model, making it a perfect monoculture.

"The risk that the economy has entered a substantial downturn appears to have diminished over the past month or so."
– Former Fed Chair Ben Bernanke, June 2008

History has consistently established that the experts are limited in the field of their own expertise, yet policies such as quantitative easing continue to be pursued, largely because macroeconomics and central banking is a monoculture, as Taleb describes. The mainstream policy position starts with the assumption that central banking is core to the function of an economy; then debate centers on what levers to pull and how best to manage the economy via central bank planning. Active management of the money supply via quantitative easing is taken as a given; it's a question of how much and when, rather than if.

However, there remains an opposing economic view which argues that the very function of a central bank and the active management of the money supply is harmful to the economy. The opposing viewpoint cannot practically co-exist within a central bank because it is antithetical to the very function, which is why the monoculture exists and why a different course is never charted. Ultimately, the economic debate played out over the course of the 20th century and ended with what has become the current mainstream position. The consequence has been an economic system that relies heavily on monetary debasement and credit creation, both of which are achieved through quantitative easing.

Now that bitcoin exists, it is no longer merely the subject of an intellectual debate. Instead, we now have two competing monetary systems that present great contrasts: one attempts to create stability through active management of the money supply, while the other tolerates interim volatility in the interest of maintaining a fixed

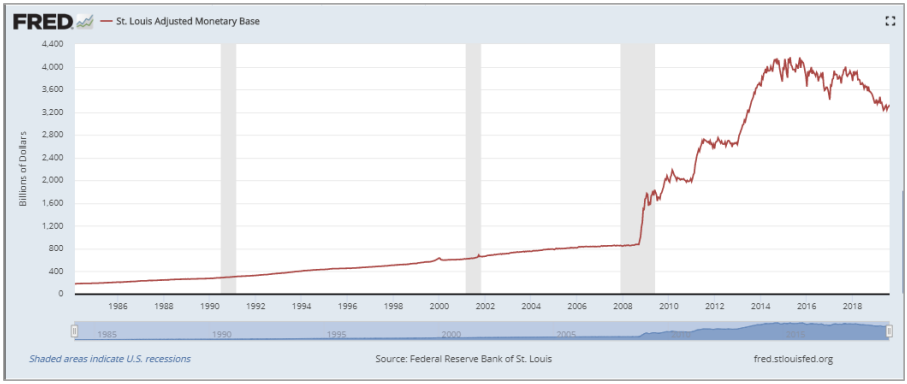
supply. For the last ten years, the bootstrapping upstart has been gaining ground on the incumbent system, as demonstrated by its adoption and steadily increasing value relative to other currencies. Opting in to bitcoin means opting out of quantitative easing, and while it may be a volatile path, the long-term trend will continue because central banks continue to pursue the very policy tool which bitcoin prevents.

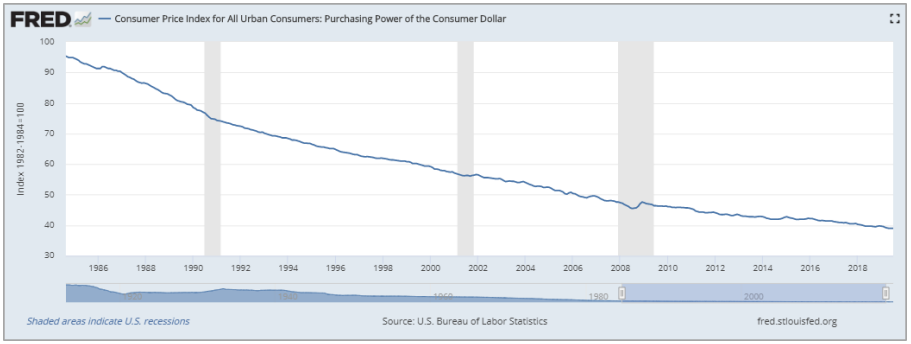
While attempting to be a source of macroeconomic stabilization, central bankers inadvertently create instability through the manipulation of the money supply. By manipulating the supply of money, all global pricing mechanisms become distorted. As Hayek describes in The Use of Knowledge in Society, the price mechanism is the greatest distribution system of knowledge in the world. When the price mechanism becomes distorted, false signals are distributed throughout the economic system and the result is an imbalance between supply and demand which ultimately creates instability and fragility. Today, this instability has primarily been created and sustained as a function of quantitative easing. The financial crisis made it clear that the size of the credit system was both unstable and unsustainable; rather than allow the system to naturally deleverage, the Fed reflated asset prices and induced further credit expansion, such that existing debt levels could be sustained. Practically speaking, the central banking approach to solving a problem of too much debt was to induce the creation of even more debt, which was the original source of instability. Fortunately, bitcoin fixes this.

What is quantitative easing?

In the most simplistic terms, quantitative easing is a technical term that describes how the Federal Reserve creates new dollars. It isn't technically "printing money," but it is functionally the same. The Fed digitally creates new digital dollars on a ledger (literally out of thin air) and uses those dollars to purchase financial assets, such as U.S. treasuries (government debt) or mortgage-backed securities. Following the financial crisis, the Fed introduced $3.6 trillion new dollars into the banking system via QE, quintupling the size of its

balance sheet. As a net effect, more dollars exist within the banking system in the form of bank reserves and those reserves can then be used to lend or to purchase other assets. In simple terms, more dollars exist, which causes the value of each individual dollar to decrease.



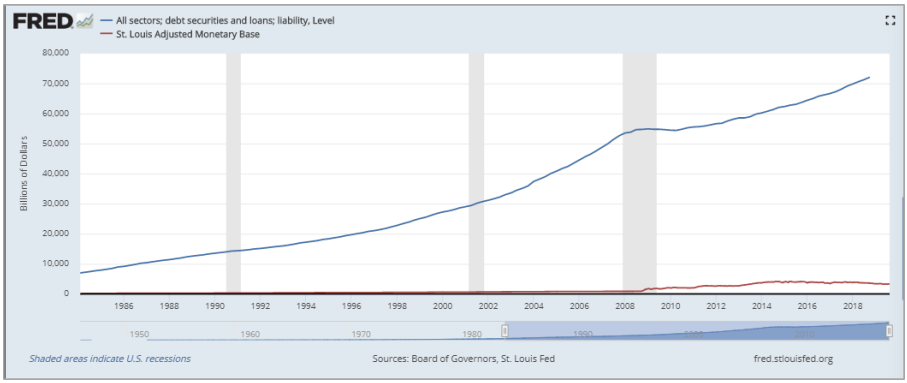


Quantitative easing is the root cause of why your dollar purchases less tomorrow; however, the effects of quantitative easing are transmitted gradually through the economy via the expansion of the credit system. Said another way, quantitative easing is designed to allow banks to expand credit; for every dollar that is created through quantitative easing, the credit system can expand by multiples of each dollar added. This incremental credit (think auto loans, mortgages, student loans, etc.) is then used to purchase goods in the real economy, which

causes the prices of goods to rise and the value of the dollar to decline on a relative basis.

Does quantitative easing work?
The short answer is no. While many believe that quantitative easing was necessary, it merely kicked the can down the road and guaranteed more QE would be necessary in the future. The root cause of the crisis was a financial system that had become far too leveraged. At the time of the financial crisis, every dollar in the banking system had been leveraged and lent 150:1 (see Fed Z.1 & H.8 reports). There was too much debt and too few dollars, and the degree of leverage was only made possible as an indirect function of the Fed sustaining economic imbalances. With every recessionary business cycle in the decades leading up to the crisis, the Fed increased the supply of dollars to lower interest rates and to induce credit expansion. Rather than allow the system to course correct as a natural market function, the Fed's continual response was to reflate asset values by increasing the money supply such that existing debt levels could be sustained and more credit could be created.

Through this function, the Fed inadvertently created the instability that existed in the financial system in 2008 because it created the environment which allowed for an unsustainable degree of system leverage to accumulate over the course of decades. While it has pursued similar policies for decades, the financial crisis created an environment that triggered a more drastic response from the Fed. Practically speaking, the Fed needed a bigger boat and in response to the market turmoil, it increased the supply of dollars by $3.6 trillion in order to stave off an impending financial collapse. This time was different; while the subprime crisis steals the headlines, the real issue was the cumulative effect of sustained imbalances in the credit system which had accumulated over many cycles and the overall degree of system leverage.



In the Fed's economy, the credit system has become the marginal price mechanism. And because the Fed has a mandate to maintain price stability, it must implicitly maintain the size of the credit system in order to sustain general price levels. During the financial crisis, the credit system began to contract and asset price levels rapidly declined in a disorderly fashion. In order to reverse the impact, the Fed was forced to drastically increase the money supply (quantitative easing) in an effort to maintain the size of the credit system. Even after the height of the crisis, the Fed determined it was necessary to add trillions more in new dollars to continue to support a languishing system, despite acknowledging the limitations of its monetary policy tools. This is the Fed's catch-22; even when it seemingly knows betters, the Fed's default position is to err on the side of more quantitative easing, not less.

> "I'm perfectly willing to accept the argument that monetary policy is not the main tool, that this is not the main thing wrong with the economy, but it's our duty to do what we can, to be palliative, to help where we can, even if we can't solve fiscal, structural, and other problems." - Ben Bernanke, Former Fed Chair – August 2011

> "I don't think it is literally the case that monetary policy is completely ineffective. I think we can see the effects on financial markets, which in turn must be affecting wealth, confidence, and some other determinants of spending and production. To the extent that transmission is weaker, that could be used to argue for more stimulus rather than less stimulus." - Ben Bernanke, Former Fed Chair – September 2011

By responding with quantitative easing, the Fed induced a credit system already saddled with too much debt to expand massively. Today, the U.S. credit system supports approximately $73 trillion of fixed maturity debt (system wide), which represents an increase of $20 trillion (+40%) above pre-crisis levels (Fed Z.1 report, pg. 7). This debt is stacked against only $1.7 trillion of actual dollars that exist within the banking system (Fed H.8 report). As a consequence, there remains far too much debt and too few dollars. Because QE induces the creation of trillions more in debt, it is more like heroin than an antibiotic; the more that is applied to a financial system, the more dependent on it that system becomes and the worse off when it is removed.

Bitcoin Fixes This

Prior to 2009, everyone was forced to opt-in to this system, and there was not a viable off-ramp. This is ultimately the option that bitcoin provides, and it exists largely as a response mechanism to global QE. There is no more simple explanation to the question of why bitcoin exists. While bitcoin would have presented a superior alternative even in the absence of quantitative easing, the global monetary debasement which occurred in response to the crisis sharpens the contrast. It is this contrast that makes the mere existence of bitcoin far more intuitive than it otherwise may be. Bitcoin literally exists because some highly intelligent individuals identified a problem and set the wheels in motion to create a solution. However, bitcoin practically exists because it presents a fundamentally better solution to the problem of money.

Because of the leverage that remains inherent in the existing financial system, future QE is not merely a possibility; it is a certainty. Future QE from the Fed, and central banks all over the world, is a "when" not "if" question. The credit system was unstable and unsustainable in 2008. As a function of QE, it has expanded massively and now supports $20 trillion more debt in the U.S. alone. Every time the Fed, or any central bank, announces subsequent rounds of QE, that is the reinforcing market signal of why bitcoin exists. It is the choice between holding a form of currency that is continually and systematically debased by central banks or a form of currency with a fixed supply that is unmanipulable. Bitcoin is the check, balance and ultimate opt out path to the problem QE presents.

In The Pretense of Knowledge, a speech delivered by Friedrich Hayek at the ceremony awarding him the Nobel Prize in economics in 1974, he articulates the first principles of why the disparate knowledge of all market participants is greater than that which any single mind possesses. It is through this reasoning that he explains why the dominant macroeconomic theory and monetary policy which guides central banks is inherently flawed. And, why the policy tools used by central banks, particularly quantitative easing, create more harm than good. I highly recommend reading the full speech as it provides the counter-narrative to the monoculture of today's economic policy making. Our current system entrusts the allocation of trillions of dollars to just a few individuals. It is not that these individuals lack a significant amount of knowledge; instead, it is that any small group of individuals necessarily possesses far less knowledge than the hundreds of millions of individuals that actually make up an economy.

The Pretense of Knowledge, Hayek
(Nobel Prize Lecture, 1974)

> In fact, in the case discussed, the very measures which the dominant "macroeconomic" theory has recommended as a remedy for unemployment — namely, the increase of aggregate demand — have become a cause of a very extensive misallocation of resources which is likely to make later large-scale unemployment inevitable. The continuous injection of additional amounts of money at points of the economic system where it creates a temporary demand which must cease when the increase of the quantity of money stops or slows down, together with the expectation of a continuing rise of prices, draws labor and other resources into which can last only so long as the increase of the quantity of money continues at the same rate — or perhaps even only so long as it continues to accelerate at a given rate. What this policy has produced is not so much a level of employment that could not have been brought about in other ways, as a distribution of employment which cannot be indefinitely maintained and which after some time can be maintained only by a rate of inflation which would rapidly lead to a disorganization of all economic activity. The fact is that by a mistaken theoretical view we have been led into a precarious position in which we cannot prevent substantial unemployment from reappearing; not because, as this view is sometimes misrepresented, this unemployment is deliberately brought about as a means to combat inflation, but because it is now bound to occur as a deeply regrettable but inescapable consequence of the mistaken policies of the past as soon as inflation ceases to accelerate.

By attempting to manage an economy through the manipulation of the money supply, the knowledge of many is not only replaced by that of a few; instead, the collective knowledge base as a whole becomes distorted. The mechanisms that govern supply and demand can no longer function efficiently, which creates imbalances that can only be sustained so long as the market remains manipulated. In the end, the ultimate negative impact to the economy is far greater than it otherwise would have been in the absence of central bank intervention. The financial crisis is patient zero and the quantitative easing response has only left us in a more precarious situation today. The first order impact is the devaluation of the currency, but the ultimate impact is the deterioration of the underlying economic structure. Bitcoin is designed to fix this but no one should expect a seamless or painless transition away from a system saddled with decades of accumulated imbalances.

Bitcoin creates a system that allows for undistorted economic activity, and it achieves this through a fixed monetary supply, which is ultimately governed by a market consensus mechanism. It is through this consensus mechanism that bitcoin dispenses with the need for conscious control of central bankers, instead relying on the distributed knowledge of all market participants. It is also completely voluntary. If you like your financial system, you can keep it (for now at least). However, monetary systems tend to one medium so if a critical mass converge on bitcoin as the most credible long-term store of value, it may become less of a choice in the future. As individuals increasingly opt in to bitcoin, it will only make the issues present in the existing system more evident, which likely accelerates the need for quantitative easing. The greater the inclination to store wealth in bitcoin, the lower the demand to store wealth in the assets that support the existing credit system. In essence, an increasing shift to bitcoin will directly impact the system-wide credit impulse, which will accelerate the need for the legacy financial system to rely on quantitative easing to sustain itself.

Bitcoin may be the sly round about way around the Fed's economic system, but it comes at the direct expense of the legacy system. And, the interim consequence of the shift to bitcoin may very well be macroeconomic volatility. Bitcoin may be mistakenly blamed for the ills of the legacy system but really, withdrawal is just a painful and necessary process. The Jackson Hole crowd may not like this; however, positive externalities will be waiting on the other side. And besides, it's in the hands of the free market now.

> "I don't believe we shall ever have a good money again before we take the thing out of the hands of government, that is, we can't take them violently out of the hands of government, all we can do is by some sly roundabout way introduce something that they can't stop." - F. A. Hayek

BITCOIN, NOT BLOCKCHAIN - SEPTEMBER 6, 2019

Have you ever heard a smart sounding friend say that they aren't sure about bitcoin but they believe in blockchain technology? This is like saying you believe in airplanes but you're not sure about the wings; and there's a good chance that anyone who thinks that may not understand either. In reality, bitcoin and its blockchain are dependent on each other. However, if new to bitcoin, understanding how it works and parsing the landscape can be incredibly difficult. Frankly, it can be overwhelming; given the complexity and sheer volume of projects, who has the time to possibly evaluate everything? There is in fact a manageable path but you have to know where to start. While there are seemingly thousands of cryptocurrencies and blockchain initiatives, there is really only one that matters: bitcoin. Ignore everything else like it didn't exist and first try to develop an understanding of why bitcoin exists and how it works; that is the best foundation to then be able to think about the entirety of everything else.

It is also the most practical entry point; before taking a flyer and risking hard-earned value, take the time to understand bitcoin and then use that knowledge to evaluate the field. There is no promise that you will come to the same conclusions, but more often than not, those who take the time to intuitively understand how and why bitcoin works more easily recognize the flaws inherent in the field. And even if not, starting with bitcoin remains your best hope of making an informed and independent assessment. Ultimately, bitcoin is not about making money and it's not a get-rich-quick scheme; it is fundamentally about storing the value you have already created, and no one should risk that without a requisite knowledge base. Within the world of digital currencies, bitcoin has the longest track record to assess and the greatest amount of resources to educate, which is why bitcoin is the best tool to learn.

To start on this journey, first realize that bitcoin was created to specifically address a problem that exists with modern money. The founder of bitcoin set out to create a peer-to-peer digital cash system without the need for a trusted third-party, and a blockchain was one critical part of the solution. In practice, bitcoin (the currency) and its blockchain are interdependent. One does not exist without the other; bitcoin needs its blockchain to function and there would not be a functioning blockchain without a native currency (bitcoin) to properly incentivize resources to protect it. That native currency must be viable as a form of money because it is exclusively what pays for security, and it must have credible monetary properties in order to be viable.

Without the money, there is no security and without the security, the value of the currency and the integrity of the chain both break down. It is for this reason that a blockchain is only useful within the application of money, and money does not magically grow on trees. Yep, it is that simple. A blockchain is only good for one thing, removing the need for a trusted third-party which only works in the context of money. A blockchain cannot enforce anything that exists

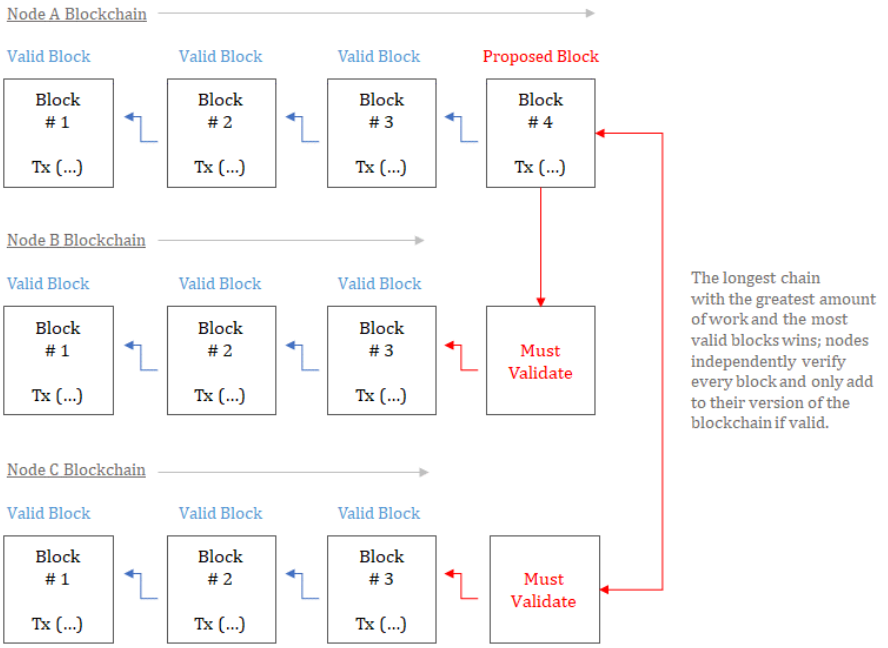
outside the network. While a blockchain would seem to be able to track ownership outside the network, it can only enforce ownership of the currency that is native to its network. Bitcoin tracks ownership and enforces ownership. If a blockchain cannot do both, any records it keeps will be inherently insecure and ultimately subject to change. In this sense, immutability is not an inherent trait of a blockchain but instead, an emergent property. And if a blockchain is not immutable, its currency will never be viable as a form of money because transfer and final settlement will never be reliably possible. Without reliable final settlement, a monetary system is not functional and will not attract liquidity.

Ultimately, monetary systems converge on one medium because their utility is liquidity rather than consumption or production. And liquidity consolidates around **the most secure**, long-term store of value; it would be irrational to store wealth in a less secure, less liquid monetary network if a more secure, more liquid network existed as an attainable option. The aggregate implication is that only one blockchain is viable and ultimately necessary. Every other cryptocurrency is competing for the identical use case as bitcoin, that of money; some realize it while others do not but value continues to consolidate around *bitcoin* because it is the **most secure** blockchain by orders of magnitude and all are competing for the same use case. Understanding these concepts is fundamental to bitcoin and it also provides a basic foundation to then consider and evaluate the noise beyond bitcoin. With basic knowledge of how bitcoin actually works, it becomes clear why there is no blockchain without bitcoin.

There is no blockchain

Often, bitcoin's transaction ledger is thought of as a public blockchain that lives somewhere in the cloud like a digital public square where all transactions are aggregated. However, there is no central source of truth; there are no oracles and there is no central public blockchain to which everyone independently commits transactions. Instead, every participant within the network constructs and maintains its own independent version of the blockchain based on a common set of

rules; no one trusts anyone and everyone validates everything. Everyone is able to come to the same version of the truth without having to trust any other party. This is core to how bitcoin solves the problem of removing third-party intermediaries from a digital cash system.



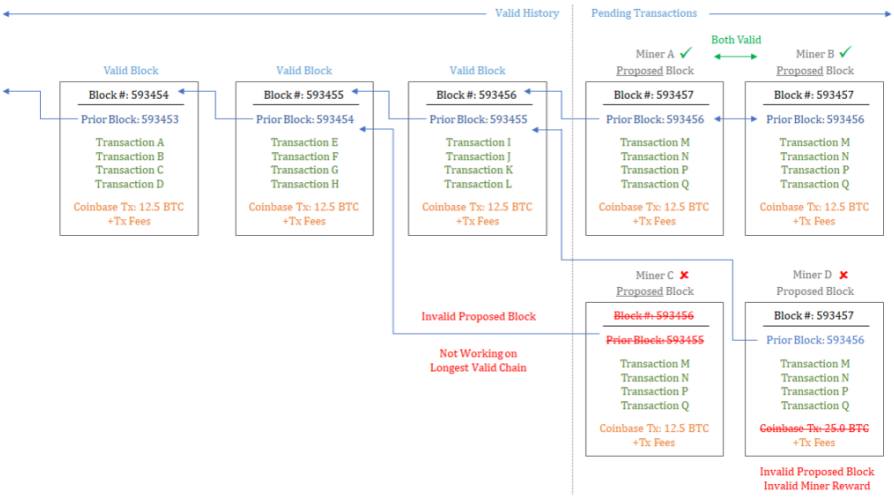
Every participant running a node within the bitcoin network independently verifies every transaction and every block; by doing so, each node aggregates its own independent version of the blockchain. Consensus is reached across the network because each node validates every transaction (and each block) based on a core set of rules (and the longest chain wins). If a node broadcasts a transaction or block that does not follow consensus rules, other nodes will reject it as invalid. It is through this function that bitcoin is able to dispose with the need for a central third-party; the network converges on the same consistent state of the chain without anyone trusting any other party.

However, the currency plays an integral role in coordinating bitcoin's consensus mechanism and ordering blocks which ultimately represents bitcoin's full and valid transaction history (or its blockchain).

The basics of bitcoin: blocks and mining

Think of a block as a dataset that links the past to the present. Technically, individual blocks record changes to the overall state of bitcoin ownership within a given time interval. In aggregate, blocks record the entire history of bitcoin transactions as well as ownership of all bitcoin at any point in time. Only changes to the state are recorded in each passing block. How blocks are constructed, solved and validated is critical to the process of network consensus, and it also ensures that bitcoin maintains a fixed supply (21 million). Miners compete to construct and solve blocks that are then proposed to the rest of the network for acceptance. To simplify, think of the mining function as a continual process of validating history and clearing pending bitcoin transactions; with each block, miners add new transaction history to the blockchain and validate the entire history of the chain. It is through this process that miners secure the network; however, all network nodes then check the work performed by miners for validity, ensuring network consensus is enforced. More technically, miners construct blocks that represent data sets which include three critical elements (again simplifying):

1. Reference to prior block → validate entire history of chain
2. Bitcoin transactions → clear pending transactions (changes to the state of ownership)
3. Coinbase transaction + fees → compensation to miners for securing the network

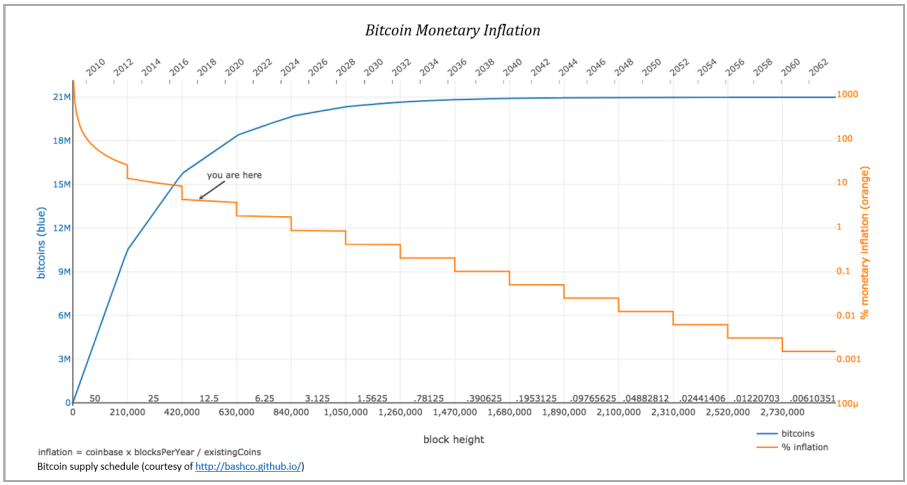


To solve blocks, miners perform what is known as a proof of work function by expending energy resources. In order for blocks to be valid, all inputs must be valid and each block must satisfy the current network difficulty. To satisfy the network difficulty, a random value (referred to as a nonce) is added to each block and then the combined data set is run through bitcoin's cryptographic hashing algorithm (SHA-256); the resulting output (or hash) must achieve the network's difficulty in order to be valid. Think of this as a simple guess and check function, but probabilistically, trillions of random values must be guessed and checked in order to create a valid proof for each proposed block. The addition of a random nonce may seem extraneous. But, it is this function that forces miners to expend significant energy resources in order to solve a block, which ultimately makes the network more secure by making it extremely costly to attack.

Adding a random nonce to a proposed block, which is an otherwise static data set, causes each resulting output (or hash) to be unique; with each different nonce checked, the resulting output has an equally small chance of achieving the network difficulty (i.e. representing a

valid proof). While it is often referred to as a highly complicated mathematical problem, in reality, it is difficult only because a valid proof requires guessing and checking trillions of possible solutions. There are no shortcuts; energy must be expended. A valid proof is easy to verify by other nodes but impossible to solve without expending massive amount of resources; as more mining resources are added to the network, the network difficulty increases, requiring more inputs to be checked and more energy resources to be expended to solve each block. Essentially, there is material cost to miners in solving blocks but all other nodes can then validate the work very easily at practically no cost.

In aggregate, the incentive structure allows the network to reach consensus. Miners must incur significant upfront cost to secure the network but are only paid if valid work is produced; and the rest of the network can immediately determine whether work is valid or not based on consensus rules without incurring cost. While there are a number of consensus rules, if any pending transaction in a block is invalid, the entire block is invalid. For a transaction to be valid, it must have originated from a previous, valid bitcoin block and it cannot be a duplicate of a previously spent transaction; separately, each block must build off the most up to date version of history in order to be valid and it must also include a valid coinbase transaction. A coinbase transaction rewards miners with newly issued bitcoin in return for securing the network but it is only valid if the work is valid.



Coinbase rewards are governed by a predetermined supply schedule and currently, 12.5 new bitcoin are issued in each valid block; in approximately eight months, the reward will be cut in half to 6.25 new bitcoin, and every 210,000 blocks (or approximately every four years), the reward will continue to be halved until it ultimately reaches zero. If miners include an invalid reward in a proposed block, the rest of the network will reject it as invalid which is the base mechanism that governs a capped total supply of 21 million bitcoin. However, software alone is insufficient to ensure either a fixed supply or an accurate transaction ledger; economic incentives hold everything together.

Consensus on a decentralized basis

Why is this so important? Within one integrated function, miners validate history, clear transactions and get paid for security on a trustless basis; the integrity of bitcoin's fixed supply is embedded in its security function, and because the rest of the network independently validates the work, consensus can be reached on a decentralized basis. If a miner completes valid work, it can rely on the fact that it will be paid on a trustless basis. Conversely, if a miner completes invalid work, the rest of the network enforces the rules, essentially withholding payment until valid work is completed. And supply of the currency is baked into validity; if a miner wants to be paid, it must also enforce the fixed supply of the currency, further aligning the entire network. The incentive structure of the currency is so strong that everyone is forced to adhere to the rules, which is the chief facilitator of decentralized consensus.

If a miner solves and proposes an invalid block, specifically one that either includes invalid transactions or an invalid coinbase reward, the rest of the network will reject it as invalid. Separately, if a miner builds off a version of history that does not represent the longest chain with the greatest proof of work, any proposed block would also be considered invalid. Essentially, as soon as a miner sees a new valid block proposed in the network, it must immediately begin to work on

top of that block or risk falling behind and performing invalid work at a sunk cost. As a consequence, in either scenario, if a miner were to produce invalid work, it would incur real cost but would be compensated nothing in return.

Through this mechanism, miners are maximally incentivized to produce honest, valid work and to work within the consensus of the chain at all times; it is either be paid or receive nothing. It is also why the higher the cost to perform the work, the more secure the network becomes. The more energy required to write or rewrite bitcoin's transaction history, the lower the probability that any single miner could (or would) undermine the network. The incentive to cooperate increases as it becomes more costly to produce work which would otherwise be considered invalid by the rest of the network. As

network security increases, bitcoin becomes more valuable. As the value of bitcoin rises and as the costs to solve blocks increases, the incentive to produce valid work increases (more revenue but more cost) and the penalty for invalid work becomes more punitive (no revenue and more cost).

Why don't the miners collude? First, they can't. Second, they tried. But third, the fundamental reason is that as the network grows, the network becomes more fragmented and the economic value compensated to miners in aggregate increases; from a game theory perspective, more competition and greater opportunity cost makes it harder to collude and all network nodes validate the work performed by miners which is a constant check and balance. Miners are merely paid to perform a service and the more miners there are, the greater the incentive to cooperate because the probability that a miner is penalized for invalid work increases as more competition exists. And recall that random nonce value; it seemed extraneous at the time but it is core to the function that requires energy resources be expended. It is this tangible cost (skin in the game) combined with the value of the currency which incentivizes valid work and which allows the network to reach consensus.

Because all network nodes independently validate blocks and because miners are maximally penalized for invalid work, the network is able to form a consensus as to the accurate state of the chain without relying on any single source of knowledge or truth. None of this decentralized coordination would be possible without bitcoin, the currency; all the bitcoin network has to compensate miners in return for security is its native currency, whether that is largely in the form of newly issued bitcoin today or exclusively in the form of transaction fees in the future. If the compensation paid to miners were not reasonably considered to be a reliable form of money, the incentive to make the investments to perform the work would not exist.

The role of money in a blockchain

Recall from Bitcoin Can't Be Copied, if an asset's primary (if not sole) utility is the exchange for other goods and services, and if it does not have a claim on the income stream of a productive asset (such as a stock or bond), it must compete as a form of money and will only store value if it possesses credible monetary properties. Bitcoin is a bearer asset, and it has no utility other than the exchange for other goods or services. It also has no claim on the income stream of a productive asset. As such, bitcoin is only valuable as a form of money and it only holds value because it has credible monetary properties (read The Bitcoin Standard, chapter 1). By definition, this is true of any blockchain; all any blockchain can offer in return for security is a monetary asset native to the network, without any enforceable claims outside the network, which is why a blockchain can only be useful in connection to the application of money. The chart below from The Bitcoin Standard articulates this point:

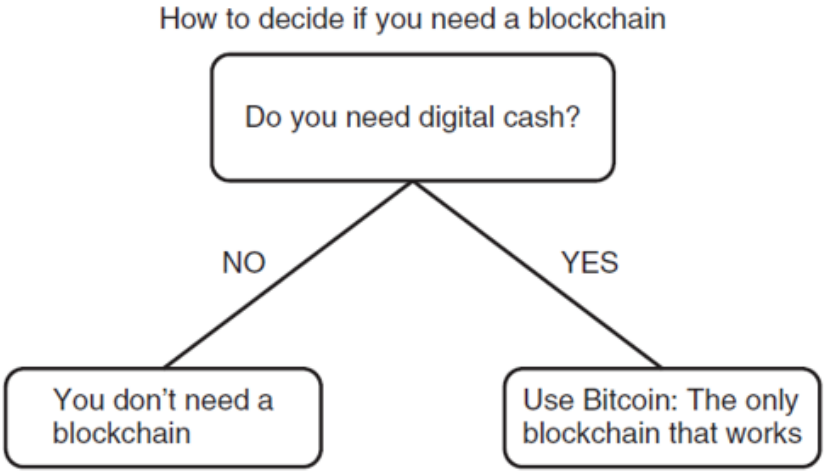


Figure 22 Blockchain decision chart.

Without a native currency, a blockchain must rely on trust for security which eliminates the need for a blockchain in the first place. In practice, the security function of bitcoin (mining), which protects the validity of the chain on a trustless basis, requires significant upfront capital investment in addition to high marginal cost (energy consumption). In order to recoup that investment and a rate of return in the future, the payment in the form of bitcoin must more than offset the aggregate costs, otherwise the investments would not be made. Essentially, what the miners are paid to protect (bitcoin) must be a reliable form of money in order to incentivize security investments in the first place.

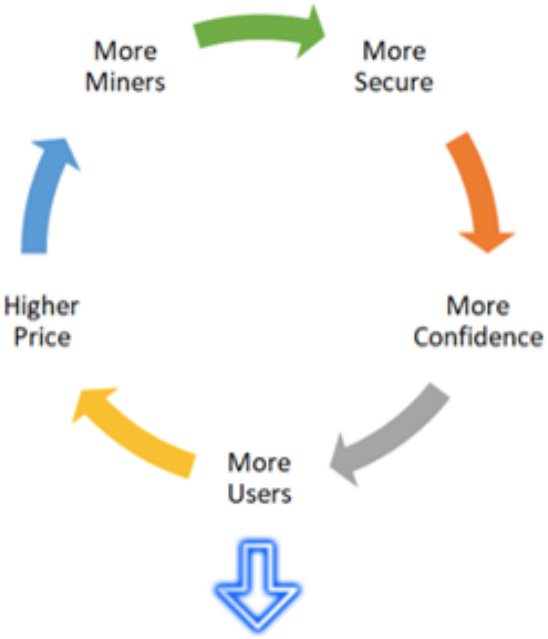
This is also fundamental to the incentive structure that aligns the network; miners have an embedded incentive to not undermine the network because it would directly undermine the value of the currency in which miners are compensated. If bitcoin were not valued as money, there would be no miners, and without miners, there would be no chain worth protecting. The validity of the chain is ultimately what miners are paid to protect; if the network could not reasonably come to a consensus and if ownership were subject to change, no one could reasonably rely on bitcoin as a value transfer mechanism. The value of the currency ultimately protects the chain, and the immutability of the chain is foundational to the currency having value. It's an inherently self-reinforcing relationship.

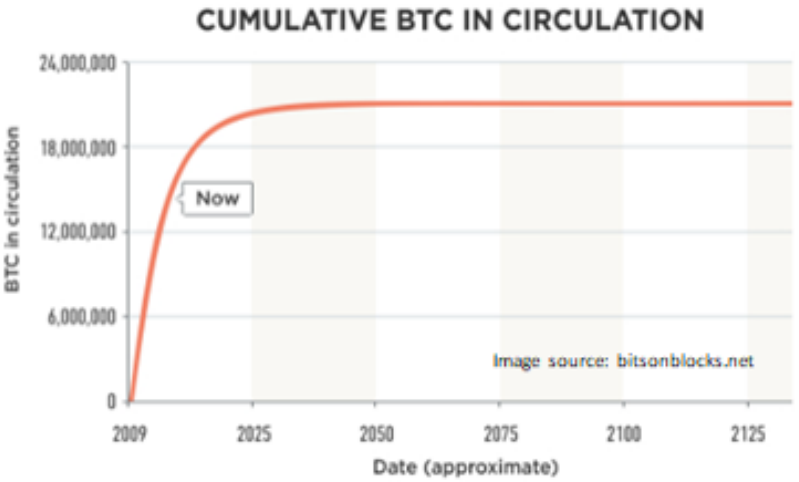
Immutability is an emergent property

Immutability is an emergent property in bitcoin, not a trait of a blockchain. A global, decentralized monetary network with no central authority could not function without an immutable ledger (i.e. if the history of the blockchain were insecure and subject to change). If settlement of the unit of value (bitcoin) could not reliably be considered final, no one would reasonably trade real world value in return. As an example, consider a scenario in which one party purchased a car from another in return for bitcoin. Assume the title for the car transfers, and the individual that purchased the car takes physical possession. If bitcoin's record of ownership could easily be

re-written or altered (i.e. changing the history of the blockchain), the party that originally transferred the bitcoin in return for the car could wind up in possession of both the bitcoin and the car, while the other party could end up with neither. This is why immutability and final settlement is critical to bitcoin's function.

Remember that bitcoin has no knowledge of the outside world; all bitcoin knows how to do is issue and validate currency (whether a bitcoin is a bitcoin). Bitcoin is not capable of enforcing anything that exists outside the network (nor is any blockchain); it is an entirely self-contained system and the bitcoin network can only ever validate one side of a two-sided value transfer. If bitcoin transfers could not reliably be considered final, it would be functionally impossible to ever trade anything of value in return for bitcoin. This is why the immutability of bitcoin's blockchain is inextricably linked to the value of bitcoin as a currency. Final settlement in bitcoin is possible but only because its ledger is reliably immutable. And its ledger is only reliably immutable because its currency is valuable. The more valuable bitcoin becomes, the more security it can afford; the greater the security, the more reliable and trusted the ledger.





Ultimately, immutability is an emergent property, but it is dependent on other emergent network properties. As bitcoin becomes more decentralized, it becomes increasingly difficult to alter the network's consensus rules and increasingly difficult to invalidate or prevent otherwise valid transactions (often referred to as censorship-resistance). As bitcoin proves to be increasingly censorship-resistant, confidence in the network grows, which fuels adoption, which further decentralizes the network, including its mining function. In essence, bitcoin becomes more decentralized and more censorship-resistant as it grows, which reinforces the immutability of its blockchain. It becomes increasingly difficult to change the history of the blockchain because each participant gradually represents a smaller and smaller share of the network; regardless of how concentrated ownership of the network and mining may be at any point in time, both decentralize over time so long as value increases, which causes bitcoin to become more and more immutable.

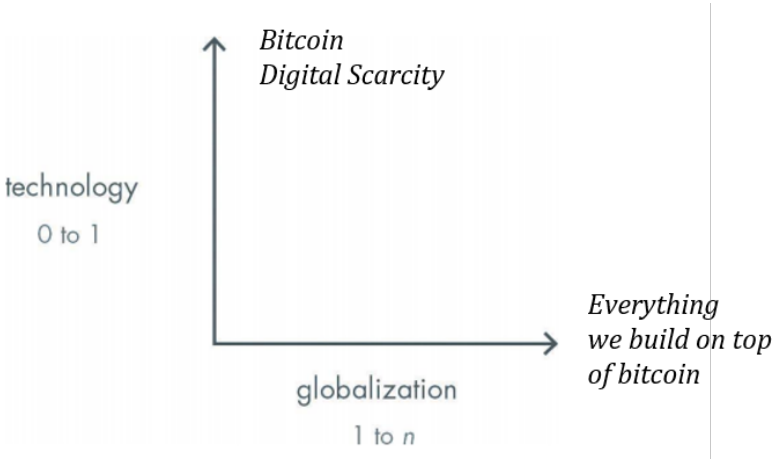
Bitcoin, not blockchain

This multi-dimensional incentive structure is complicated but it is critical to understanding how bitcoin works and why bitcoin and its blockchain are dependent on each other. Why each is a tool that relies

on the other. Without one, the other is effectively meaningless. And this symbiotic relationship only works for money. Bitcoin as an economic good is only valuable as a form of money because it has no other utility. This is true of any asset native to a blockchain. The only value bitcoin can ultimately provide is through present or future exchange. And the network is only capable of a single aggregate function: validating whether a bitcoin is a bitcoin and recording ownership.

The bitcoin network is a closed loop and an entirely independent system; its only connection to the physical world is through its security and clearing function. The blockchain maintains a record of ownership and the currency is used to pay for the security of those records. It is through the function of its currency that the network can afford a level of security to ensure immutability of the blockchain, which allows network participants to more easily and consistently reach consensus without the need for trust in any third-parties. The cumulative effect is a decentralized and trustless monetary system with a fixed supply that is global in reach and accessible on a permissionless basis.

Every other fiat currency, commodity money or cryptocurrency is competing for the **exact same use case as bitcoin** whether it is understood or not, and monetary systems tend to a single medium because their utility is liquidity rather than consumption or production. When evaluating monetary networks, it would be irrational to store value in a smaller, less liquid and less secure network if a larger, more liquid and more secure network existed as an attainable option. Bitcoin is valuable, not because of a particular feature, but instead, because it achieved finite, digital scarcity. This is the backbone of why bitcoin is secure as a monetary network and it is a property that is dependent on many other emergent properties.



A blockchain on the other hand is simply an invention native to bitcoin that enables the removal of trusted third parties. It serves no other purpose. It is only valuable in bitcoin as a piece to a larger puzzle and it would be useless if not functioning in concert with the currency. The integrity of bitcoin's scarcity and the immutability of its blockchain are ultimately dependent on the value of the currency itself. Confidence in the aggregate function drives incremental adoption and liquidity which reinforces and strengthens the value of the bitcoin network as a whole. As individuals opt in to bitcoin, they are at the same time, opting out of inferior monetary networks. This is fundamentally why the emergent properties in bitcoin are next to impossible to replicate and why its monetary properties become stronger over time (and with greater scale), while also at the direct expense of inferior monetary networks.

> "I don't believe we shall ever have a good money again before we take the thing out of the hands of government, that is, we can't take them violently out of the hands of government, all we can do is by some sly roundabout way introduce something that they can't stop." - F. A. Hayek

Ultimately, a blockchain is only useful in the application of money because it is dependent on a native currency for security. Bitcoin represents the most secure blockchain by orders of magnitude. Because all other blockchains are competing for the same fundamental use case of money and because bitcoin's network effects only continue to increase its security and liquidity advantage over the field, no other digital currency can compete with bitcoin. Liquidity begets liquidity and monetary systems tend to one medium as a derivative function. Bitcoin's security and liquidity obsoleted any other cryptocurrencies before they left the proverbial gates. Find me a cryptocurrency that comes close to bitcoin relative to security, liquidity or the credibility of its monetary properties, and I will find you a unicorn.

The real competition for bitcoin has and will remain the legacy monetary networks, principally the dollar, euro, yen and gold. Think about bitcoin relative to these legacy monetary assets as part of your education. Bitcoin does not exist in a vacuum; it represents a choice relative to other forms of money. Evaluate it based on the relative strengths of its monetary properties and once a baseline is established between bitcoin and the legacy systems, this will then provide a strong foundation to more easily evaluate any other blockchain related project.

To learn more, I suggest reading, The Bitcoin Standard (Saifedean Ammous), Inventing Bitcoin (Yan Pritzker) and Mastering Bitcoin (Andreas Antonopolous), probably in that order.

BITCOIN IS NOT BACKED BY NOTHING - SEPTEMBER 27, 2019

Contrary to popular belief, bitcoin is in fact backed by something. It is backed by the only thing that backs any form of money: the credibility of its monetary properties. Money is not a collective hallucination nor merely a belief system. Over the course of history, various mediums have emerged as money, and each time, it has not just been by coincidence. Goods that emerge as money possess unique properties that differentiate them from other market goods. While The Bitcoin Standard provides a more full discussion, monetary goods possess unique properties that make them particularly useful as a means of exchange; these properties include scarcity, durability, divisibility, fungibility and portability, among others. With each emergent money, inherent properties of one medium improve upon and obsolete the monetary properties inherent in a pre-existing form of money, and every time a good has monetized, another has demonetized. Essentially, the relative strengths of one monetary medium out-compete that of another, and bitcoin is no different. It represents a technological advancement in the global competition for money; it is the superior successor to gold and the fiat money systems that leveraged gold's monetary properties.

Bitcoin is out-competing its analog predecessors on the basis of its monetary properties. Bitcoin is finitely scarce, and it is more easily divisible and more easily transferable than its incumbent competitors. It is also more decentralized, and as a derivative, more resistant to censorship or corruption. There will only ever be 21 million bitcoin, and each bitcoin is divisible to eight decimal points (1 one-hundred millionth). Value can be transferred to anyone and anywhere in the world on a permissionless basis, and final settlement does not rely on any third-party. In aggregate, its monetary properties are vastly superior to any other form of money used today. And, these properties do not exist by chance, nor do they exist in a vacuum. The emergent monetary properties in bitcoin are secured and reinforced through a

combination of cryptography, a network of decentralized nodes enforcing a common set of consensus rules, and a robust mining network ensuring the integrity and immutability of bitcoin's transaction ledger. The currency itself is the keystone which binds the system together, creating economic incentives that allow the security columns to function as a whole. But even still, bitcoin's monetary properties are not absolute; instead, these properties are evaluated by the market relative to the properties inherent in other monetary systems.

Coinbase Pro: bitcoin exchange rate for dollars over the last six months (as of September 27, 2019).

Recognize that every time a dollar is sold for bitcoin, the exact same number of dollars and bitcoin exist in the world. All that changes is the relative preference of holding one currency versus another. As the value of bitcoin rises, it is an indication that market participants increasingly prefer holding bitcoin over dollars. A higher price of bitcoin (in dollar terms) means more dollars must be sold to acquire an equivalent amount of bitcoin. In aggregate, it is an evaluation by the market of the relative strength of monetary properties. Price is the output. Monetary properties are the input. As individuals evaluate the monetary properties of bitcoin, the natural question becomes: which possesses more credible monetary properties? Bitcoin or the dollar? Well, what backs the dollar (or euro or yen, etc.) in the first place? When attempting to answer this question, the retort is most often that the dollar is backed by the government, the military (guys with guns), or taxes. However, the dollar is backed by none of these. Not the

government, not the military and not taxes. Governments tax what is valuable; a good is not valuable because it is taxed. Similarly, militaries secure what is valuable, not the other way around. And a government cannot dictate the value of its currency; it can only dictate the supply of its currency.

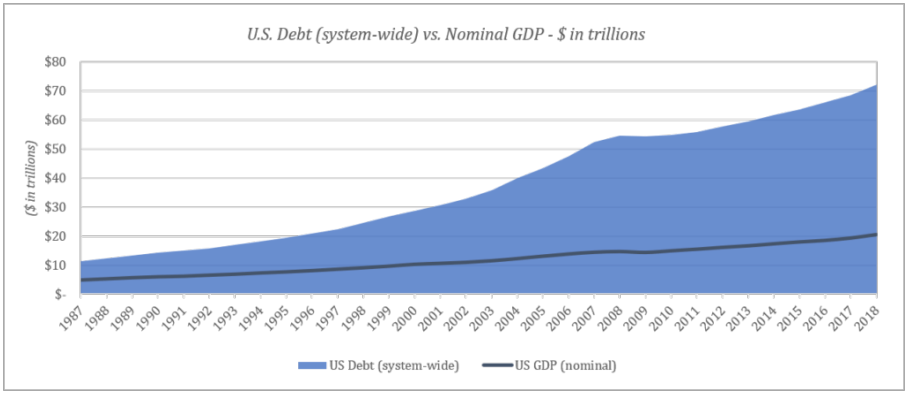
Venezuela, Argentina, and Turkey all have governments, militaries and the authority to tax, yet the currencies of each have deteriorated significantly over the past five years. While it's not sufficient to prove the counterfactual, each is an example that contradicts the idea that a currency derives its value as a function of government. Each and every episode of hyperinflation should be evidence enough of the inherent flaws in fiat monetary systems, but unfortunately it is not. Rather than understanding hyperinflation as the logical end game of all fiat systems, most simply believe hyperinflation to be evidence of monetary mismanagement. This simplistic view ignores first principles, as well as the dynamics which ensure monetary debasement in fiat systems. While the dollar is structurally more resilient as the global reserve currency, the underpinning of all fiat money is functionally the same, and the dollar is merely the strongest of a weak lot. Once the mechanism(s) that back the dollar (and all fiat systems) is better understood, it provides a baseline to then evaluate the mechanisms that back bitcoin.

Why does the dollar have value?

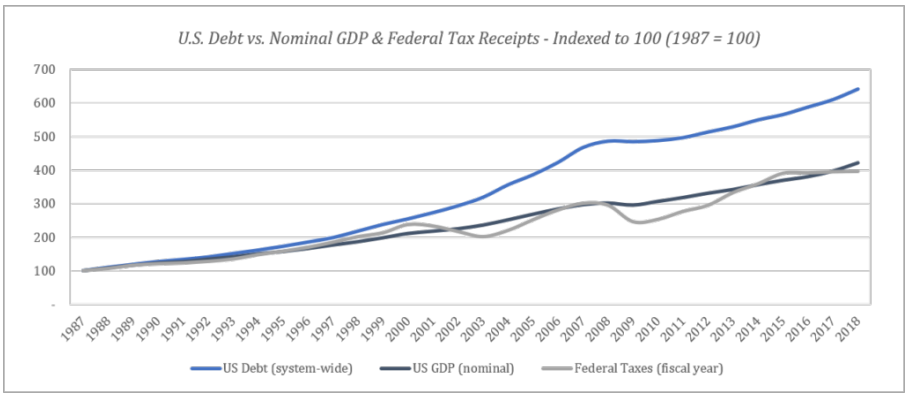
The value of the dollar did not emerge on the free market. Instead, it emerged as a fractional representation of gold (and silver initially). Essentially, the dollar was a solution to the inherent limitations in the convertibility and transferability of gold; its inception was dependent on the monetary properties of base metals, rather than properties inherent in the dollar itself. It was also initially a system based on trust: accept dollars and trust that it could be converted back to gold at a fixed amount in the future. Gold's limitation and ultimate failure as money is the dollar system, and without gold, the dollar would have never existed in its current construct. For a quick review of the dollar's history with gold:

1900	Gold Standard Act of 1900 established that gold was the only metal convertible to the dollar; gold convertible to dollars at $20.67/oz.
1913	The Federal Reserve was created as part of the Federal Reserve Act of 1913.
1933	President Roosevelt banned the hoarding (saving) of gold via Executive Order 6102, requiring citizens to convert gold to dollars at $20.67 per ounce or face a penalty in the form of a fine up to $10,000 and/or up to 5 to 10 years imprisonment.
1934	President Roosevelt signed the Gold Reserve Act, devaluing the dollar by approximately 40% to $35 per ounce of gold.
1944	Bretton Woods agreement formalized ability of foreign governments and central banks to convert gold to dollars (and vice versa) at $35/oz and established fixed exchange ratios between dollars and other foreign currencies.
1971	President Nixon officially ended all convertibility of dollars to gold, effectively ending the Bretton Woods system. The value of dollar was changed to $38/oz of gold.
1973	The U.S. government repriced gold to $42 per ounce.
1976	The U.S. government then decoupled the value of the dollar from gold altogether in 1976.

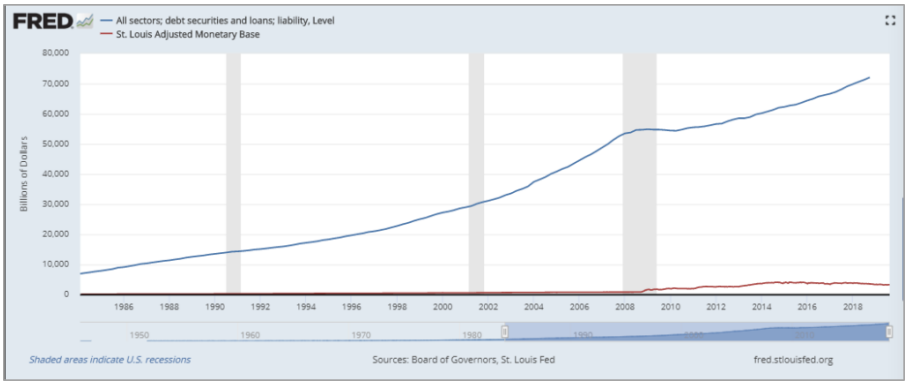
Over the course of the twentieth century, the dollar transitioned from a reserve-backed currency to a debt-backed currency. While most people never stop to consider why the dollar has value in the post gold era, the most common explanation remains that it is either a collective hallucination (i.e. the dollar has value simply because we all believe it does), or that it is a function of the government, the military, and taxes. Neither explanation has any basis in first principles, nor is it the fundamental reason why the dollar retains value. Instead, today, the dollar maintains its value as a function of debt and the relative scarcity of dollars to dollar-denominated debt. In the dollar world, everything is a function of the credit system. Nominal GDP is functionally dependent on the size, and growth of the credit system, and taxes are a derivative of nominal GDP. The mechanisms that fund the government (taxes and deficit spending) are both dependent on the credit system, and it is the credit system that allows the dollar to function in its current construct.



The size of the credit system is several times larger than nominal GDP. Because the credit system is also orders of magnitude larger than the base money supply, economic activity is largely coordinated by the allocation and expansion of credit. However, the growth of the credit system has far outpaced the growth of GDP over the course of the last three decades. The chart below indexes the rate of change of the credit system compared to the rate of change of both nominal GDP and federal tax receipts (from 1987 to today). In the Fed's system, credit expansion drives nominal GDP which ultimately dictates the nominal level of federal tax receipts.



Today, there is $73 trillion of debt (fixed maturity / fixed liability) in the U.S. credit system according to the Federal Reserve (z.1 report), but there are only $1.6 trillion actual dollars in the banking system. This is how the Fed manages the relative stability of the dollar. Debt creates future demand for dollars. In the Fed's system, each dollar is leveraged approximately 40:1. If you borrow dollars today, you need to acquire dollars in the future to repay that debt, and currently, each dollar in the banking system is owed 40 times over. The relationship between the size of the credit system relative to the amount of dollars gives the dollar relative scarcity and stability. In aggregate, everyone needs dollars to repay dollar denominated credit.



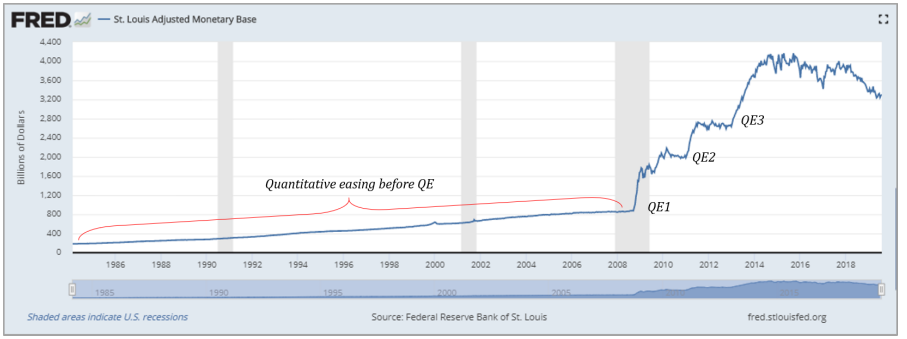
The system as a whole owes far more dollars than exist, creating an environment where on net there is a very high present demand for dollars. If consumers did not pay debt, their homes would be foreclosed upon, or their cars would be repossessed. If a corporation did not pay debt, company assets would be forfeited to creditors via a bankruptcy process, and equity could be entirely wiped out. If a government did not pay debt, basic government functions would be shut down due to lack of funding. In most cases, the consequence of not securing the future dollars necessary to repay debt means losing the shirt on your back. Debt creates the ultimate incentive to demand dollars. So long as dollars are scarce relative to the amount of

outstanding debt, the dollar remains relatively stable. This is how the Fed's economy works, incentivize credit creation and you create the source of future demand for the underlying currency. In a sense, it's kind of like a drug dealer. Get an addict hooked on your drug and he will keep coming back for more. In this case, the drug is debt, and it forces everyone, on net, to stay on the dollar hamster wheel.

The problem for the Fed's economy (and the dollar) is that it depends on the functioning of a highly leveraged credit system. And in order to sustain it, the Fed must increase the amount of base dollars. This is what quantitative easing is and why it exists. In order to sustain the amount of debt in the system, the Fed has to systematically increase the supply of actual dollars, otherwise the credit system would collapse. Increasing the amount of base dollars has the immediate effect of deleveraging the credit system, but it has the longer-term effect of inducing more credit. It also has the effect of devaluing the dollar gradually over time. This is all by design. Credit is ultimately what backs the dollar because what the credit actually represents is claims on real assets, and consequently, people's livelihoods. Come with dollars in the future or risk losing your house is an incredible incentive to work for dollars.

The relationship between dollars and dollar credit keeps the Fed's game in play, and central bankers believe this can go on forever. Create more dollars; create more debt. Too much debt? Create more dollars, and so on. Ultimately, in the Fed's (or any central bank's) system, the currency is the release valve. Because there is $73 trillion of debt and only $1.6 trillion dollars in the U.S. banking system, more dollars will have to be added to the system to support the debt. The scarcity of dollars relative to the demand for dollars is what gives the dollar its value. Nothing more, nothing less. Nothing else backs the dollar. And while the dynamics of the credit system create relative scarcity of the dollar, it is also what ensures dollars will become less and less scarce on an absolute basis.

Too much debt → Create more money → More debt → Too much debt



Note: The Adjusted Monetary Base is the sum of currency (including coin) in circulation outside Federal Reserve Banks and the U.S. Treasury, plus deposits held by depository institutions at Federal Reserve Banks. These data are adjusted for the effects of changes in statutory reserve requirements on the quantity of base money held by depositories.

As is the case with any monetary asset, scarcity is the monetary property that backs the dollar, but the dollar is only scarce relative to the amount of dollar-denominated debt that exists. And it now has real competition in the form of bitcoin. The dollar system and its lack of inherent monetary properties provides a stark contrast to the monetary properties emergent and inherent in bitcoin. Dollar scarcity is relative; bitcoin scarcity is absolute. The dollar system is based on trust; bitcoin is not. The dollar's supply is governed by a central bank, whereas bitcoin's supply is governed by a consensus of market participants. The supply of dollars will always be wed to the size of its credit system, whereas the supply of bitcoin is entirely divorced from the function of credit. And, the cost to create dollars is marginally zero, whereas the cost to create bitcoin is tangible and ever increasing. Ultimately, bitcoin's monetary properties are emergent and increasingly unmanipulable, whereas the dollar is inherently and increasingly manipulable.

Money and digital scarcity

The hardest mental hurdle to overcome, when evaluating bitcoin as money, is often that it is digital. Bitcoin is not tangible, and on the surface, it is not intuitive. How could something entirely digital be

money? While the dollar is mostly digital, it remains far more tangible than bitcoin in the mind of most. While the digital dollar emerged from its paper predecessor and physical dollars remain in circulation, bitcoin is natively digital. With the dollar, there is a physical representation that anchors our mental models in the tangible world; with bitcoin, there is not. While bitcoin possesses **far more credible monetary properties** than the dollar, the dollar has always been money (for most of us), and as a consequence, its digital representation is seemingly a more intuitive extension from the physical to the digital world. While the dollar's basis as money is anchored in time and while its digital nature may seem more tangible, bitcoin represents finite scarcity. The supply of the dollar on the other hand has no limits.

Remember that the dollar does not have any inherent monetary properties. It leveraged the monetary properties of gold in its ascent to global reserve status, but in itself, there are no unique properties that ground the dollar as a stable form of money, other than its relative scarcity in the construct of its credit-linked monetary system. When evaluating bitcoin, the first principle question to consider is whether something digital could share the quintessential properties that made gold a store of value (and a form of money). Did gold emerge as money because it was physical or because it possessed transcendent properties beyond being physical? Of all the physical objects in the world, why gold? Gold emerged as money not because it was physical, but instead because its aggregate properties were unique. Most importantly, gold is scarce, fungible and highly durable. While gold possessed many properties which made it superior to any money that came before it, its fatal flaw was that it was difficult to transport and susceptible to centralization, which is ultimately why the dollar emerged as its transactional counterpart.

> "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"
> – Satoshi Nakamoto (August 27, 2010)

Bitcoin shares the monetary properties that caused gold to emerge as a monetary medium, but it also improves upon gold's flaws. While gold is relatively scarce, bitcoin is finitely scarce and both are extremely durable. While gold is fungible, it is difficult to assay; bitcoin is fungible and easy to assay. Gold is difficult to transfer and highly centralized. Bitcoin is easy to transfer and highly decentralized. Essentially, bitcoin possesses all of the desirable traits of both physical gold and the digital dollar combined in one, but without the critical flaws of either. When evaluating monetary mediums, first principles are fundamental. Ignore the conclusion or end point, and start by asking yourself: if bitcoin were actually scarce and finite, ignoring that it is digital, could that be an effective measure of value and ultimately a store of value? Is scarcity a sufficiently powerful property that bitcoin could emerge as money, regardless of whether the form of that scarcity is digital?

While money may be an intangible concept, so long as there are benefits from trade and specialization, there is real demand and utility in money. Money is the tool we use to be the arbiter in determining relative value among more abundant consumption goods and capital goods. It is the good that coordinates all other economic activity. The absolute quantity of money is less important than its properties of being scarce and measurable. Scarcity is money's most important property. If supply of the unit of measure were constantly and unpredictably changing, it would be very difficult to measure the value of goods relative to it, which is why scarcity, on its own, is an incredibly valuable property. While the value of the underlying measurement unit may fluctuate relative to goods and services, stability in the supply of money results in the least amount of noise in the relative price signal of other goods.

Despite being digital, bitcoin is designed to provide absolute scarcity, which is why it has the potential to be such an effective form of money (and measure of value). There will only ever be 21 million bitcoin, and 21 million is a scarily small number in relative and absolute terms. The Fed created $100 billion dollars just last week, with the click of a button. That is approximately $5,000 per bitcoin that will ever exist, created in just a week (and by only one central bank). To provide broader context, the Federal Reserve, the Bank of Japan and the European Central bank have collectively created $10 trillion dollars-worth of new money since the financial crisis, the equivalent of approximately $500,000 per bitcoin. Despite dollars, euro, yen and bitcoin all being digital, bitcoin is the only medium that is tangibly scarce and the only one with inherent monetary properties.

However, it is insufficient to simply claim that bitcoin is finitely scarce; nor should anyone simply accept this as fact. It is important to understand how and why that is the case. Why can't more than 21 million bitcoin be created and why can't it be copied? Why is bitcoin secure and why can't it be manipulated? While there are countless building blocks that collectively allow bitcoin to function with a reliably fixed supply, there are three key columns of security within the bitcoin network which are woven together and reinforced by the economic incentives of the currency itself:

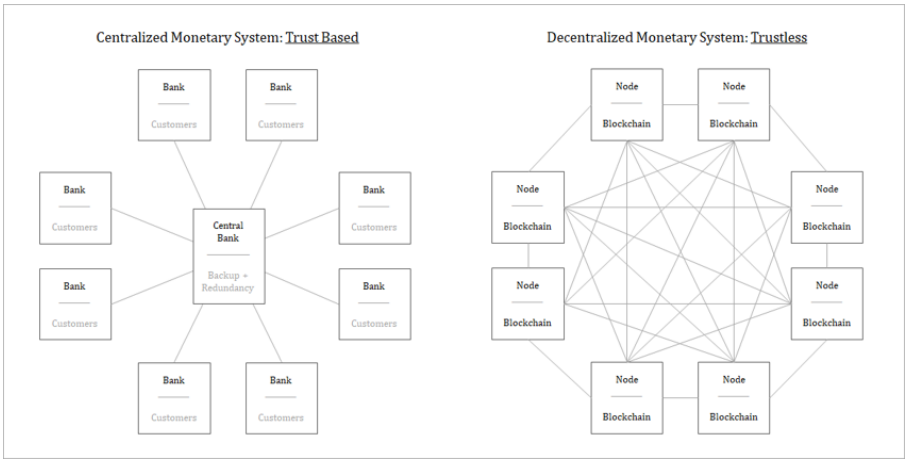
- Network Consensus & Full Nodes: enforce common set of governing rules
- Mining & Proof-of-Work: validate transaction history, anchor bitcoin security in the physical world
- Private Keys: secures the unit of value, ensures ownership is independent from validation

What Secures Bitcoin – Network Consensus & Full Nodes

21 million is not just a number guaranteed by software. Instead, bitcoin's fixed 21 million supply is governed by a consensus mechanism, and all market participants have an economic incentive to enforce the rules of the bitcoin network. While a consensus of the

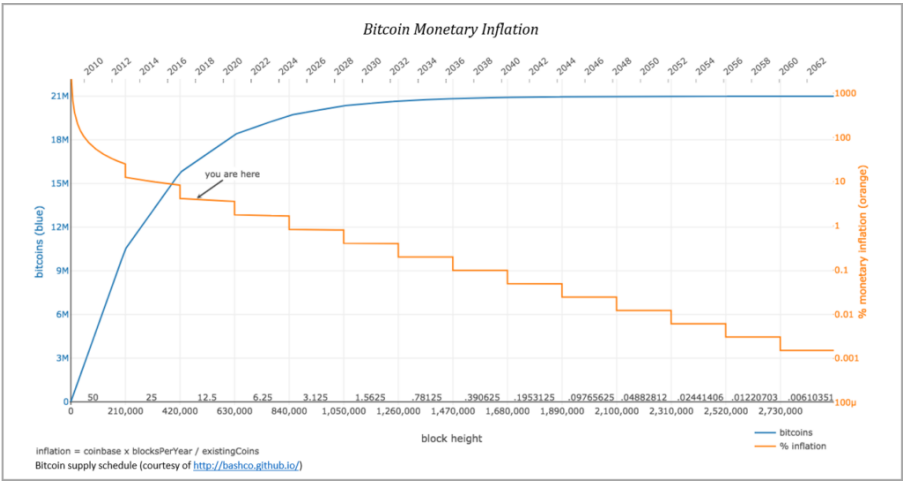
bitcoin network could theoretically determine to increase the supply of bitcoin such that it exceeds 21 million, an overwhelming majority of bitcoin users would have to collectively agree to debase their own currency in order to do so. In practice, a global and decentralized network of rational economic actors, operating within a voluntary, opt-in currency system would not collectively and overwhelmingly form a consensus to debase the currency which they have all independently and voluntarily determined to use as a store of wealth. This reality then underpins and reinforces bitcoin's economic incentives, technical architecture and network effect.

In bitcoin, a full node is a computer or server that maintains a full version of the bitcoin blockchain. Full nodes independently aggregate a version of the blockchain based on a common set of network consensus rules. While not everyone that holds bitcoin runs a full node, everyone is able to do so, and each node validates all transactions and all blocks. By running a full node, anyone can access the bitcoin network and broadcast transactions (or blocks) on a permissionless basis. And nodes do not trust any other nodes. Instead, each node independently verifies the complete history of bitcoin transactions based on a common set of rules, allowing the network to converge on a consistent and accurate version of history on a trustless basis.



This is the mechanism by which the bitcoin network removes trust in any centralized third-party and hardens the credibility of its fixed supply. All nodes maintain a history of all transactions, allowing each node to determine whether any future transaction is valid. In aggregate, bitcoin represents the most secure computing network in the world because anyone can access it and no one trusts anyone. The network is decentralized and there are no single points of failure. Every node represents a check and balance on the rest of the network, and without a central source of truth, the network is resistant to attack and corruption. Any node could fail or could become corrupted, and the rest of the network would remain unimpacted. The more nodes that exists, the more decentralized bitcoin becomes, which increases redundancy, making the network harder and harder to corrupt or censor.

Each full node enforces the consensus rules of the network, a critical element of which is the currency's fixed supply. Each bitcoin block includes a pre-defined number of bitcoin to be issued and each bitcoin transaction must have originated from a previously valid block in order to be valid. Every 210,000 blocks, the bitcoin issued in each valid block is cut in half until the amount of bitcoin issued ultimately reaches zero in approximately 2140, creating an asymptotic, capped supply schedule. Because each node independently validates every transaction and each block, the network collectively enforces the fixed 21 million supply. If any node broadcasts an invalid transaction or block, the rest of the network would reject it and that node would fall out of consensus. Essentially, any node could attempt to create excess bitcoin, but every other node has an interest in ensuring the supply of bitcoin is consistent with the pre-defined fixed limit, otherwise the currency would be arbitrarily debased at the direct expense of the rest of the network.



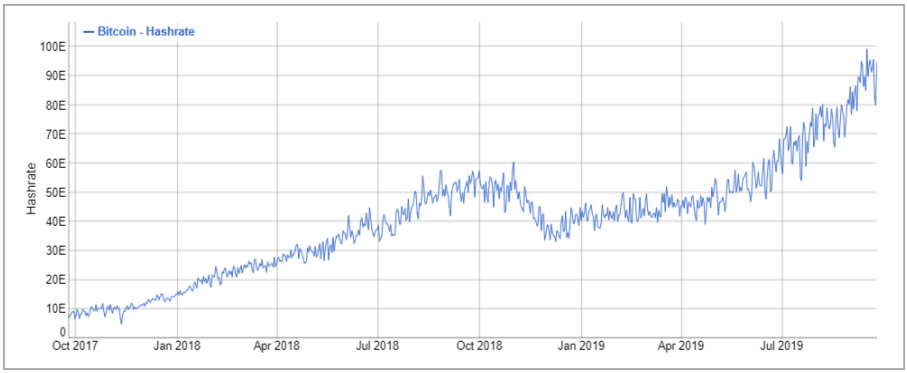
Separately, anyone within or outside the network could copy bitcoin's software to create a new version of bitcoin, but any units created by such a copy would be considered invalid by the nodes operating within the bitcoin network. Any subsequent copies or units would not be considered valid, nor would anyone accept the currency as bitcoin. Each bitcoin node independently validates whether a bitcoin is a bitcoin, and any copy of bitcoin would be invalid, as it would not have originated from a previously valid bitcoin block. It would be like trying to pass off monopoly money as dollars. You can wish it to be money all you want, but no one would accept it as bitcoin, nor would it share the emergent properties of the bitcoin network. Running a bitcoin full node allows anyone to instantly assay whether a bitcoin is valid, and any copy of bitcoin would be immediately identified as counterfeit. The consensus of nodes determines the valid state of the network within a closed-loop system; anything that occurs beyond its walls is as if it never happened.

What Secures Bitcoin – Mining and Proof of Work

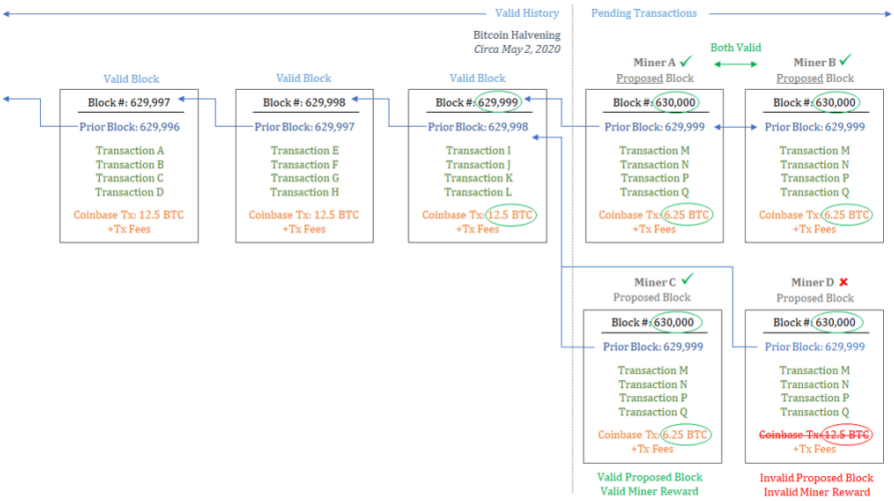
As part of the consensus mechanism, certain nodes (referred to as miners) perform bitcoin's proof of work function to add new bitcoin blocks to the blockchain. This function validates the complete history of transactions and clears pending transactions. The process of mining

is ultimately what anchors bitcoin security in the physical world. In order to solve blocks, miners must perform trillions of cryptographic computations, which require expending significant energy resources. Once a block is solved, it is proposed to the rest of the network for validation. All nodes (including other miners) verify whether a block is valid based on a common set of network consensus rules discussed previously. If any transaction in the block is invalid, the entire block is invalid. Separately, if a proposed block does not build on the latest valid block (i.e. the longest version of the block chain), the block is also invalid.

For context, at 90 exahashes per second, the bitcoin network currently consumes approximately 9 gigawatts of power, which translates to ~$11 million per day (or ~$4 billion per year) of energy at a marginal cost of 5 cents per kWh (rough estimates). Blocks are solved on average every ten minutes, which translates to approximately 144 blocks per day. Across the network, each block costs approximately $75,000 to solve, and the reward per block is approximately $100,000 (12.5 new bitcoin x $8,000 per bitcoin, excluding transaction fees). The higher the cost to solve a block, the more costly the network is to attack. The cost to solve a block represents the tangible resources it requires to write history to the bitcoin transaction ledger. As the network grows, the network becomes more fragmented, and the economic value compensated to miners in aggregate increases. From a game theory perspective, more competition and greater opportunity cost makes it harder to collude, and all network nodes validate the work performed by miners, which serves as a constant check and balance.

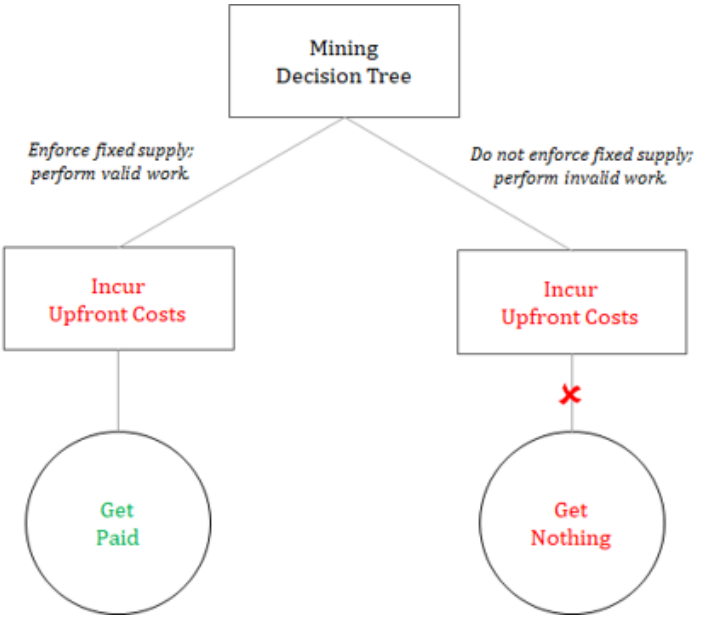


And recall that a pre-defined number of bitcoin are issued in each valid block (that is, until the 21 million limit is reached). The bitcoin issued in each block combined with network transaction fees represent the compensation to miners for performing the proof-of-work function. The miners are paid in bitcoin to secure the network. As part of the block construction and proposal process, miners include the pre-defined number of bitcoin to be issued as compensation for expending tangible, real world resources to secure the network. If a miner were to include an amount of bitcoin inconsistent with the pre-defined supply schedule as compensation, the rest of the network would reject the block as invalid. As part of the security function, miners must validate and enforce the fixed supply of the currency in order to be compensated. Miners have material skin-in-the-game in the form of upfront capital costs (and energy expenditure), and invalid work is not rewarded.



For a technical example, the valid reward paid to miners is halved every 210,000 blocks with the next halvening (a “technical” term) scheduled to occur at block 630,000 (or approximately in May 2020).

At the time and scheduled block of the next halvening, the valid reward will be reduced from 12.5 bitcoin to 6.25 bitcoin per block. Thereafter, if any miner includes an invalid reward (an amount other than 6.25 bitcoin), the rest of the network will reject it as invalid. The halvening is important not just because the supply of newly issued bitcoin is reduced, but also because it demonstrates that the economic incentives of the network continue to effectively coordinate and enforce the fixed supply of the currency on an entirely decentralized basis. If any miner attempts to cheat, it will be maximally penalized by the rest of the network. Nothing other than the economic incentives of the network coordinate this behavior; that it occurs on a decentralized basis without the coordination of any central authority reinforces the security of the network.



Because mining is decentralized and because all miners are constantly competing with all other miners, it is not practical for miners to collude. Separately, all nodes validate the work performed by miners, instantly and at practically no cost, which creates a very powerful

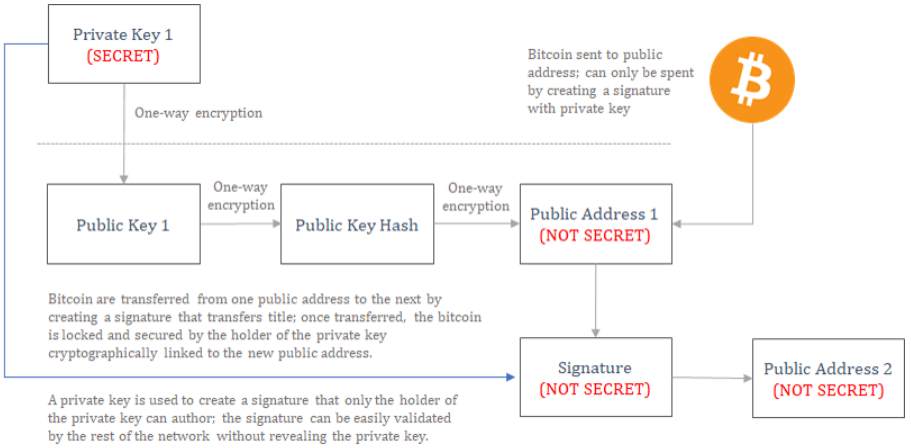
check and balance that is divorced from the mining function itself. Blocks are costly to solve but easy to validate; in aggregate, this is a fundamental differentiator between bitcoin and the monetary systems with which bitcoin competes, whether gold or the dollar. And the compensation paid to miners for securing the network and enforcing the network's fixed supply is exclusively in the form of bitcoin. The economic incentives of the currency (compensation) is so strong and the penalty is both so severe and so easily enforced that miners are maximally incentivized to cooperate and perform valid work. By introducing tangible cost to the mining process, by incorporating the supply schedule in the validation process (which all nodes verify), and by divorcing the mining function from ownership of the network, the network as a whole reliably and perpetually enforces the fixed supply (21 million) of the currency on a trustless basis, while also able to reach consensus on a decentralized basis.

What Secures Bitcoin – Private Keys and Equal Rights

While miners construct, solve and propose blocks and while nodes check and validate work performed by miners, private keys control access to the unit of value itself. Private keys control the rights to the 21 million bitcoin (technically only 18.0 million have been mined to date). In bitcoin, there are no identities; bitcoin knows nothing of the outside world. The bitcoin network validates signatures and keys. That is all. Only someone in control of a private key can create a valid bitcoin transaction by creating a valid signature. Valid transactions are included in blocks, which are solved by miners and validated by each node, but only those in possession of private keys can produce valid transactions.

When a valid transaction is broadcast, bitcoin are spent (or transferred) to specific bitcoin public addresses. Public addresses are derived from public keys, which are derived from private keys. Public keys and public addresses can be calculated using a private key, but a private key cannot be calculated from a public key or public address. It is a one-way function secured by strong cryptography. Public keys and public addresses can be shared without revealing anything about

the private keys. When a bitcoin is spent to a public address, it is essentially locked in a safe, and in order to unlock the safe to spend the bitcoin, a valid signature must be produced by the corresponding private key (every public key and address has a unique private key). The owner of the private key produces a unique signature, without actually revealing the secret itself. The rest of the network can verify that the holder of the private key produced a valid signature, without actually knowing any details of the private key itself. Public and private key pairs are the foundation of bitcoin. And ultimately, private keys are what control access rights to the economic value of the network.



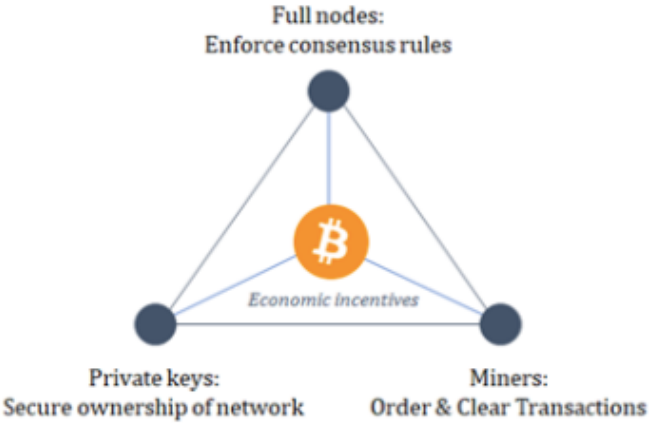
It doesn't matter whether someone has one-tenth of a bitcoin or ten thousand bitcoin. Either and each are secured and validated by the same mechanism and by the same rules. Everyone has equal rights. Regardless of the economic value, each bitcoin (and bitcoin address) is treated identically within the bitcoin network. If a valid signature is produced, the transaction is valid and it will be added to the blockchain (if a transaction fee is paid). If an invalid signature is produced, the network will reject it as invalid. It does not matter how powerful or how weak any particular participant may be. Bitcoin is

apolitical. All it validates is keys and signatures. Someone with more bitcoin may be able to pay a higher fee to have a transaction prioritized, but all transactions are validated based on the same set of consensus rules. Miners prioritize transactions based on value and profitability, nothing else. If a transaction is equally valuable, it will be prioritized based on a time sequence. But importantly, the mining function, which clears transactions, is divorced from ownership. Bitcoin is not a democracy; ownership is controlled by keys and every bitcoin transaction is evaluated based on the same criteria within the network. It is either valid or it is not. And every bitcoin must have originated within a block consistent with the 21 million supply schedule in order to be valid.

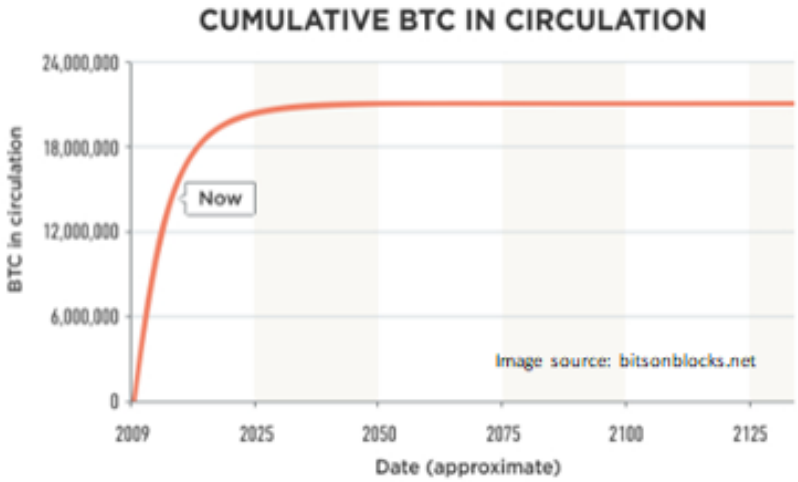
This is why users controlling keys is such a significant ethos in bitcoin. Bitcoin are extremely scarce, and private keys are the gatekeeper to the transfer of every bitcoin. The saying goes: not your keys, not your bitcoin. If a third-party party controls your keys, such as a bank, that entity is in control of your access to the bitcoin network, and it would be very easy to restrict access or seize funds in such a scenario. While many people choose to trust a bank-like entity, the security model of bitcoin is unique; not only can each user control their own private keys, but each user can also access the network on a permissionless basis and transfer funds to anyone anywhere in the world. This is only possible if a user is in control of a private key. In aggregate, users controlling private keys decentralize the control of the network's economic value, which increases the security of the network as a whole. The more distributed access is to the network, the more challenging it becomes to corrupt or co-opt the network. Separately, by holding a private key, it becomes extremely difficult for anyone to restrict access or seize funds held by any individual. Every bitcoin in circulation is secured by a private key; miners and nodes may enforce that 21 million bitcoin will ever exist, but the valid bitcoin that do exist are ultimately controlled and secured by a private key.

Bitcoin versus.

In summary, the supply of bitcoin is governed by a network consensus mechanism, and miners perform a proof-of-work function that grounds bitcoin's security in the physical world. As part of the security function, miners get paid in bitcoin to solve blocks, which validate history and clear pending bitcoin transactions. If a miner attempts to compensate themselves in an amount inconsistent with bitcoin's fixed supply, the rest of the network will reject the miner's work as invalid. The supply of the currency is integrated into bitcoin's security model, and real world energy resources must be expended in order for miners to be compensated. Still yet, every node within the network validates the work performed by all miners, such that no one can cheat without a material risk of penalty. Bitcoin's consensus mechanism and validation process ultimately governs the transfer of ownership of the network, but ownership of the network is controlled and protected by individual private keys held by users of the network.


Full nodes:
Enforce consensus rules
Economic incentives
Private keys:
Secure ownership of network
Miners:
Order & Clear Transactions


More
Miners
More
Secure
More
Confidence
More
Users
Higher
Price



Set aside any preconceived notions of what money is, and imagine a currency system that has an enforceably scarce and fixed supply. Anyone in the world can connect to the network on a permissionless basis and anyone can send transactions to anyone anywhere in the world; everyone can also independently and easily validate the supply of the currency as well as ownership across the network. Imagine a global economy where billions of people, disparately located throughout the world, can transact across one common decentralized network, and everyone can arrive at the same consensus of the ownership of the network, without the coordination of any central party. How valuable would that network be? Bitcoin is valuable because it is finite, and it is finite because it is valuable. The economic incentives and governance model of the network reinforce each other; the cumulative effect is a decentralized and trustless monetary system with a fixed supply that is global in reach and accessible by anyone.

Because bitcoin has inherent and emergent monetary properties, it is distinct from all other digital monies. While the supply of bitcoin remains fixed and finitely scarce, central banks will be forced to expand the monetary base in order to sustain the legacy system. Bitcoin will become a more and more attractive option, as more

market participants figure out that future rounds of quantitative easing are not just a central bank tool but a necessary function to sustain the alternate and inferior option. Before bitcoin, everyone was forced to opt in to this system by default. Now that bitcoin exists, there is a viable alternative. Each time the Fed returns with more quantitative easing to sustain the credit system, more and more individuals will discover that the monetary properties of bitcoin are vastly superior to the legacy system, whether the dollar, euro or yen. Is A better than B? That is the test. In the global competition for money, bitcoin has inherent monetary properties that the fiat monetary system lacks. **Ultimately, bitcoin is backed by something, and it's the only thing that backs any money: the credibility of its monetary properties**.

BITCOIN IS NOT A PYRAMID SCHEME - OCTOBER 18, 2019

A few years ago, I received an email from a friend asking for my opinion about an investment opportunity that a mutual contact of ours was considering. After a quick search on the internet and after having watched a few videos, I explained that it looked like a pyramid scheme. This was my shorthand for "avoid at all cost." The information was forwarded along to our mutual contact and the reply back was not what I was expecting: "Are all pyramid schemes bad?" Some pyramid schemes are harder to identify than others, but even those that are easy to identify find prey in unassuming victims. A good rule of thumb is to run, not walk, away from anything that even hints of being a pyramid scheme. Thankfully, bitcoin is not one of them. While it may seem obvious, not everyone understands what a pyramid scheme actually is, what the warning signs may be, or why such schemes always fail.

Definition of a Pyramid Scheme – Securities & Exchange Commission

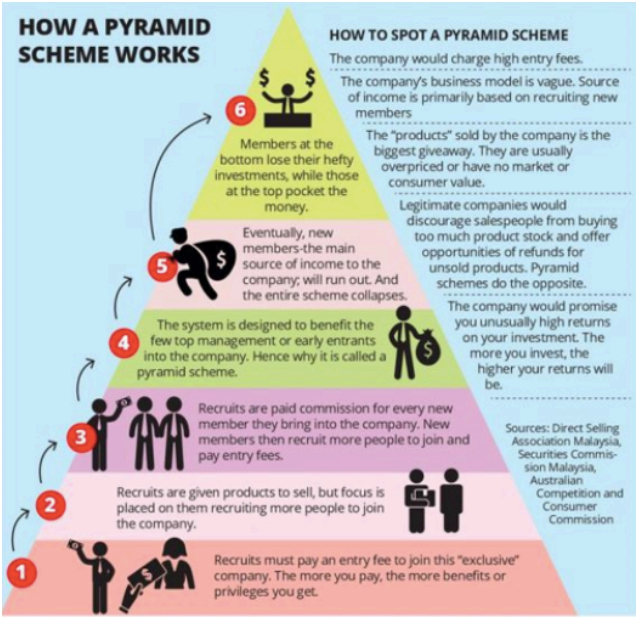
> *In the classic "pyramid" scheme, participants attempt to make money solely by recruiting new participants into the program. The hallmark of these schemes is the promise of sky-high returns in a short period of time for doing nothing other than handing over your money and getting others to do the same. The fraudsters behind a pyramid scheme may go to great lengths to make the program look like a legitimate multi-level marketing (MLM) program. But despite their claims to have legitimate products or services to sell, these fraudsters simply use money coming in from new recruits to pay off early stage investors. – US Securities & Exchange Commission (SEC)*

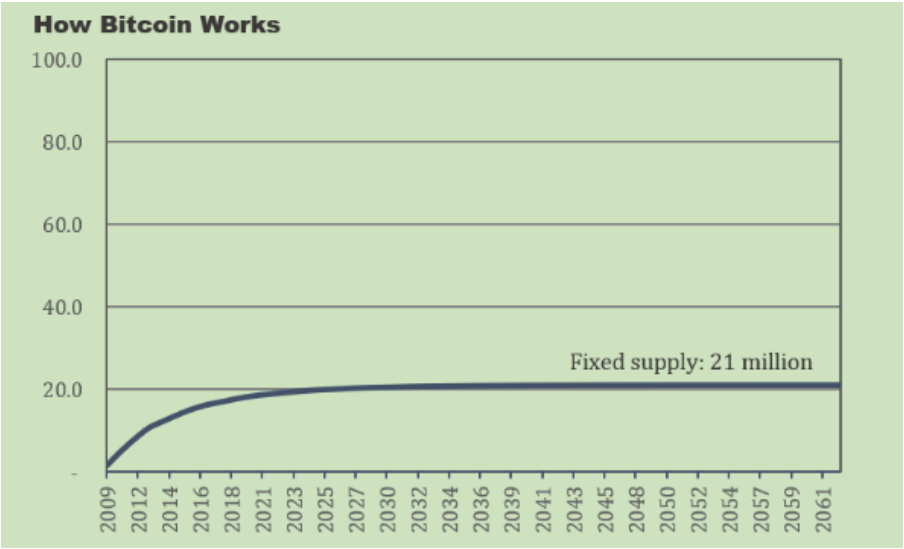
Warning Signs of a Pyramid Scheme – Federal Trade Commission

- *Promoters make extravagant promises about your earning potential. Stop. Such promises are false.*
- *Promoters emphasize recruiting new distributors for your sales network as the real way to make money. Walk away. In a legitimate MLM program, you should be able to make money just by selling the product.*
- *Promoters play on your emotions or use high-pressure sales tactics, maybe saying you'll lose the opportunity if you don't act now and discouraging you from taking time to study the company. Leave by the nearest exit. Any company that tries to pressure you to join is one to avoid.*
- *Distributors buy more products than they want to use or can resell, just to stay active in the company or to qualify for bonuses or other rewards. If you see this happening, keep your money.*

Not all multi-level marketing programs are pyramid schemes, but all pyramid schemes are in some fashion a multi-level marketing program. With pyramid schemes, there is always some company and it is selling a product for which the end demand falls far short of the available supply. The company recruits participants to purchase inventory and to recruit new participants. The participants are all sales people, and compensation is tied mostly to recruiting, rather than selling the actual product. Often the sale of product is purposefully woven into the recruitment process.

In a normal sales-driven business, the company takes on the inventory risk and pays commissions based on sales to end users. In a pyramid scheme, the sales people take on the inventory risk, rather than the company, and compensation is paid for recruiting more sales people and selling product through to new participants. It all falls apart because sufficient end demand for the product does not actually exist. Everyone up the chain can make money at the expense of the new recruits at the end of the line. This is a pyramid scheme. Bitcoin is not. Bitcoin is not a company. It has no employees and its supply is finitely scarce. No matter how many people adopt it, there will only ever be 21 million bitcoin.





The distinctions should be glaringly obvious, but because bitcoin is complex and the very idea of money is not well understood, it can easily be confused. Bitcoin will only become a global reserve currency if hundreds of millions (if not billions) more adopt it. And seemingly everyone that goes down the bitcoin rabbit hole ends up on the other side explaining it to their family and friends, pitching it as a better form of money. Sounds kind of like a pyramid scheme, right? Wrong. When Dell started selling PCs on its website in 1996 and everyone told their friends to get a Dell, was it a pyramid scheme? When Apple released the first iPhone in 2007 and everyone told their friends to drop the Blackberry for its superior successor, was it a pyramid scheme?

Technological shifts often happen fast. Ten and twenty years later, smartphones and PCs are ubiquitous. It is all about the quality of the product and the incentive structure. If someone owned Apple stock or Dell stock, did it change the fact that the product itself provided a real value proposition? Was there a direct benefit for telling people about a new technological innovation? The value proposition of an innovation

trumps all else. It does not matter how you learn about it; all that matters is whether the innovation provides utility. If it does, people will want to use it; if it doesn't, they won't. That is what makes a market.

The Utility & Innovation of Bitcoin

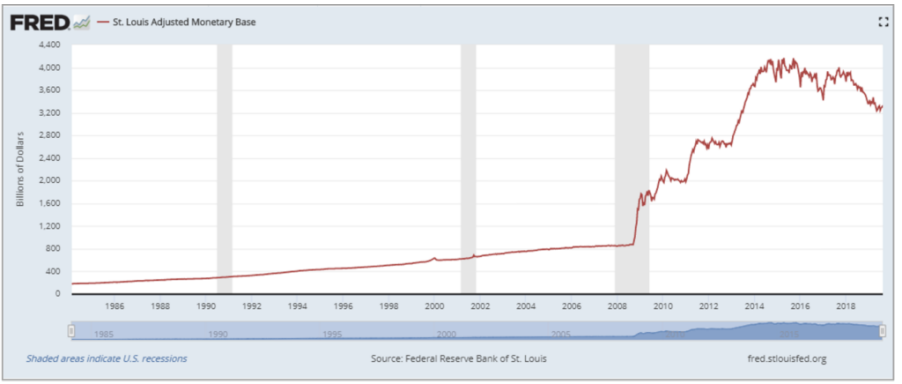
Bitcoin's utility is as money. It has a market because it solves a problem inherent in modern money. Not only is bitcoin not a pyramid scheme; it is fundamentally distinct from the class of innovation that could be offered by any individual company. Bitcoin is not Dell and it is not Apple. It is not a tech stock. There is no company that exists behind bitcoin. Bitcoin is not a company selling a product and there is no income stream to pay future dividends. Bitcoin is not about making money; instead, bitcoin is money, or at least it has become money to those choosing to store a portion of their wealth in it. And it's not a get-rich-quick scheme; it is fundamentally about storing the value you have already created. Bitcoin is a bearer asset; however, unlike a bearer bond, there is no income stream.

Bitcoin's innovation is that it represents a superior form of money, but there are no future promises beyond being in possession of a digital bearer instrument. The only utility of bitcoin is in holding it as a currency and transacting with it in the future, whether that be in exchange for legacy currencies or other goods and services. Bitcoin is only useful as a form of money, and it will only maintain value if others demand it in the future. But this is true of any form of money (not just bitcoin). Money is not a collective hallucination or merely a belief system; monetary goods have distinct properties which make them more or less effective in facilitating exchange. However, monetary properties are not absolute; the relative strength of monetary properties is the fundamental basis of demand. When the market evaluates bitcoin, it does so relative to other monetary mediums (the dollar, euro, yen, gold, etc.).

The supply of bitcoin, and its rigid supply constraint, is the foundation of bitcoin's utility and fundamental demand; it is also why

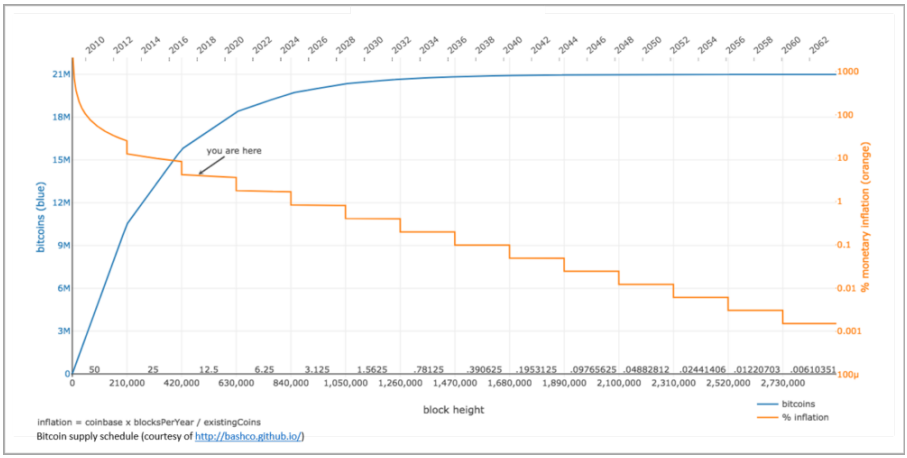
bitcoin is not a pyramid scheme. There will only ever be 21 million bitcoin. That is bitcoin's schelling point. Everyone knows it; everyone remembers it. Everyone can also verify it at any point in time. For discussion of how and why bitcoin has a credibly fixed supply, see Bitcoin, Not Blockchain and Bitcoin is Not Backed by Nothing. But for now, just work on the assumption that the supply of bitcoin is capped at 21 million. In contrast, no one knows the supply of dollars. The Fed estimates the current supply of dollars, but no one knows how many dollars will exist in the future. There is no constraint on the supply of the dollar, other than the Federal Reserve, and all we know for sure is that many more dollars will exist in the future; it is a limitless function. In the end, there is fundamental demand for bitcoin because its monetary policy is i) optimally engineered and ii) credibly enforced. Relative to its competition, bitcoin is a vastly superior monetary medium.

Exhibit A – Dollar Historical Supply



Note: The Adjusted Monetary Base is the sum of currency (including coin) in circulation outside Federal Reserve Banks and the U.S. Treasury, plus deposits held by depository institutions at Federal Reserve Banks. These data are adjusted for the effects of changes in statutory reserve requirements on the quantity of base money held by depositories.

Exhibit B – Bitcoin Supply Schedule



The monetary base in fiat systems changes unpredictably whereas the monetary base in bitcoin is governed by a well-defined supply schedule. Think about the monetary base as setting the foundation of a global economic system. The unpredictable changes in the supply of dollars is not merely akin to shifting the proverbial goal posts. Instead, it is more similar to building the field on a 1980s-style water bed, and then shifting the goal posts. The whole game is distorted, not just the end points. Bitcoin, on the other hand, is a bedrock as a function of its fixed supply, and over time, the foundation becomes stronger and stronger. The credibility of its supply schedule is reinforced with each passing bitcoin block. As it becomes more evident that bitcoin's supply schedule is credibly enforced, more people adopt bitcoin as a form of money, and those that already have increasingly use it as a store of wealth. Fixed supply + increasing adoption = increased value. As adoption increases and as value rises, bitcoin becomes further decentralized. And as bitcoin decentralizes over time, it becomes harder to change, reinforcing the credibility of its foundation: its fixed supply.

You are the Scammer

In a pyramid scheme, the people selling the scheme are the scammers. These scammers are selling the promise of future monetary gains through high-pressure sales tactics and by recruiting new members to the scheme as the primary compensation mechanism. In bitcoin, the people buying bitcoin are the scammers, as described in Michael Goldstein's timeless piece, Everyone's a Scammer. If this is you, you are the scammer. In most cases today, whenever someone buys bitcoin, they are directly trading a fractionally reserved form of currency (with the promise of future debasement) in return for a bearer asset with a finite supply and a vastly superior monetary policy. The person on the other end of the line is getting the raw deal. It is not to say that literally everyone that sells a bitcoin does so without good reason. It is money after all, and its utility is in exchange; by definition, market participants have a wide variety of present needs for liquidity and real value is transferred every time a bitcoin is transacted, whether for dollars or for goods and services. However, on average and over the longer-term, it is information asymmetry in full effect. Bitcoin's monetary policy is optimally engineered and credibly enforced, though few understand it, which is why it represents the greatest asymmetry in the world today.

Supply	Fixed Supply: 21 million	>	Limitless: QE
Supply Schedule	Fixed schedule: 10 minute intervals	>	Unpredictable: QE / Reverse QE
Governance	Consensus	>	Central Bank

Monetary First Principles

A monetary medium with the lowest rate of change is most effective in communicating economic signals, and a fixed supply (zero rate of change) is the optimal monetary policy end game. While the monoculture that is modern mainstream academia disagrees with this view, a fixed supply currency is superior to a currency that increases in supply over time (and at unpredictable rates). In any economy, supply and demand for goods and services relative to the supply and demand of money dictates prices. Price is what ultimately coordinates economic activity, and money is the foundation of the pricing mechanism within an economy. A currency with a fixed supply would remove the noise created by changes to the money supply in the price system, thus creating more reliable market signals. Because a monetary good facilitates the exchange between goods used for the purpose of either consumption or production, the form of money with the lowest rate of change will most accurately reflect changes in supply and demand of all other goods. Essentially, money is used to communicate the relative value of other goods and services, and changes in the money supply distort the communication of this information by introducing an extraneous variable to the equation.

For example, an iPhone costs approximately $1,000, whereas a barrel of oil costs approximately $50. The information communicated through a monetary medium is that an iPhone costs approximately 20 times more than a barrel of oil. Money communicates opportunity cost (economic trade-offs) through its price system, and the more constant the quantity of money (lower rate of change), the more reliable the communication of information and economic trade-offs. If the money supply increased by 10% and prices adjusted equally, an iPhone would cost $1,100 and a barrel oil would cost $55. An iPhone would still cost 20 times more than a barrel of oil, and that is the relevant information which all market participants rely upon. In the real world, the problem is that prices do not adjust equally as the money supply changes. Instead, price signals become distorted. In a world with a constant money supply, changes in price would more accurately reflect changes in supply and demand in underlying

markets for goods and services rather than also reflecting the unequal impact of a changing money supply. Changes in the money supply create noise extraneous to the underlying economic activity. Price coordinates economic trade-offs, and the reliability of a pricing system is dependent on the stability of the form of money used to communicate information.

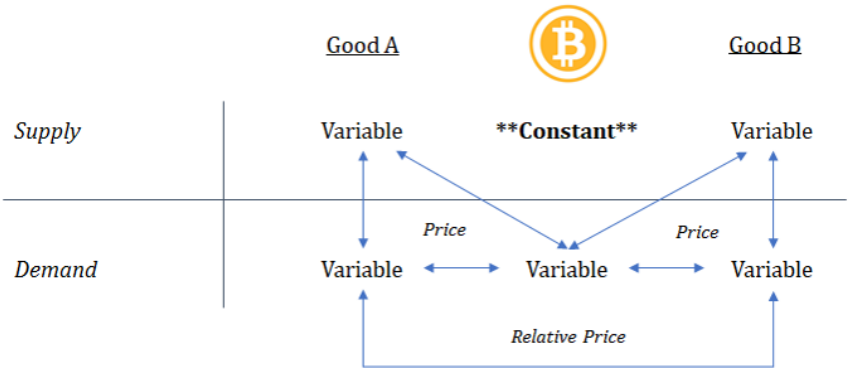
Hayek, The Use of Knowledge in Society

> We must look at the price system as such a mechanism for communicating information if we want to understand its real function—a function which, of course, it fulfils less perfectly as prices grow more rigid. (Even when quoted prices have become quite rigid, however, the forces which would operate through changes in price still operate to a considerable extent through changes in the other terms of the contract.) The most significant fact about this system is the economy of knowledge with which it operates, or how little the individual participants need to know in order to be able to take the right action. In abbreviated form, by a kind of symbol, only the most essential information is passed on and passed on only to those concerned. It is more than a metaphor to describe the price system as a kind of machinery for registering change, or a system of telecommunications which enables individual producers to watch merely the movement of a few pointers, as an engineer might watch the hands of a few dials, in order to adjust their activities to changes of which they may never know more than is reflected in the price movement.

In that regard, monetary goods are differentiated (at least those that emerge on the free market); it is why money is an effective communication tool. The market structure for money is different than that of all other goods. A consumption good is consumed and a production good is ultimately consumed in the production of other consumption goods. Whereas, the utility of money is in exchange; it is functional in the coordination of trade by and between consumption and production goods, rather than being consumed itself. Because the utility of money is in exchange, scarcity is more important than the nominal amount of money in an economy. As demand for money increases and as its price rises, there is not a commensurate supply response because of natural supply constraints. The same is not true for any individual good or service. The relative supply constraint of money is what allows it to communicate relative value between other goods and services. Consumption goods and production goods can be

substituted for each other, but money facilitates virtually all exchange between all other goods. The value of a money may fluctuate relative to goods and services but relative scarcity of a money supply allows price to be communicated in terms of the money itself.

Prior to bitcoin, no form of money was finitely scarce. Bitcoin has a fixed supply, capped at 21 million. Finite scarcity creates a constant where none existed previously. Imagine the supply of one good being perfectly constant while the supply of all other goods fluctuates. Demand for all goods changes, but only one constant exists: the supply of bitcoin. In this world, everything would be measured against the constant. The purchasing power of money would communicate far more perfect information through this pricing mechanism than if the supply of the money itself were changing. By creating one constant, everything else can be more reliably measured. And the desired information is not the absolute value of any one good. All value is subjective. Instead, the critical information communicated through a pricing mechanism is the relative value (or relative price) of many goods to each other. While price levels are ever changing due to constantly shifting supply and demand, the stability of the pricing mechanism itself allows for economic coordination via the communication of opportunity cost (i.e. how we know, or learn, that an iPhone costs approximately 20 times more than a barrel of oil).

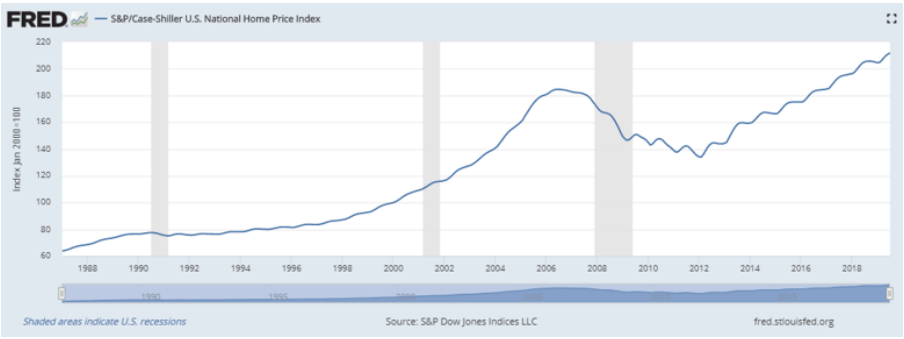


Distortion of the Price System

In our current system, the supply of money changes unpredictably and increases over time. This is core to the central banking monetary model, and it derives from monetarist economic theory which argues that an active management of the money supply stimulates aggregate demand and ultimately promotes full employment. What it technically does is manipulate interest rates downward by increasing the supply of money. Lower interest rates increase the willingness and incentive to borrow; however, all else being equal, a lower interest would otherwise decrease the willingness to lend. Essentially, by inflating the money supply, the central bank artificially manipulates the function of credit, creating a sustained imbalance between the incentive to borrow and the willingness to lend. The more pervasive consequence is the distortion of the pricing mechanism that coordinates economic activity. By manipulating the supply of money and the supply of credit, central banks distort all prices throughout the market. False signals (and bad information) are distributed to all market participants.

The entire supply and demand structure of the economy becomes distorted as hundreds of millions of people respond to manipulated price signals and when resources within the economy are re-allocated based on those signals. When the money supply is increased, new money (and credit) enters the system through various channels and at unpredictable times. The quantity and rate of change is unknown to most market participants. Instead, market participants react to price signals; that is how information is communicated. A price signal may be the cost of a good at the supermarket or it may be a salary an employer is willing to pay for a certain job. The change in the money supply creates a distortion of prices such that market participants cannot effectively understand whether changes in price are driven by changes in underlying supply and demand structures, or to what extent changes in price are merely a function of more or less money in the system. Regardless, everyone reacts to distorted signals.

For a more tangible example, the Fed purchased $1.7 trillion of mortgage-backed securities (~17% of all mortgages) following the financial crisis as part of its quantitative easing program, which ultimately increased the base money supply by $3.6 trillion. Most people recall that prior to the financial crisis there was a housing bubble. By directly purchasing mortgages and by inflating the money supply, the Fed manipulated interest rates lower. Housing relies heavily on the supply of credit and ultimately on the cost of interest. With lower interest rates and more money available to lend, housing prices were manipulated higher. As a result, distorted price signals were sent to both buyers and sellers. Developers of housing respond by building more homes (increasing supply) and buyers of homes believe they can take on more debt at lower rates to purchase homes. More resources in the economy are devoted to the function of housing because of higher price levels. However, any increase in demand can only be sustained so long as the cost of credit is continually manipulated downward as a function of an increasing money supply.



Despite wide recognition of the unsustainable housing bubble in 2007, the national home price index is now 15% higher than it was at the prior peak. This is the manipulation of price levels on full display, and it happens as an intended function of central bank monetary policy. The Fed increases the money supply, lowers interest rates, and inflates asset prices such that the amount of existing debt in the credit system can be sustained. Credit expansion is the Fed's objective in

stimulating growth, and net new credit cannot be created unless existing debt levels can be sustained, which is why the Fed must inflate asset prices to achieve its objectives. Asset prices support existing debt levels. When everyone figures out that the price signals are unsustainable and unreliable, it causes a shock to the system. This is what happened in 2007 and it is likely to happen again as the market signals have become even further distorted. But it is not some evil scheme; the Fed is not a purposively malicious actor. The Fed ultimately intends to promote "full employment" through its policies, but what it actually does is manipulate relative price signals which creates imbalances in the underlying supply and demand structures of the economy, creating sudden and more chronic unemployment.

Hayek spoke on this subject in his 1974 Nobel Prize winning speech, the Pretense of Knowledge. As a function of manipulated prices, more resources are devoted to a segment of the economy than could otherwise be sustained naturally; when the central bank changes the course of its monetary policy, prices begin to respond and the market corrects. Because price levels have been manipulated on a sustained basis, a demand shock becomes inevitable and everyone figures out imbalances exist. In the case of the housing example, supply (both of goods and labor) significantly exceeds sustainable demand at current price levels. More broadly, imbalances are everywhere. It becomes apparent that supply and demand are significantly out of balance and unemployment increases rapidly. The market cannot find an equilibrium because all markets have been manipulated on a sustained basis for extended periods of time.

Hayek, The Pretense of Knowledge

In fact, in the case discussed, the very measures which the dominant "macroeconomic" theory has recommended as a remedy for unemployment — namely, the increase of aggregate demand — have become a cause of a very extensive misallocation of resources which is likely to make later large-scale unemployment inevitable. The continuous injection of additional amounts of money at points of the economic system where it creates a temporary demand which must cease when the increase of the quantity of money stops or slows down, together with the expectation of a continuing rise of prices, draws labor and other resources into which can last only so long as the increase of the quantity of money continues at the same rate — or perhaps even only so long as it continues to accelerate at a given rate. What this policy has produced is not so much a level of employment that could not have been brought about in other ways, as a distribution of employment which cannot be indefinitely maintained and which after some time can be maintained only by a rate of inflation which would rapidly lead to a disorganization of all economic activity. The fact is that by a mistaken theoretical view we have been led into a precarious position in which we cannot prevent substantial unemployment from reappearing; not because, as this view is sometimes misrepresented, this unemployment is deliberately brought about as a means to combat inflation, but because it is now bound to occur as a deeply regrettable but inescapable consequence of the mistaken policies of the past as soon as inflation ceases to accelerate.

This is what occurred during, and in the aftermath of, the financial crisis. It was the boiling over point after the Fed had manipulated the supply of money and the supply of credit for decades. As portrayed in the Big Short, the financial crisis often gets blamed on the subprime crisis, but the not-often-discussed 800-pound gorilla in the room is central bank monetary policy. Following the crisis, the Fed responded by pursuing the same policy action it had pursued for decades but on a much greater scale; it massively increased the money supply, further manipulating price signals. When the money supply is manipulated, recognize that not all price levels respond ratably. Money enters the system through different channels and the expansion of credit impacts certain segment of the economy more than others. All prices are manipulated, but not equally. It is fundamentally the distortion of relative prices which disrupt the underlying supply and demand function of a market. Price communicates information. It is how market participants communicate what they value on a relative basis. And, it is how all market participants then respond to those preferences on the supply side: what skills people train themselves with, what businesses people choose to build, what employment opportunities people seek. The Fed may not intend to do harm by

manipulating the money supply, but ultimately, it is the unavoidable consequence of distorting the price mechanism within an economy.

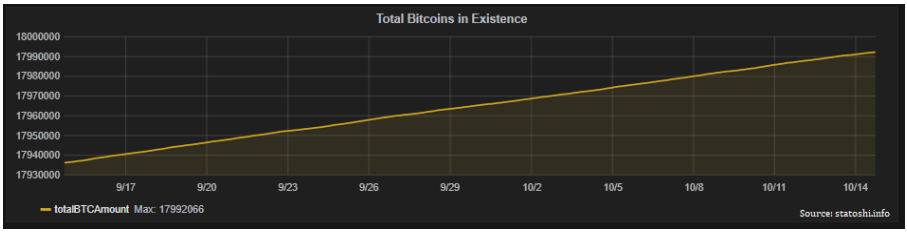
Predictability of the Money Supply

Bitcoin is the white knight. Or at least, it has the potential to be. By creating a fixed supply, bitcoin has the potential to be the greatest pricing mechanism the world has ever known. Once bitcoin reaches its maximum supply of 21 million, changes to the money supply will be removed entirely from the equation of price signals. It should be axiomatic that the creation of money does nothing to generate real economic activity. It doesn't matter whether the change in the money supply is predictably small or whether the money supply increases significantly and unpredictably. Printing money does nothing to generate economic activity; it only serves to distort supply and demand. The utility of money is in exchange. Whether present exchange or future exchange, that is all. Money is not consumed; it is used to coordinate the economic activity that allows for capital to be accumulated. Whether it be physical capital required to produce real goods or human capital which advances arts, science, mathematics etc. That capital is the true savings of a society and it is fundamental to the function of an economy.

Most people think of savings in monetary terms because money is a unit of account, but real savings is represented by the accumulated capital that enriches the lives of individuals, families, and communities. In a world with a fixed money supply, monetary savings would be constant. Money would transfer from individual to individual, family to family, or business to business. But, in total, the money supply would neither increase or decrease. Economic activity would be coordinated as a function of money and with an undistorted pricing mechanism. The aggregate preferences of all markets would be more accurately communicated without the distortion of a changing money supply. Imbalances in supply and demand would be naturally corrected and not sustained over long periods of time; as a consequence, imbalances would also be smaller and not systemic to the economy as a whole. It does not mean all prices would always be

perfect or that other variables, such as government spending or taxes, could not influence or distort economic activity. However, it would eliminate the primary mechanism that distorts price signals and market structures.

Bitcoin's fixed supply is the foundation of its more reliable pricing system but it is also issued at a predictable rate. In the future state, when bitcoin reaches its maximum supply, the rate of change thereafter will be zero. But on its way to that future state, bitcoin imbeds a stable and predictable supply schedule, which is a distinct and equally important part of the equation. Bitcoin are issued through a mining process that helps to secure the network and the network adjusts to ensure that bitcoin are issued on average every ten minutes. If more mining resources are added to the network, the network adjusts to prevent bitcoin from being issued at a faster rate. More mining results in greater levels of network security, rather than increasing the rate of issuance or increasing the total amount of bitcoin that will ultimately be issued. This allows the entire economic system to plan for the future. It allows miners building security infrastructure to forecast future compensation, but it also allows all market participants to predictably know the rate of change of the currency at any point in time.

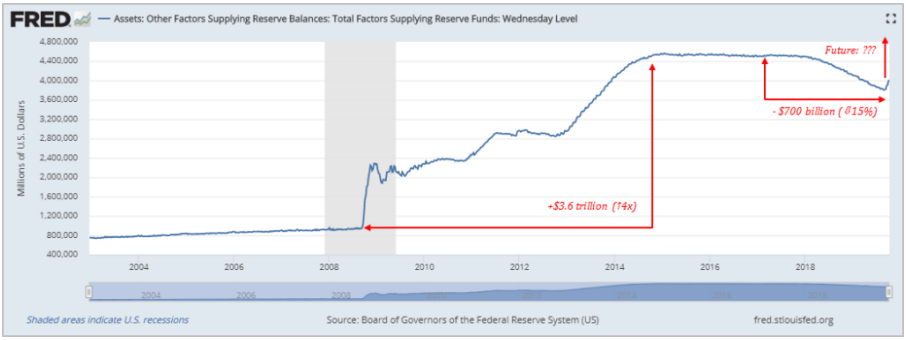


Rather than allowing bitcoin to be issued rapidly or at an unpredictable rate, the network ensures that bitcoin will be issued steadily over time and as a consequence, on a more distributed basis. Most importantly, it constantly reinforces the credibility of the overall issuance structure. Every ten minutes (on average), a certain number

of bitcoin are issued. Approximately every four years that number is cut in half until ultimately no incremental bitcoin will be issued. On the path to 21 million, the enforcement of the fixed supply every ten minutes builds credibility in the future state supply over time. All market participants come to understand that the fixed supply will be enforced not because of a magical point in time when the maximum is actually reached, but instead because the network enforces its monetary policy every 10 minutes. By creating a predictable supply schedule, the rate of change predictably decreases, and all market participants can observe for themselves that the system is functioning as intended.

Monetary Policy by Consensus vs. Central Bank

This process which constantly reinforces the credibility of bitcoin's monetary system is occurring in parallel to the dysfunction of legacy monetary systems. Central banks everywhere are increasing the money supply of their respective economies at unpredictable rates. As discussed previously, the Fed increased the money supply in the U.S. by $3.6 trillion following the financial crisis, from 2008 to 2014. Despite the Fed forecasting its plans, no one knew what the total would ultimately be. Everyone was guessing. The Fed didn't even know. And, after increasing the money supply by several multiples, the Fed then began removing $50 billion dollars from the economy each month, a process which began in October 2017. Again, no one knew exactly how much money would actually be removed from the system, in total or for how long. In aggregate, approximately $700 billion in base money was removed over the course of approximately two years. And now, as of October 2019, the Fed has once again shifted course and has begun to add more money back into the system. Just recently, the Fed signaled plans to add $60 billion dollars to the financial system each month (planned for the next six months). But once again, no one really knows for how long this will go on or whether the amounts will change. Realistically, the Fed does not know because it is impossible to know.

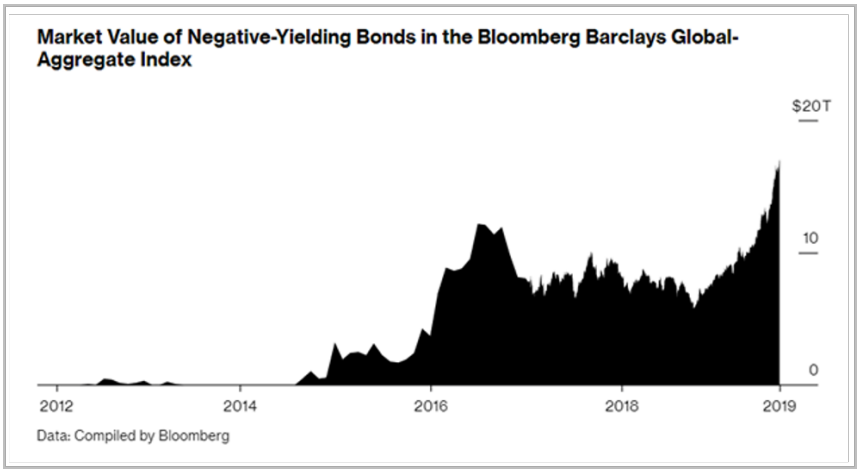


All we practically know is that from this point forward the money supply will increase (and by a lot). But recognize, most market participants have no idea any of this has occurred or is occurring. All market participants really know is what is communicated to them via prices and employment opportunities. Those that have an understanding of the Fed's actions may be in a better position to forecast or predict the directional consequences, but economic systems are complex. We all react to the pricing mechanisms around us and no one has anywhere close to perfect knowledge; this is the pretense of knowledge. The aggregate knowledge of millions of people is communicated through price which is ultimately a function of ever-changing preferences of the individuals that make up an economy.

Individuals are inherently limited in the knowledge they possess. And this is certainly true of central banks. In the central banking monetary model, twelve individuals (or thereabout) determine how and when to create billions, if not trillions, of dollars despite possessing inherently limited knowledge. No matter how well-intentioned or how much knowledge possessed, the net consequence is the distortion of the fundamental mechanism (i.e. the pricing mechanism) which aggregates knowledge possessed by the market as a whole. For everyone relying upon the dollar as a unit of account and as a mechanism to communicate economic trade-offs, the very foundation changes unpredictably, unbeknownst to most of its participants.

Distorted price signals are communicated gradually through millions of markets impacting the decisions made by hundreds of millions and the centralized mechanism that dictates monetary policy is a root cause of the distortion.

And even if a reasonable person believed active money supply management to be a net benefit, bitcoin is now operating alongside the legacy economic system: a decentralized system vs. a centralized system. Monetary policy by consensus vs. monetary policy by central bank. While the money supply of the legacy system is unpredictably changing, the bitcoin network is operating flawlessly with a known supply and with a predictable rate of change. Rather than it being a philosophical or economic debate, there are now two competing systems, and the market will have the last say. While bitcoin may be complicated and the very subject of money may not be well understood, the flaws in the existing system are independent of bitcoin. The $17 trillion of negative yielding debt should be evidence enough and it only exists as a direct consequence of central bank monetary policy. Ultimately, the currencies that support the legacy system will be the release valve because central banks will be forced to increase the money supply in order to sustain what is an otherwise unsustainable credit system.



With the legacy system coordinated by central banks, all one can rely on is that the money supply will change and at unpredictable rates. With bitcoin, everyone can verify the supply and the predictable rate of change. By running a bitcoin full node, anyone can verify the number of valid bitcoin that exist in circulation and the amount of new bitcoin issued in each block. Anyone and everyone can verify this information without trusting anyone else. This is how bitcoin works. Each node not only verifies information; it also validates information independently. Bitcoin's monetary policy is enforced on a decentralized basis by all nodes within the network. With precision, everyone can calculate when future blocks will be solved and when the rate of issuance will change. The fact that everyone can verify and validate the money supply, regardless of the nominal amount, reinforces the credibility of the monetary system. This reinforcement occurs every 10 minutes, 6 times an hour, 144 times a day, 4,320 times a month, 52,560 times a year, with each passing bitcoin block. The monetary system hardens as market participants validate that the monetary policy is enforced, over and over again, every ten minutes.

Supply & rate of issuance verified on four year-old Apple laptop (supply: 17,988,755; block subsidy = 12.5 bitcoin or 1,250,000,000 satoshis)

A fixed supply is of little meaning without the credibility of its enforcement. Anyone can copy bitcoin's architecture and code base. But what cannot be replicated is the credibility of its monetary properties. The consensus mechanism which governs bitcoin is the foundation of its credibility and what ultimately sets bitcoin apart from its competition. Even if an individual remained unconvinced that a currency with a fixed supply would communicate better information through its pricing mechanism, it does not matter what any individual believes. Bitcoin entrusts its monetary policy to a consensus mechanism. While the maximum supply of bitcoin is practically capped at 21 million, the supply is ultimately governed by a consensus of those that hold bitcoin as a currency.

If the market, which unquestionably possesses more information than any individual, collectively determined that it would be better to change the supply schedule rather than implementing a fixed cap, it is theoretically possible. However, the market would have to come to an overwhelming consensus to effect that change, and practically speaking, a decentralized network of rational economic actors would not form an overwhelming consensus to debase its own currency. Bitcoin's monetary policy is flexible enough to change but it is impossible to do so without an overwhelming consensus. Bitcoin ultimately represents the contrast between monetary policy by consensus and monetary policy by central bank. The information possessed by a market consensus mechanism will always exceed that of a small number of individuals, which is why bitcoin out-competes the legacy system at every step.

Bitcoin is Not a Pyramid Scheme

So no, bitcoin is not a pyramid scheme. It is not organized by a sketchy company, pushing high pressure sales tactics. It is not peddling some inferior consumer good, with abundant supply, where compensation is directly tied to recruiting new members to the scheme. Bitcoin is money and its supply is finitely scarce. It does not matter how many people adopt bitcoin; as adoption increases, the same pie is distributed across more and more people, and on average,

more people control a smaller and smaller share of the network. Its value increases as a function adoption, and adoption is increasing because its monetary properties are superior to the competition. Bitcoin has a fixed supply, its supply schedule is predictable, and its monetary policy is governed and enforced by consensus. Bitcoin's pricing mechanism is unmanipulable and cannot be distorted because of its fixed supply. Everything changes around bitcoin but bitcoin's fixed supply is the constant. Because bitcoin's supply is fixed and cannot be manipulated, it will eventually become the most reliable pricing mechanism in the world, and consequently, the greatest distribution system of knowledge.

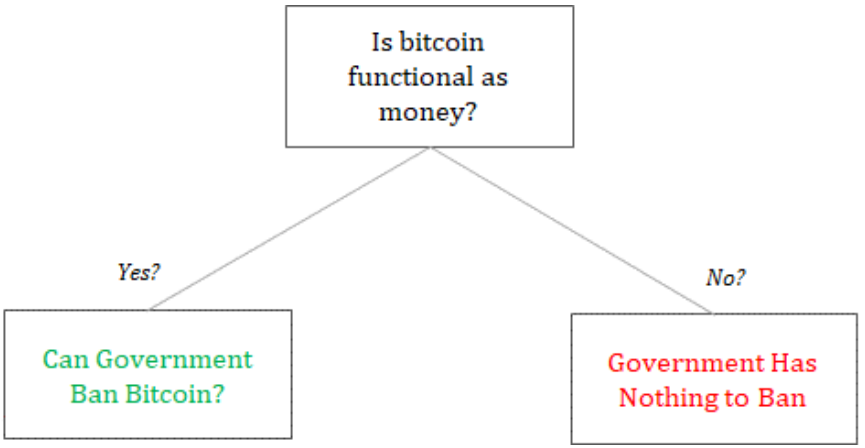
That is the promise which bitcoin provides, and it will only proliferate if it creates utility for those that adopt it. Today and into future, that utility will continue to be the ability to reliably store wealth in a monetary medium that cannot be debased. When people make the claim that bitcoin could be "bigger-than-the-internet," it is generally not a linear application, but instead rooted in the idea that a sovereign, unmanipulable form of money has the potential to be one of the greatest instruments of freedom ever invented. The success of bitcoin is not a given, but if successful in delivering on its promise, it will facilitate more effective and more peaceable coordination by and amongst people throughout the world. At the end of the day, bitcoin is a communication tool. That is the function of money. Bitcoin simply provides an alternative system, operating on a decentralized basis which no one controls. It is the lack of control and the lack of conscious direction which will allow bitcoin to accumulate and communicate knowledge more effectively than any pre-existing monetary medium. Current volatility is nothing more than the logical path of price discovery, as adoption increases exponentially over time and as we advance toward that future state of full adoption.

> "Many of the greatest things man has achieved are the result not of consciously directed thought, and still less the product of a deliberately coordinated effort of many individuals, but of a process in which the

individual plays a part which he can never fully understand. They are greater than any individual because they result from the combination of knowledge more extensive than a single mind can master."
– Hayek, The Counter-Revolution of Science

BITCOIN CANNOT BE BANNED - NOVEMBER 8, 2019

The idea that somehow bitcoin can be banned by governments is the final stage of grief, right before acceptance. The consequence of the statement is an admission that bitcoin "works." In fact, it posits that bitcoin works so well that it will threaten the incumbent government-run monopolies on money in which case governments will regulate it out of existence to eliminate the threat. Think about the claim that governments will ban bitcoin as conditional logic. Is bitcoin functional as money? If not, governments have nothing to ban. If yes, then governments will attempt to ban bitcoin. So the anchor point for this line of criticism assumes that bitcoin is functional as money. And then, the question becomes whether or not government intervention could successfully cause an otherwise functioning bitcoin to fail.



As a starting point, anyone trying to understand how, why, or if bitcoin works should assess the question entirely independent from the implications of government regulation or intervention. While bitcoin will undoubtedly have to co-exist alongside various regulatory regimes, imagine governments did not exist. On a standalone basis, would bitcoin be functional as money, if left to the free market? This will inevitably lead to a number of rabbit hole questions. What is

money? What are the properties that make a particular medium a better or worse form of money? Does bitcoin share those properties? Is bitcoin a better form of money based on its properties? If the ultimate conclusion becomes that bitcoin is not functional as money, the implications of government intervention are irrelevant. However, if bitcoin is functional as money, the question then becomes relevant to the debate, and anyone considering the question would need that prior context as a baseline to evaluate whether or not it would be possible.

By design, bitcoin exists beyond governments. But bitcoin is not just beyond the control of governments, it functions without the coordination of any central third parties. It is global and decentralized. Anyone can access bitcoin on a permissionless basis and the more widespread it becomes, the more difficult it becomes to censor the network. The architecture of bitcoin is practically purpose-built to resist and immunize any attempts by governments to ban it. This is not to say that governments all over the world will not attempt to regulate, tax or even ban its use. There will certainly be a fight to resist bitcoin adoption. The Fed and the Treasury (and their global counterparts) are not just going to lay down as bitcoin increasingly threatens the monopolies of government money. However, before debunking the idea that governments could outright ban bitcoin, first understand the very consequence of the statement and the messenger.

The Progression of Denial & Stages of Grief

The skeptic's narrative consistently shifts over time. Stage one of grief: bitcoin could never work – it is backed by nothing. It is nothing more than a present-day tulip mania. With each hype cycle, the value of bitcoin rises dramatically and is then followed by a correction. Often extolled as a crash by skeptics, bitcoin fails to die and in each instance, it finds support at levels higher than prior adoption waves. The tulip narrative becomes tired and the skeptics move on to more nuanced issues, re-anchoring the debate. Stage two of grief follows: bitcoin is flawed as a currency. It is too volatile to be money, or it is too slow to be a payments system, or it cannot scale to satisfy all the

payments in the world, or it wastes energy. The list goes on. This second step is a progression of denial and it is a significant departure from the idea that bitcoin is nothing more than nothingness.

Despite the supposed flaws, the value of the bitcoin network continues to rise over time. Each time it does not die, it gains strength. While the skeptics are busy pointing out flaws, bitcoin never sleeps. An increase in value is driven by a very simple market dynamic: more buyers than sellers. That is all and it is a function of increasing adoption. More and more people figure out why there is fundamental demand for bitcoin and why/how it works. This is what creates long-term demand for bitcoin. As more people increasingly demand it as a store of wealth, there is no supply response. There will only ever be 21 million bitcoin. No matter how many people demand bitcoin, the supply side is completely fixed and inelastic. As the skeptics continue to shout the same tired lines, the crowd continues to parse the noise and demand bitcoin due to the strengths of its monetary properties. And no constituency is more well-versed in the arguments against bitcoin than adopters of bitcoin themselves.

Bitcoin FUD (Fear, Uncertainty & Doubt) Dice v1 and v2, courtesy of Nic Carter.

Desperation begins to kick in, and the debate re-anchors once again. The narrative predictably shifts. It is no longer that bitcoin is not backed by anything, nor that it is flawed as a currency; instead, the debate centers on regulation and government authorities. In the final stage of grief, it is actually that bitcoin works too well, and as a

consequence, the government will never let it happen and ban it. Really? So human ingenuity somehow re-invents money in a technologically superior medium, the consequences of which are mind-bending, and the government is somehow going to ban that? Recognize that in claiming as much, the skeptics are admitting defeat. It is the dying whimper in a series of failed arguments. The skeptics simultaneously accept that there is fundamental demand for bitcoin and then pivot to the unfounded belief that governments can ban it.

Play this one out. When exactly would developed world governments actually step in and attempt to ban bitcoin? Today, the Fed and the Treasury do not view bitcoin as a serious threat to dollar supremacy. In their collective mind, bitcoin is a cute little toy and is not functional as a currency. Presently, the bitcoin network represents a total purchasing power of less than $200 billion. Gold on the other hand has a purchasing power of approximately $8 trillion (40x the size of bitcoin) and broad money supply of dollars (M2) is approximately $15 trillion (75x the size of bitcoin). When does the Fed or Treasury start seriously considering bitcoin a credible threat? Is it when bitcoin collectively represents $1 trillion of purchasing power? $2 trillion or $3 trillion? Pick your level, but the implication is that bitcoin will be far more valuable, and held by far more people globally, before government powers that be view it as a credible competitor or threat.

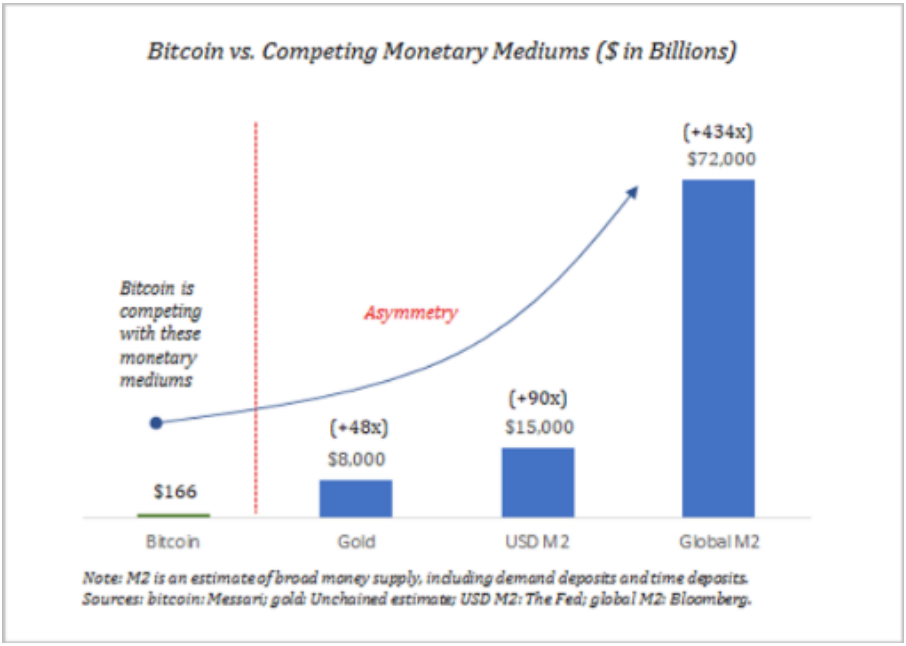
President Trump & Treasury Secretary Mnuchin on Bitcoin (2019)

"I won't be talking about Bitcoin in 10 years, I can assure you that [...] I would bet even in 5 or 6 years I'm no longer talking about Bitcoin as Treasury Secretary. I'll have other priorities [...] I can assure you I will personally not be loaded up on Bitcoin." – Treasury Secretary Steve Mnuchin

"I am not a fan of Bitcoin [...], which [is] not money, and whose value is highly volatile and based on thin air." – President Donald J. Trump.

So the skeptic logic follows: bitcoin does not work, but if it does work, the government will ban it. But, governments in the free world will not attempt to ban bitcoin until it becomes more apparent that it

is a threat. At which time, bitcoin will be more valuable and undoubtedly harder to ban, as it will be held by far more people in far more places. So, ignore fundamentals and the asymmetry inherent in a global monetization event because in the event you turn out to be right, the government will step in to regulate bitcoin out of existence. Which side of the fence would a rational economic actor rather be on? Owning a monetary asset that has increased in value so dramatically that it threatens the global reserve currency, or the opposite – not owning that asset? Assuming an individual possesses the knowledge to understand why it is a fundamental possibility (and increasingly a probability), which is the more defensible and logical position? The asymmetry alone dictates the former and any fundamental understanding of the demand for bitcoin only reinforces the same position.



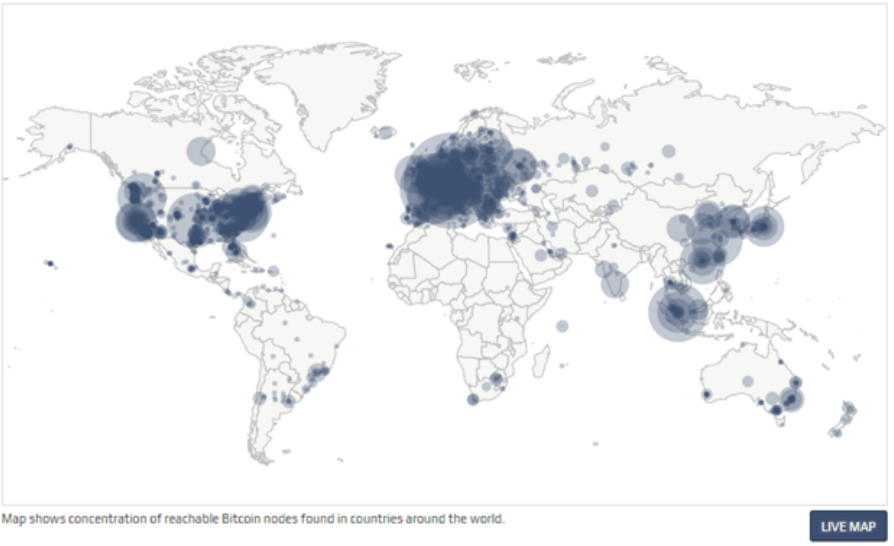
But Bitcoin Cannot Be Banned. Think about what bitcoin actually represents and then what a ban of bitcoin would represent. Bitcoin represents the conversion of subjective value, created and exchanged in the real world, for digital keys. Said more plainly, it is the conversion of an individual's time into money. When someone demands bitcoin, they are at the same time forgoing demand for some other good, whether it be a dollar, a house, a car, or food, etc. Bitcoin represents monetary savings that comes with the opportunity cost of other goods and services. Banning bitcoin would be an affront to the most basic freedoms it is designed to both provide and preserve. Imagine the response by all those that have adopted bitcoin: "Well that was fun, the tool that the experts said would never work, now works too well, and the same experts and authorities say we can't use it. Everyone go home. Show's over folks." To believe that all the people in the world that have adopted bitcoin for the financial freedom and sovereignty it provides would suddenly lay down and accept the ultimate infringement of that freedom is not rational.

> "Money is one of the greatest instruments of freedom ever invented by man. It is money which in existing

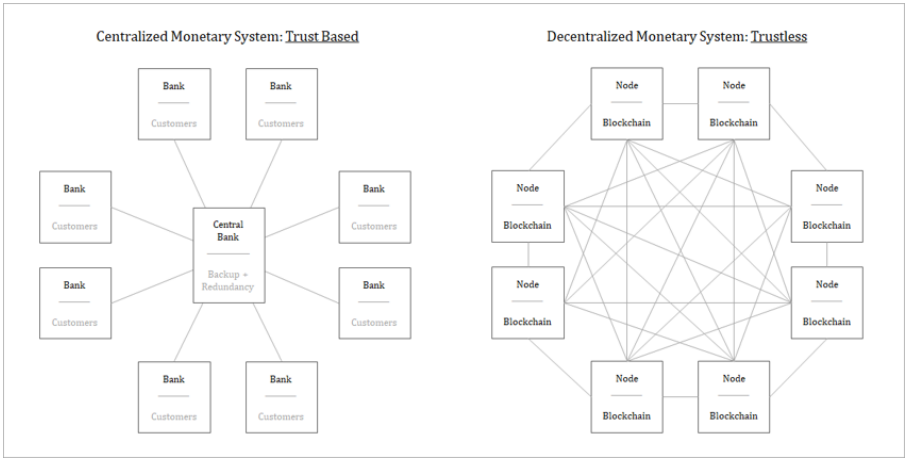
> society opens an astounding range of choice to the poor man – a range greater than that which not many generations ago was open to the wealthy.." – F.A. Hayek

Governments could not successfully ban the consumption of alcohol, the use of drugs, the purchase of firearms, or the ownership of gold. A government can marginally restrict access, or even make possession illegal, but it cannot make something of value demanded by a broad and disparate group of people magically go away. When the U.S. made the private ownership of gold illegal in 1933, gold did not lose its value or disappear as a monetary medium. It actually increased in value relative to the dollar, and just thirty years later, the ban was lifted. Not only does bitcoin provide a greater value proposition relative to any other good that any government has ever attempted to ban (including gold); but by its nature, it is also far harder to ban. Bitcoin is global and decentralized. It is without borders and it is secured by nodes and cryptographic keys. The act of banning bitcoin would require preventing open source software code from being run and preventing digital signatures (created by cryptographic keys) from being broadcast on the internet. And it would have to be coordinated across numerous jurisdictions, except there is no way to know where the keys actually reside or to prevent more nodes from popping up in different jurisdictions. Setting aside the constitutional issues, it would be technically infeasible to enforce a ban of bitcoin in any meaningful way.

Bitcoin Node Concentration by Country (earn.com)



Even if all countries in the G-20 coordinated to ban bitcoin in unison, it would not kill bitcoin. Instead, it would be the fait accompli for the fiat system. It would reinforce to the masses that bitcoin is a formidable currency, and it would set off a global and hopeless game of whack-a-mole. There is no central point of failure in bitcoin; bitcoin miners, nodes and keys are distributed throughout the world. Every aspect of bitcoin is decentralized, which is why running nodes and controlling keys is core to bitcoin. The more keys and the more nodes that exist, the more decentralized bitcoin becomes, and the more immune bitcoin is to attack. The more jurisdictions in which mining exists, the less risk any single jurisdiction represents to bitcoin's security function. A coordinated state level attack would only serve to build the strength of bitcoin's immune system. It would ultimately accelerate the shift away from the legacy financial system (and legacy currencies), and it would accelerate innovation within the bitcoin economic system. With each passing threat, bitcoin innovates to immunize the threat. A coordinated state level attack would be no different.



Permissionless innovation on a globally decentralized basis is the reason bitcoin gains strength from every attack. It is the attack vector itself which causes bitcoin to innovate. It is Adam Smith's invisible hand on steroids. Individual actors may believe themselves to be motivated by a greater cause, but in reality, the utility embedded in bitcoin creates a sufficiently powerful incentive structure to ensure its survival. The self-interests of millions, if not billions, of uncoordinated individuals aligned by their individual and collective need for money incentivizes permissionless innovation on top of bitcoin. Today, it may seem like a cool new technology or a nice-to-have portfolio investment, but even if most people do not yet recognize it, bitcoin is a necessity. It is a necessity because money is a necessity, and legacy currencies are fundamentally broken. Two months ago, the repo markets in the U.S. broke, and the Fed quickly responded by increasing the supply of dollars by $250 billion, with more to come. It is precisely why bitcoin is a necessity, not a luxury. When an innovation happens to be a basic necessity to the functioning of an economy, there is no government force that could ever hope to stop its proliferation. Money is a very basic necessity, and bitcoin represents a step-function change innovation in the global competition for money.

And more practically, any attempt to ban bitcoin or heavily regulate its use by any jurisdiction would directly benefit a competing jurisdiction. The incentive to defect from any coordinated effort to ban bitcoin would be far too high to sustain such an agreement across jurisdictions. If the United States made the possession of bitcoin illegal tomorrow, would it slow down proliferation, development and adoption of bitcoin and would it cause the value of the network to decline intermittently? Probably. Would it kill bitcoin? No. Bitcoin represents the most mobile capital in the world. Countries and jurisdictions that create regulatory certainty and place the least amount of restrictions on the use of bitcoin will benefit significantly from capital inflows.

Banning Bitcoin Prisoner's Dilemma

	Country B Bans Bitcoin (cooperates)	Country B Accepts Bitcoin (defects)
Country A Bans Bitcoin (cooperates)	Bitcoin wins Ban fails, bitcoin adoption accelerates Fiat currencies deteriorate more rapidly	Bitcoin wins Capital outflows from Country A Capital inflows to Country B
Country A Accepts Bitcoin (defects)	Bitcoin wins Capital outflows from Country B Capital inflows to Country A	Bitcoin wins Everyone wins Benefits from trade & specialization

In practice, the prisoner's dilemma is not one-to-one. It is multi-dimensional involving numerous jurisdictions, all with competing interests, making any attempts to successfully ban bitcoin that much more impractical. Human capital, physical capital and monetary capital will flow to the countries and jurisdictions with the least restrictive regulations on bitcoin. It may not happen overnight, but attempting to ban bitcoin is the equivalent of a country cutting off its nose to spite its face. It doesn't mean that countries will not try. India has already tried to ban bitcoin. China has attempted to heavily

restrict its use. Others will follow. But each time a country takes an action to restrict the use of bitcoin, it actually has the unintended effect of promoting bitcoin adoption. Attempts to ban bitcoin are an extremely effective marketing tool for bitcoin. Bitcoin exists as a non-sovereign, censorship-resistant form of money. It is designed to exist beyond the state. Attempts to ban bitcoin merely serve to reinforce bitcoin's reason for existence and ultimately, its value proposition.

The only winning move is to play

Banning bitcoin is a fool's errand. Some will try; all will fail. And the very attempts to ban bitcoin will accelerate its adoption and proliferation. It will be the hundred mile-per-hour wind that fuels the wildfire. It will also make bitcoin stronger and more reliable, further immunizing it from attack and reinforcing its antifragile nature. And in any case, believing governments will ban bitcoin, if it becomes a credible threat to global reserve currencies, is an irrational reason to discount it as a savings technology. It both cedes that bitcoin is viable as money, while at the same time ignoring the principal reasons as to why: decentralization and censorship-resistance. Imagine understanding the greatest present secret in the world and not capitalizing on the asymmetry and utility that bitcoin provides in fear of government. More likely, either someone understands why bitcoin works and that it will not fail at the hands of a government, or a knowledge gap exists as to how bitcoin is able to function in the first place. Begin by understanding the fundamentals, and then apply that as a baseline to assess any potential risk posed by future government intervention or regulation. And never discount the value of asymmetry; the only winning move is to play.

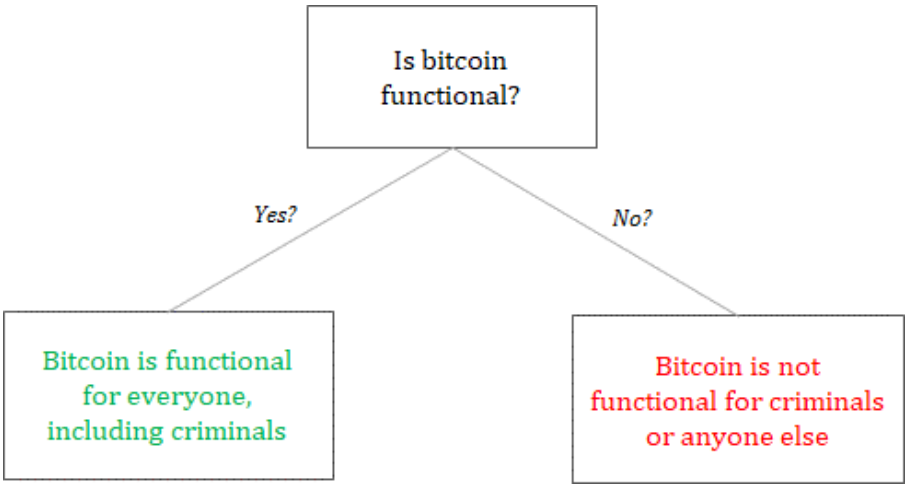
BITCOIN IS NOT FOR CRIMINALS - NOVEMBER 29, 2019

If you have ever heard (or happen to believe) that bitcoin is primarily a tool used by criminals, stop and take a quick sample of your friends and family that you suspect may own bitcoin, and then ask yourself how many are known criminals. There have in fact been widely publicized cases in which criminals have used bitcoin, and because skeptics cannot otherwise explain why anyone else would use it, use for illicit purposes becomes the default assumption. It is generally founded on a view that bitcoin is inferior to the dollar, either because of the belief that it is too volatile or too slow, or because it is not widely accepted for day-to-day transactions; with a flawed mental framework, the logical explanation then becomes that, from a practical perspective, someone would only use bitcoin for the purpose of facilitating some illicit activity, generally as a means to evade law enforcement. Your favorite Senator or Treasury Secretary may occasionally make the claim, but thankfully, bitcoin is not for criminals; it is however for everyone.

> "The clear ends of Bitcoin for either transacting in illegal goods and services or speculative gambling make me weary of its use." – Letter to regulators from Senator Joe Manchin (February 2014)

If bitcoin were principally used for illicit purposes, it may more logically follow that bitcoin is primarily used by criminals. Because it is not, the typical follow-on arguments that bitcoin should be banned in order to prevent such activity similarly do not hold water. The very foundation of the idea is based on the false premise that bitcoin is inferior to the dollar; when in fact, it is superior to any form of money that has previously existed, principally as a function of its fixed supply (see Bitcoin is Not Backed by Nothing or Bitcoin is Not a Pyramid Scheme). Bitcoin's fixed supply forms the basis of the fundamental demand for bitcoin, whether it be related to criminal activity or otherwise. And regardless of how many point-of-sale

transactions bitcoin may facilitate daily, it is used every day as a censorship-resistant and inflation-resistant form of savings. Without doubt, bitcoin is definitely used by the likes of drug dealers and nefarious characters on the dark web. However, it would be irrational to believe that is its primary use or to believe bitcoin should be banned because of it. It is logically inconsistent to form a view that bitcoin is sufficiently functional to be viable as a currency for criminals, while at the same time deny the implication that such a view would merely establish that bitcoin is functional for everyone.



But before turning the drugs narrative completely upside down, let's all first admit that criminals rely upon any number of commonly-trafficked access points and not just bitcoin. Roads, the internet, the postal service, airports, the banking system, etc.? Yep, all used by criminals and often used to facilitate crimes. But then again, criminals also use all of the above not to commit crimes as well. And that is where the logic that bitcoin must be banned because it enables criminal activity completely breaks down. Crimes are crimes. There is nothing inherent about the tools used to facilitate crimes that makes them criminal in themselves. Using the mail to send a letter to mom is not a crime. But using the mail to send drugs is mail fraud. Similarly,

using the dollar to purchase flowers for mom, perfectly fine. But buying narcotics with dollars (or bitcoin), that's crime. Despite criminal use, no one is calling for the ban of roads, the internet, mail, etc. And you definitely do not see any prominent defenders of the public interest calling for a ban of the dollar, which just happens to be the preferred funding currency of criminals everywhere. Sure, fear of criminal activity has been used to infringe on the rights of law-abiding citizens seemingly everywhere, but believing bitcoin should be banned because drug dealers use it would be no different than calling for a ban on the dollar for the same reason.

Missing the point

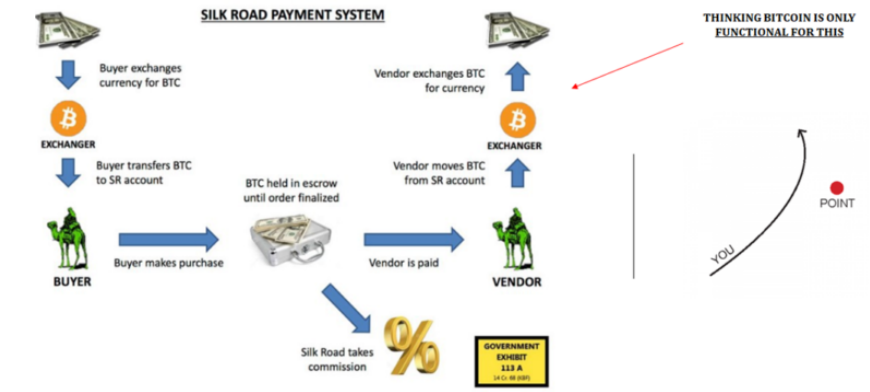
Such a view becomes that much more untenable once it is understood that bitcoin is not actually for criminals, but in order to understand that, it must also be understood that bitcoin is for criminals. It's a paradox. The very idea is turned on its head when viewed through the proper lens. The fact that criminals can use (and have used) bitcoin to facilitate commerce merely demonstrates that bitcoin can be used to facilitate any form of commerce. That a very early, and well publicized, use case for bitcoin involved the Silk Road website, which facilitated transactions involving drugs and other illicit goods using bitcoin as a means of payment, changes nothing about the broader implication: that bitcoin worked. But rather than focus here, bitcoin research often attempts to prove the counterfactual, that only a small percentage of bitcoin transactions are used for illicit purposes. For example, a headline from last year:

> "A new study finds less than 1% of bitcoin transactions to exchanges are illicit." (Coincenter, January 2018)

The substance may be true, but these counter-narratives fight the battle along the wrong lines. If the Silk Road demonstrated anything, it was simply that individuals would accept bitcoin as a form of payment in return for goods and services. It does not matter that the goods sold on the Silk Road website were generally illicit. The Silk Road, which is estimated to have facilitated in excess of a million

transactions, was one of the earliest demonstrations of a mass real-world use case for bitcoin. So yes, bitcoin is (and was) used for drug deals but it is merely one use case that has helped prove bitcoin's general utility, nothing more. And when it comes to buying drugs, the dollar remains far preferred to bitcoin among drug dealers despite them all generally being aware of bitcoin and capable of accepting it. Whether it be in response to the Silk Road or otherwise, anyone that comes away with the narrow conclusion that "bitcoin works for drugs" is failing to see the forest through the trees. The more consequential and assumption-shattering implication is simply that bitcoin works. Period.

If bitcoin could work for drug dealers to facilitate commerce, could it not "work" to facilitate any other form of commerce? It does not require much imagination to carry forward the logic. If Person A would accept bitcoin for Good B, is it possible that any person might be willing to accept bitcoin for any good regardless of who or what? In the case of the Silk Road, drug dealers may not have fully understood why bitcoin "worked," but it worked sufficiently well that they were willing to trade drugs for it. What they seemingly understood was that there was sufficient market demand for bitcoin to make it viable as a medium of exchange. And because it provided an electronic mechanism to facilitate transactions, it opened up a market and market mechanism that may have otherwise been unavailable. Love it or hate it, it was just a market taking advantage of new technology.



Despite the existence of bitcoin, drug dealers have not magically stop accepting dollars as their preferred funding currency. Nor have they stop laundering dollars back into the banking system. Drug dealers on the Silk Road did not use bitcoin merely to evade law enforcement nor did the dollar drug trade suddenly disappear; they used bitcoin because it was functional and because it satisfied a market need. If bitcoin were not functional and if it were not expected to hold a certain threshold of value over a particular time horizon, it would not have been used as a medium of exchange on the Silk Road. Drug dealers are not in the money losing business after all. But more importantly, anytime anyone decries that bitcoin is used by criminals for illicit purposes, whether it be a U.S. Senator or Treasury Secretary, the default question to ask should be: why does bitcoin work as a medium to facilitate commerce in the first place?

The litmus test

Focusing on criminals distracts from the more fundamental question and consequence. If bitcoin could work for a criminal, it could work for anyone, and in order for bitcoin to be viable as a currency, it has to work for everyone, including criminals. However, this is not a promotion of criminal activity using bitcoin as a funding mechanism; it is merely a recognition of the properties that allow bitcoin to function in the first place. Think of criminal activity as a litmus test. If bitcoin does not work for drug dealers, it doesn't work for anyone. But if it works for drug dealers, it can work for everyone. If it were possible to censor (or prevent) bitcoin transactions related to certain activity or certain individuals, it would be possible to censor any activity and any individuals. And if there were a prime target of activities or individuals to censor, it would be that of a criminal enterprise. The attempts have already begun.

> "The U.S. Treasury Department's Office of Foreign Assets Control (OFAC) has sanctioned three Chinese nationals and their cryptocurrency addresses, alleging they violated money laundering and drug smuggling

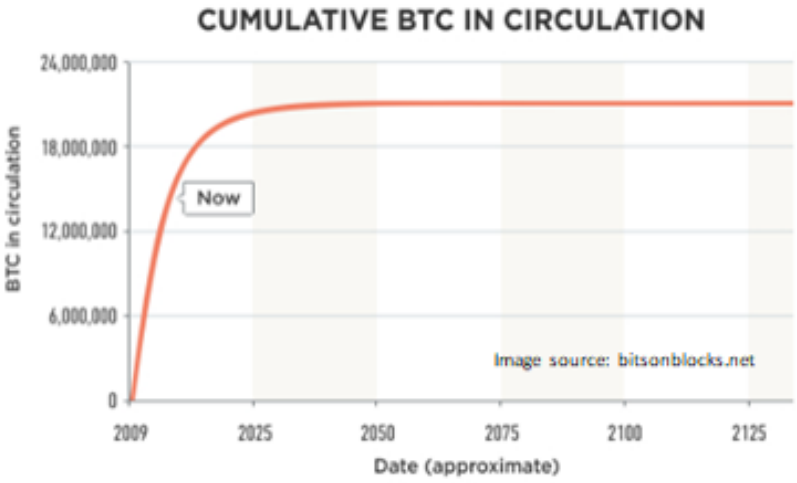
> laws […] The agency also listed a number of bitcoin addresses […] that the agency claims belong to the Chinese citizens." (Coindesk, August 2019)

Recognize that in this context, bitcoin "working" is specifically a reference to the network protocol layer. Whether a company or individual is willing to accept bitcoin from an address sanctioned by OFAC, or whether a third-party financial institution freezes an account associated with such an address is of little consequence to the long-term viability of bitcoin. What is consequential is whether the network would validate a transaction originated from a sanctioned address or validate a block that includes such a transaction. Stated another way, whether bitcoin miners or nodes would reject such a transaction despite it otherwise being valid based on the network's consensus rules. Bitcoin is only viable as a currency because it is decentralized. But decentralization is not an end in itself. The end game is censorship-resistance. And it is not an end game to protect criminals. It is an end game to protect the very root level functioning of the currency system.

Censorship resistance is all or nothing

Censorship-resistance is the network's most critical property because it ensures that the rules of the network will neither change arbitrarily or be enforced inconsistently, without which the system would be inoperable. Most important of these rules is the finite scarcity of the currency itself. Censorship-resistance reinforces scarcity and scarcity reinforces censorship-resistance. Bitcoin becomes more resistant to censorship as it scales because the network becomes more decentralized over time. As adoption increases, each individual (on average) controls an ever-diminishing share of the network's fixed supply, and it is the scarcity of the currency which primarily drives adoption. As the network becomes further decentralized, it becomes increasingly difficult for any individual or business to censor the network. However, at any point in time, whether bitcoin is sufficiently censorship-resistant is ultimately unknown and practically unknowable. Instead, censorship-resistance can only be measured

through the test of time and through each failed attempt to censor the network.



From a practical perspective, the risk of censorship principally comes in two forms: forcing changes to the network's consensus rules, or invalidating (or preventing) otherwise valid transactions. By design, anyone can access the bitcoin network on a permissionless basis by running a bitcoin full node. Each node can broadcast transactions to the rest of the network, and every node validates a full history of the blockchain with each passing block based on a common set of rules. Through this operation, nodes distributed throughout the world are able to come to a common consensus regarding the valid state of bitcoin ownership across the network, on a decentralized basis and without anyone trusting any other participant. The consensus rules of bitcoin are the common language that coordinate all peers within the network, but no single party dictates the rules; everyone opts in voluntarily. If it were possible for any single party or central authority(s) to force a change on to the network or to influence activity within the network in such a way that would invalidate an otherwise valid transaction, it would demonstrate that the network was not sufficiently decentralized to prevent censorship.

But what about the criminals and what does this have to do with that? If it were possible to censor criminal-related activity within the network, either by inhibiting access to the network or by preventing otherwise valid transactions from being confirmed, it would demonstrate that the network is not sufficiently decentralized to ensure censorship-resistance. The bitcoin network has no understanding of criminality or who defines it. It is amoral and apolitical. All bitcoin understands (when validating transactions) is its consensus rules; it is a closed loop system. A bitcoin transaction is valid if it is consistent with the network's consensus rules; if it were not, all bets would be off. If criminal activity could be censored, it simply would prove that any activity could be censored. But that is not where it ends. If any activity within the network could be censored, the network as a whole would be censorable. By demonstrating that a single transaction could be prevented or censored, it would establish that the network's consensus rules would also be at risk.

> Bitcoin can't be a little bit censorship-resistant, just like you can't be a little bit pregnant.

Censorship resistance is an all or nothing proposition. It either is or it is not. And if it is not, then everything is at risk, including bitcoin's fixed 21 million supply. That number and the reliability of its scarcity underpins every other economic incentive that allows the bitcoin network to function and accumulate value, including the mechanism by which the network comes to consensus. Accepting that the bitcoin network will always to some extent be used for illicit purposes is not some libertarian bent. Instead, it is a recognition that in order for bitcoin to be functional and viable as a currency system, it has to be so for everyone. If anyone could prevent anyone else from utilizing the network, whether an individual, an organization or a nation-state, bitcoin would be at risk of failure. Censorship within bitcoin at the protocol layer is not the equivalent of PayPal de-platforming an individual or company; nor is it the equivalent of Bank of America shutting down a checking account or Visa not authorizing a transaction. Bitcoin is a currency issuer and settlement layer. Any effective form of censorship would undermine the system as a whole, which is why the activity most susceptible to censorship forms a litmus test for the rest of the network. If it were not possible to censor the most at-risk activity, it reinforces that bitcoin reliably works in all cases.

Bitcoin is for everyone

Ultimately, bitcoin represents a technological advancement in the global competition for money; it is the superior successor to existing fiat monetary systems, even if not well or widely understood today. And as an extension of an idea discussed in Bitcoin Cannot Be Banned, anyone who calls for a ban on bitcoin due to the belief that it enables criminal activity is concurrently admitting that bitcoin is functional as a currency. Consequently, if bitcoin is functional in facilitating commerce associated with illicit activities, and despite the best efforts of a powerful regulatory authority, ipso facto, it can be functional in facilitating any other form of commerce as well,

including by law abiding citizens. Practically, operating within that reality and recognizing that bitcoin is a finitely scarce resource, it does not logically follow that it will be confined to the dark web, nor is it today.

The competition for bitcoin is global. Over time, those that produce the most relative value will accumulate the greatest share of bitcoin. To think that those involved in illicit activities will account for a larger share of the future bitcoin economy than today's dollar economy is not rational. And calling for a ban on bitcoin is somewhat like being scared of your own shadow. Not only would it not be practical to enforce, but the activity such a policy would seek to prevent is enabled today in far greater proportions by the dollar. It would be analogous to throwing the baby out with the bath water. We accept the good with the bad, recognizing that due to the very nature of bitcoin, we do not get to decide. There are always trade-offs, and in this case, that bitcoin will unavoidably be used for illicit purposes is the trade-off we gladly accept in exchange for the economic stability that an unmanipulable global currency will provide. As with every technology, value will accrue to those that utilize bitcoin in its highest and best use, a function which only the market can determine. The net benefit will not be zero-sum and just as the internet is not for drug dealers and terrorists, bitcoin is not for criminals. It is for everyone.

> "It is more important that innocence be protected than it is that guilt be punished, for guilt and crimes are so frequent in this world that they cannot all be punished. But if innocence itself is brought to the bar and condemned, perhaps to die, then the citizen will say, 'whether I do good or whether I do evil is immaterial, for innocence itself is no protection,' and if such an idea as that were to take hold in the mind of the citizen that would be the end of security whatsoever." – John Adams

> "Govern wisely, and as little as possible" – Sam Houston

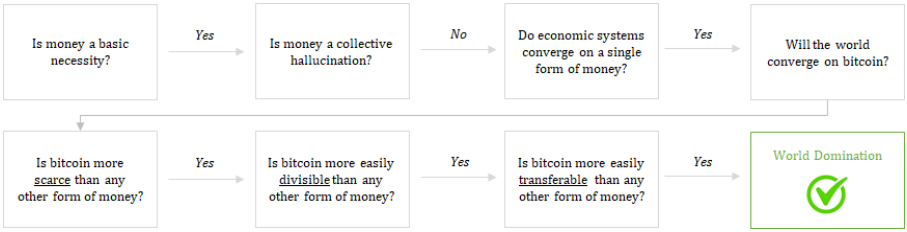
Final thought (stealing a page from @martybent's playbook): History will look back far more favorably on Ross Ulbricht, the alleged founder of the Silk Road, than central bankers everywhere. Not for the drugs but for the bitcoin.

BITCOIN OBSOLETES ALL OTHER MONEY - JANUARY 24, 2020

When it comes to bitcoin adoption, there are generally two rules that never seem to fail. Everyone always feels late, and everyone always wishes they had bought more bitcoin. There are exceptions to every rule, but bitcoin has an uncanny ability to screw with the human psyche. It turns out that 21 million is a scarily small number, and it actually becomes smaller as more individuals come to understand that the fixed supply of bitcoin is credibly enforced and that monetary networks converge on a single medium. Demand for bitcoin is driven by the credibility of its monetary properties and the convergent nature of money, but increasing demand for bitcoin reinforces the scarcity of bitcoin's fixed supply. As it does, bitcoin becomes more valuable as a monetary medium. While this becomes evident the further down the bitcoin rabbit hole one travels, it is not uncommon for individuals on the periphery to be overwhelmed by the sheer number of cryptocurrencies. Sure, bitcoin is in the "lead" today, but there are thousands; how do you know bitcoin is not MySpace? How can you be sure that something new doesn't overtake bitcoin?

It may sound crazy to believe that bitcoin will be the dominant global currency, and it likely would be if evaluating the possibility from a top-down, probability-weighted perspective. Today, bitcoin is one of a thousand-plus competing digital currencies that all look the same on the surface. Its purchasing power of $150 billion is a drop in the bucket compared to the global financial system which supports $250 trillion of debt. Gold alone has a purchasing power of $8 trillion (50 times the size of bitcoin). What are the chances that an 11-year old internet sensation rises from the ashes of the 2008 financial crisis and goes from nothing to becoming the dominant global currency? The idea sounds laughable, or at the very least, it appears to be too low of a probability to warrant consideration. However, when starting from the bottom-up and developing conviction around a few foundational principles, the noise of a thousand cryptocurrencies fades to the

background. When added together, just a few foundational principles create simplicity and clarity around what once may have seemed too complex to possibly discern. If someone had to evaluate one thousand possibilities to come to the right solution, it may not be practical or possible. But if you could eliminate 999 of those possibilities based on one, or a few starting first principles, it then becomes more practical to arrive at a coherent answer.



This is the roadmap to cutting out the noise and focusing on what really matters. Individuals may come to different conclusions concerning any of these questions, but this is the path to consider when attempting to understand why bitcoin consistently outcompetes all other currencies and whether it will continue to do so. Money is a basic necessity, but it is not a collective hallucination, nor is it a shared belief system. Individuals adopt bitcoin because it possesses unique properties that make it superior as a form of money relative to all other currencies. Because money is a solution to an intersubjective problem, monetary systems tend to converge on a single medium. Or rather, economic systems naturally emerge from a single medium due to the function of money. The properties inherent in bitcoin are causing the market to converge on it as a tool to communicate and measure value because it represents a step-function change improvement over any other monetary medium. If anyone comes away with the fundamental view that money is a necessity and that monetary systems naturally converge, the question then centers on whether bitcoin is optimized to fulfill the monetary function better than any of the competition.

Money is a necessity

Civilization as we know it would not exist without money. Without money, there would be no airplanes, no cars, no iPhones, and the ability to fulfill very basic necessities would become materially impaired. Millions of people could not peacefully inhabit a single city, state, or country without the function of money. Money is the economic good that allows food to reliably show up on grocery shelves, gas to be at the gas station, electricity to power homes, clean water to be abundant, etc. It is money that makes the world turn and it would not turn in the way that most have taken for granted if not for the function of money. It is a massively underappreciated function; one that is poorly understood because it is generally not consciously considered. In the developed world, reliable money is taken as given. So too are the basic necessities delivered through the coordination function of money.

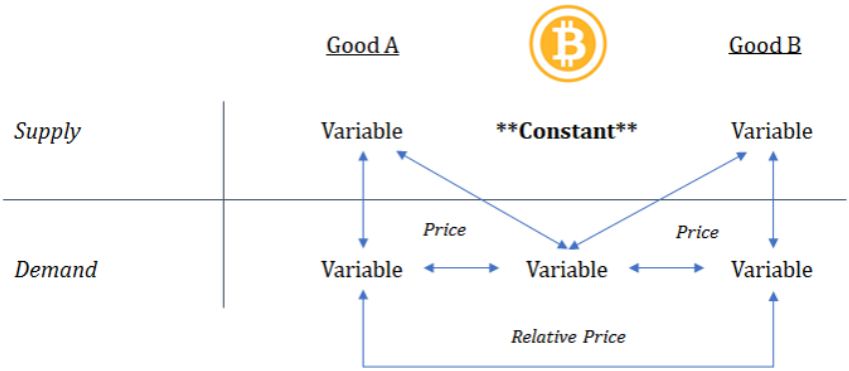
Consider, for example, a local grocery store and the range of choice that converges in a single store. The number of individual contributions and skills that are required to make that happen is mind-boggling. From the coordination of the store itself, to the individual packaging, to the technology providers, to the logistics networks, to the transportation networks, to the payments systems, and right down to each individual item of food. Then as a derivative, consider all the unique inputs that go into each item on the shelf. The grocery store is just the fulfillment side; the production of each input has its own diverse supply chain. And it is just one modern marvel. Deconstructing the inputs of a modern telecom network, energy grid or water and waste management system is similarly complex. Each network and the participants therein rely on the others. Producers of food rely on individuals that help fulfill energy demand, telecom services, logistics, clean water, etc. among others and vice versa. Practically all networks are connected, and it is all made possible through the coordination function of money. Everyone is able to contribute their own skills based on their own personal interests and preferences: receive money in return for value delivered today, and

then use that same money to acquire the specialized value created by others in the future.

And it does not all happen by chance either. Some not-so-rigorous thinkers suggest that money is either a collective hallucination or that it derives value from the government. In reality, money is a tool that was invented by man to satisfy a very specific market need in facilitating trade. Money helps facilitate this activity by acting as an intermediary between a series of present and future exchanges. Without any conscious control or direction, market participants evaluate various different goods and converge on the tool with the properties best-suited to facilitate the very express purpose of converting present value for future value. Whereas individual consumption preferences vary from person to person and change constantly, the need for exchange is practically universal, and the function is distinctly uniform. For every individual, money allows for value produced in the present to be converted into consumption in the future. The value one places on a home, a car, food, leisure, etc. naturally changes over time and logically varies from person to person. But the need to consume and the need to communicate preferences does not change and applies to all individuals on an intersubjective basis.

Money exists to communicate these preferences and ultimately, value. But recognizing that all value is subjective (and not intrinsic), money forms the baseline to establish an expression of value and more importantly relative value. Money represents the collective recognition that everyone benefits from the existence of a common language to communicate individual preferences. It aggregates and measures the preferences of all individuals within an economy, at any point in time, and it would not be possible, or at the very least extremely inefficient, to communicate value if not for a common constant upon which everyone could agree. Think of money as the constant against which to measure all other goods. If it did not exist, everyone would be at a practical standstill, not able to agree on the value of anything. By comparing against a single constant, it then

becomes more practical to discern the relative value of two other goods. There are billions of goods and services produced by billions of individuals, all with unique preferences. Through the convergence on a single form of money to aggregate and communicate all preferences, a price system ultimately emerges. By measuring and expressing the value of all goods in a common intermediary (money), it then becomes possible to understand how much one good (or resource) is valued relative to any other.



Without the use of a common currency, there would be no concept of price. And without the concept of price, it would not be possible to do any range of economic calculation. The ability to perform economic calculation allows individuals to take independent actions, relying on the information communicated through a price system, to best satisfy their own needs by understanding the needs of others. In fact, it is a price system that allows supply and demand structures to form, and it is ultimately a necessity because it provides for the communication of information, without which the fulfillment of basic needs would not be possible. Imagine if nothing you consumed had a discernible price. How would you know what you needed to produce in order to obtain the goods you prefer? Then recognize that your own conception of the value you produce and the very existence of goods and services

produced by others would not be available if not for some expression of price existing. It becomes circular, but money is the good that allows the underlying structures of an economy to form through the price system. While it is often extolled as the root of all evil, money may just be the greatest accidental invention ever created by man, and one that could not have emerged by conscious control.

> *"I have deliberately used the word "marvel" to shock the reader out of the complacency with which we often take the working of [the price] mechanism for granted. I am convinced that if it were the result of deliberate human design, and if the people guided by the price changes understood that their decisions have significance far beyond their immediate aim, this mechanism would have been acclaimed as one of the greatest triumphs of the human mind. Its misfortune is the double one that it is not the product of human design and that the people guided by it usually do not know why they are made to do what they do. But those who clamor for "conscious direction"—and who cannot believe that anything which has evolved without design (and even without our understanding it) should solve problems which we should not be able to solve consciously—should remember this: The problem is precisely how to extend the span of our utilization of resources beyond the span of the control of any one mind; and therefore, how to dispense with the need of conscious control, and how to provide inducements which will make the individuals do the desirable things without anyone having to tell them what to do."*
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> – F.A. Hayek (The Use of Knowledge in Society)

Economic systems converge on a single monetary medium

Late stage Silicon Valley thinking has many people believing that hundreds, if not thousands, of currencies may exist in the future. The machines are going to do all the calculation! AI and quantum will handle it. An intellectually "safe" view to hold is that 95% of cryptocurrencies will probably fail but there are some "interesting" projects. "It is inherently difficult to know which will succeed." "Much like venture capital investing, most will fail but the ones that win will win big." At least, this is what most of Silicon Valley would have you believe because it is a defensible parallel to historical experiences investing in companies. In reality, it is a blanket hedge lacking in first principles. It is also applying a familiar formula to an entirely distinct class of problem.

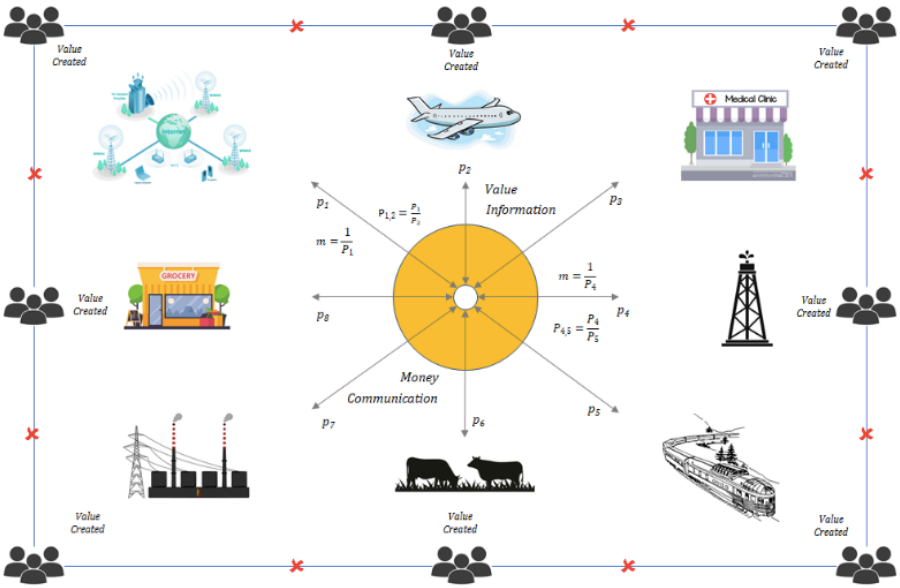
While it may seem logical to form a mental framework around bitcoin in relation to the rhyming history of technology startups, there can be

no comparison whatsoever. Bitcoin is money, not a company. It would be illogical to assume competition between two monetary mediums (or multiple) would be in any way parallel or would follow a similar pattern to that of two companies. Companies compete in a capital formation arms race; in order to do so, they need money to coordinate economic activity. How do they get money? By using money to coordinate the production of goods and services and by selling the output for more money (profit). In essence, companies compete for the same pool of money in order to accumulate capital. Money is the tool that makes the wheel go round. It simply would not be possible to coordinate all the individual skills necessary in order to allow for the fulfillment of goods and services derived from the complexity of most modern supply chains without money. It also would not be possible if it were not for the fact that a large group of people accepted a common form of money.

> *"Having a single medium of exchange allows the size of the economy to grow as large as the number of people willing to use that medium of exchange. The larger the size of the economy, the larger the opportunities for gains from exchange and specialization, and perhaps more significantly, the longer and more sophisticated the structure of production can become."*
>
> – Saifedean Ammous (The Bitcoin Standard)

In the supply chain of production, money serves a distinct function of a different class than any individual good or service. It is the distinction between the fulfillment of preferences (production of goods and services) and the coordination of preferences (money). The fulfillment of preferences is dependent on the coordination of preferences, and the coordination of preferences is dependent on a price system, which can only form as a derivative of mass convergence on a single monetary medium. Without a pricing system, division of labor would not exist, at least not to the extent necessary to allow for the functioning of complex supply chains. This is the root level principle most miss when contemplating a world of many currencies. Any pricing system is derived from a single currency. The

concept of price would not exist if not for a critical mass of individuals producing a diverse set of goods and services and communicating the value of those goods and services through a common medium. In order to derive the benefit of money and price, convergence is a precursor. As a result, it may be more accurate to say that economic systems emerge from a single monetary medium rather than converge on one. Individuals converge on a single monetary medium and the output is an economic system.



Value is created by individuals through the fulfillment of goods and services.

However, the communication of value is not direct; instead, it is communicated through money as an intermediary.

Money provides the baseline to express the very concept of value in the first place.

Information is communicated each time a price is determined or changes; this occurs every time an individual converts goods and services into money as an intermediary, thus determining a price and the inverse being the value of a unit of money.

Price is ultimately the information and money is the medium through which price communicates value.

While all other goods are non-fungible and variable, money is a utility because it provides a single, fungible constant that allows for the measure of value AND exchange.

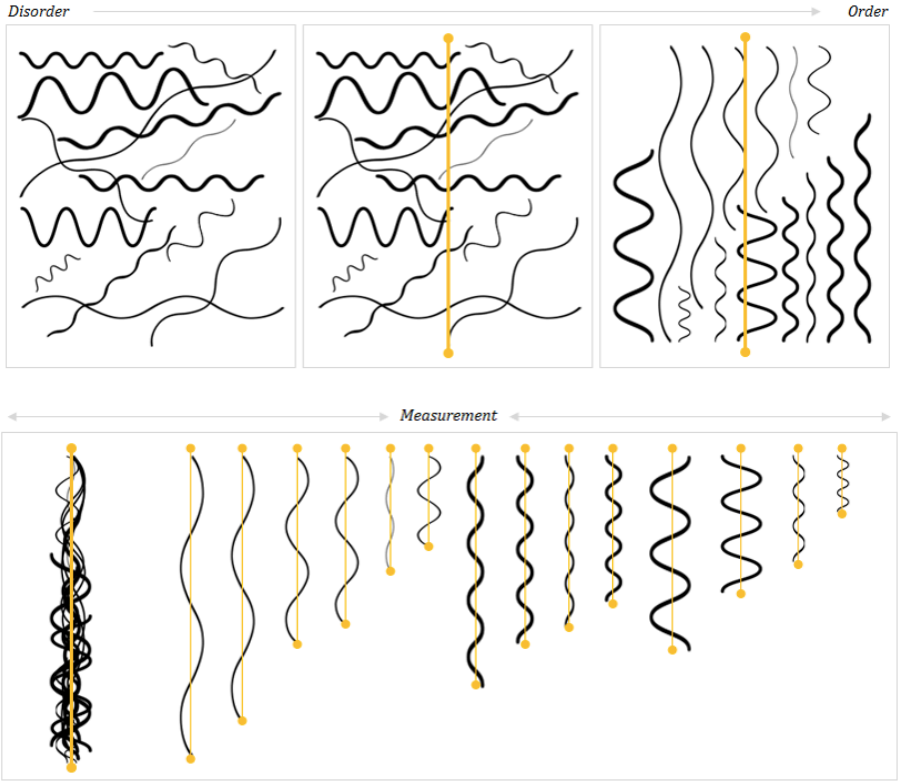
Price $\{P_1,\ldots P_n\}$ and relative price $\{\frac{P_1}{P_2},\ldots,\frac{P_1}{P_n}\}$ would not exist if there were not an intermediary constant to measure value.

Individuals value money differently but everyone can at least agree that the constant is a relative constant and that it is the source of least friction in communicating preferences and procuring future value.

Whereas the value of all other goods and services is consumption, the value of money is exchange. Exchange is the good any individual is purchasing when choosing to convert value (the subjective output of time, labor and physical capital) into a monetary good. Individual consumption preferences are unique, but money serves one singular function for all market participants: to bridge the present to the future (whether it be for a day, week, year or longer). In any exchange of present value, some time continuum exists until a future exchange. At the point of exchange, each individual must make a decision as to which monetary good will best serve the function of preserving value created in the present into the future. A or B? While an individual can choose to hold one or multiple currencies, one is definitionally going to perform that function more effectively. One will preserve future purchasing power better than the other. Everyone intuitively understands this and makes a decision based on the inherent properties of one medium relative to another. When deciding which monetary good to use, the preference of one individual is impacted by the preference of others, but each individual is making an independent evaluation discerning the relative strengths of multiple monetary goods. It is not coincidence that the market converges on a single medium because each individual is attempting to solve the same problem of future exchange, which is interdependent on the preference of others.

The ultimate goal is to reach consensus such that each individual can communicate and exchange with the widest and most relevant set of trading partners. Collectively, it is an objective evaluation of tangible goods based on an intersubjective need. The whole point is to find the one good that everyone can agree is i) a relative constant, ii) measurable and iii) functional in exchange. The existence of a constant creates order where none existed previously, but that constant must also be functional as both a measurement tool and a means of exchange. It is the combination of these characteristics, often described as aggregating the properties of scarcity, durability, fungibility, divisibility, and transferability, which are unique to

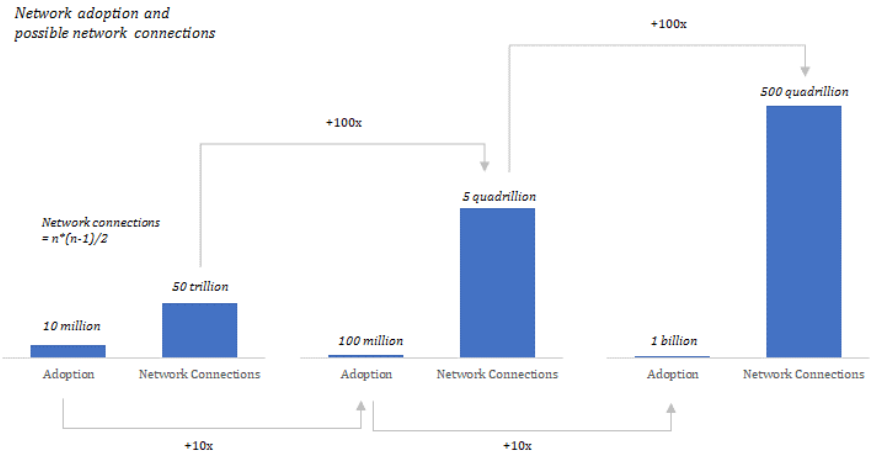
money. Very few goods possess all of these properties, and every good is unique, with inherent properties that cause each to be better or worse in fulfilling certain functions within an economy. A is always different than B, and the combination of properties that perfect a monetary good are so rare that the distinction from one to another is never marginal.



More practically, everyone agrees on a single monetary good through which to express value because it is in their individual and collective interests to do so. It is the problem itself: how to communicate value with other market participants. It would be counterproductive to the entire exercise if a consensus were not formed. But it is the properties of a monetary good itself that allow for convergence and consensus.

The imagined world of thousands of currencies is blind to these fundamental first principles. A critical mass of individuals converging on a common medium is the input required to ascertain the information that is actually desired. And the value of a common medium only increases in value as more and more people converge on it as a tool to facilitate exchanges. The fundamental reason being that with more individuals converging on a single medium, the medium actually accumulates more information and presents a greater utility.

Think of each individual as a potential trading partner. As individuals adopt the common medium as a standard of value, all existing participants in the monetary network gain new trading partners, as do the individuals that become part of the network. There is mutual benefit, and ultimately the range of choice expands. But what also occurs as a monetary network expands is that more goods come to be valued in the common medium of exchange. More prices exist, and as a result, more relative prices do as well. More information is aggregated into the common medium, which can then be relied upon by all individuals within the network (and by the network as a whole) to better coordinate resources and respond to changing preferences. The constant becomes more valuable and inherently more reliable as it communicates more information about more goods produced by more individuals. The constant actually becomes more constant as more variable information is communicated through it.

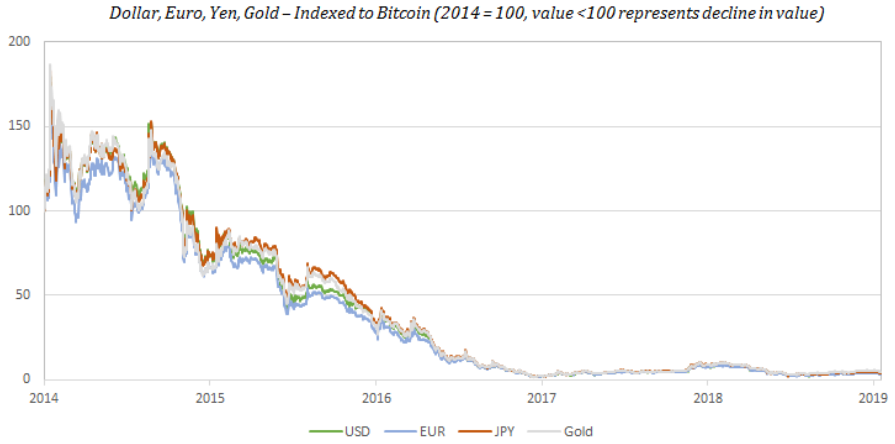


As adoption of a monetary network increases by an order of magnitude (10x), possible network connections increase by two orders of magnitude (100x). While this helps demonstrate the mutual benefit of adoption, it also highlights the consequence of converting value into a smaller monetary network. A network that is one-tenth the size has 1% of the number of potential connections. Not every network distribution is equal, but a larger monetary network translates to a more reliable constant to communicate information – greater density, more relevant information and ultimately a broader range of choice. The size of a monetary network and the expected growth of that network become critical components of the intersubjective A/B test, when each individual is determining which medium to utilize. While the number of people with whom any individual can maintain social relationships is inherently limited, the same limits do not apply to monetary networks. It is money that allows humans to break from the constraints of Dunbar's number. A monetary network allows for millions (if not hundreds of millions) of people unknown to each other to contribute value at end points in the network, with relatively few direct connections needed.

Monetary networks ultimately accumulate the value of all other networks because all other network effects would not exist without a monetary network. Complex networks cannot form without a common currency to coordinate the economic inputs necessary to kick start the positively reinforcing feedback loops of price. A common currency is the very foundation of any monetary network, which allows other value networks to form. It provides the common language to communicate value, ultimately leading to trade and specialization, and organically creating the ability to expand the use of resources beyond the reach of "conscious control" (to steal Hayek). When contemplating the network effects of a social network, a logistics network, a telecom network, energy grid etc., add them all together and that is the value of a monetary network. A monetary network not only provides the foundation for all other value networks to form, but the currency of that network is what pays for access to all

derivative networks within the monetary network. The existence of the common currency is the engine and the oil.

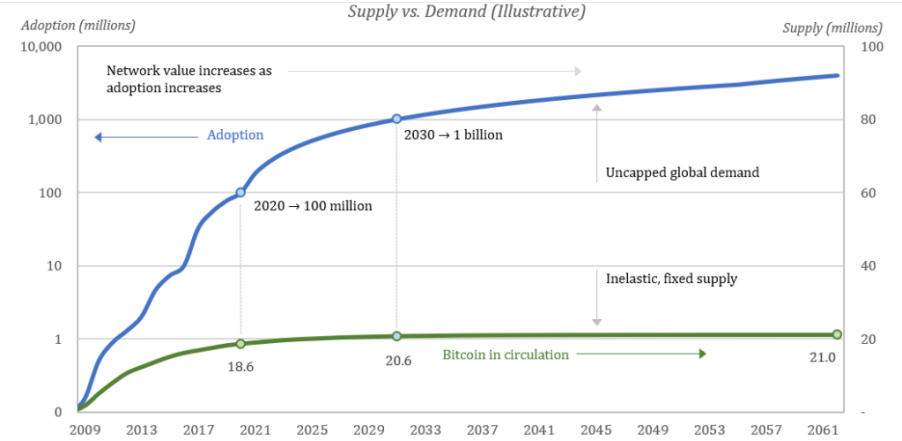
Yes, the dollar, euro, yen, pound, franc, yuan, ruble, lira, peso, etc. all co-exist today, but this is not a natural function of an open, global economy. Instead, each fiat currency that exists today emerged as a fractional representation of gold, which the world had previously converged upon as a monetary standard. None would subsist without the forces of government intervention; nor would any fiat currency have ever emerged if not for the prior existence (and limitations) of gold as a monetary medium. Modern monetary theorists and gold bugs alike will never admit it, but the calamity that is all fiat systems is nothing more than the manifestation of gold's failure as a monetary medium. It is a dead man walking. The gold standard was formally abandoned in 1971, and the subsistence of jurisdictional fiat systems since then merely represents a transient departure from free market monetary forces. Modern fiat systems have only managed to survive as long as they have because a solution to the very problem created by fiat did not yet exist. Bitcoin is that solution, and ever since its creation, individuals have been converging upon it as a new monetary standard; a trend that will only continue as knowledge naturally distributes.

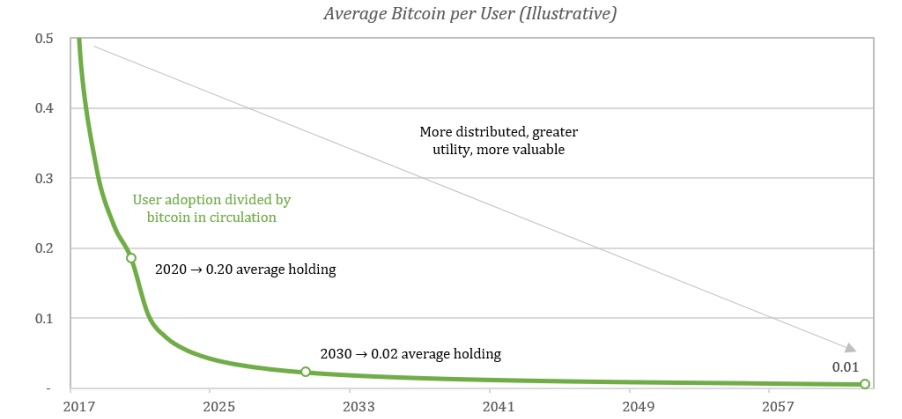


All Roads Converge on Bitcoin

The Greatest Constant – Finite Scarcity

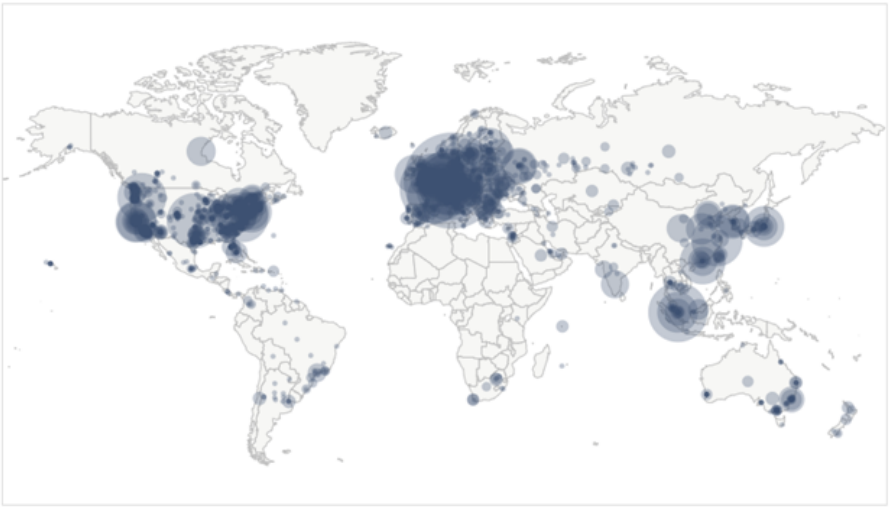
The market converges on bitcoin over time and its value continues to increase because it provides a constant that is superior to any other form of money. Bitcoin has an optimal monetary policy, and that policy is credibly enforced on a decentralized basis. Only 21 million bitcoin will ever exist, and the element of trust is removed from the equation entirely. Bitcoin's fixed supply is enforced by a network consensus mechanism on a decentralized basis. No one trusts anyone, and everyone enforces the rules independently. As an aggregate of these two functions, bitcoin is becoming the scarcest form of money that has ever existed. Finite scarcity is a property no other form of money has ever or will ever achieve, and demand for bitcoin is fundamentally driven by that scarcity. However, scarcity is a two-sided equation. A fixed supply may be the primary draw, but demand is a critical and often overlooked aspect of scarcity. Demand is what actually makes scarcity a utility as a constant in exchange. Bitcoin becomes more and more scarce as a two-way function of increasing demand and a completely inelastic terminal supply. The scarcity of its fixed supply creates demand but increasing demand then creates greater scarcity. It sounds circular because it is. If there were 21 million bitcoin and only 1 person valued it, there would be nothing scarce or useful about bitcoin. But if 100 million people valued bitcoin, 21 million starts to become scarce. And if the network grew to one billion people, 21 million would become extremely scarce, and bitcoin would represent a greater utility as a constant.





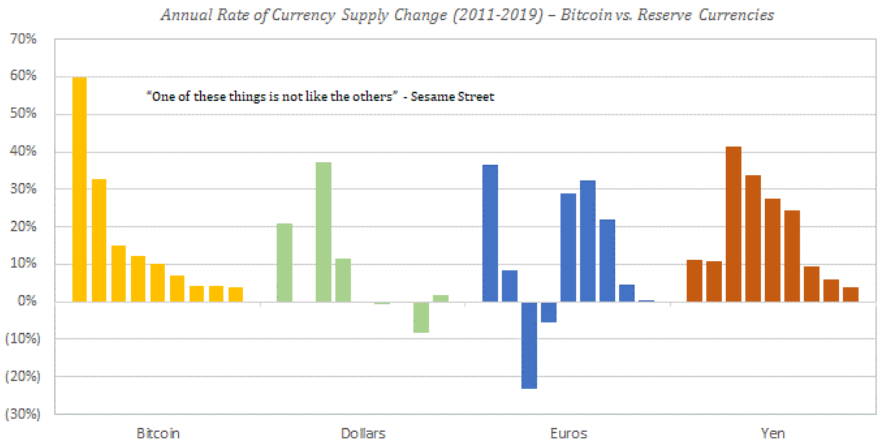
With a fixed supply, increased demand naturally results in bitcoin becoming more distributed. There is only so much to go around, and the pie ends up getting split up into smaller and smaller shares owned by more and more people. As more individuals value bitcoin, the network not only becomes a greater utility; it also becomes more secure. It becomes a greater utility because more people are communicating in the same language of value through a more reliable constant. And as more individuals participate in the network consensus mechanism, the entire system becomes more resistant to

corruption and ultimately more secure. Recognize that there is nothing about a blockchain that guarantees a fixed supply, and bitcoin's supply schedule is not credible because software dictates it be so. Instead, 21 million is only credible because it is governed on a decentralized basis and by an ever increasing number of network participants. 21 million becomes a more credibly fixed number as more individuals participate in consensus, and it ultimately becomes a more reliable constant as each individual controls a smaller and smaller share of the network over time. As adoption increases, security and utility work in lock-step. Consider the distribution and relative density of bitcoin adoption throughout the world (heat map below of network nodes). As reach and density within each market spread, bitcoin's constant becomes harder and harder.



As individuals increasingly opt-in, 21 million becomes more and more credible, and in the mind of those who adopt it, finite scarcity becomes what differentiates bitcoin from all other forms of money – both legacy currencies and competing cryptocurrencies alike. All other currencies either centralize over time (e.g. the dollar, euro, yen,

gold) or were too centralized from the start (e.g. all other cryptocurrencies) to credibly compete with a fixed supply of 21 million. Centralization inherently creates the need to rely on trust, and trust ultimately puts the supply of any currency at risk, which in turn impairs demand and marginalizes its utility in the function of exchange. Whereas all other currencies depend on trust, the constant bitcoin provides is trustless. 21 million is only credible because bitcoin is decentralized, and bitcoin becomes increasingly decentralized over time. The best any other form of money could possibly do is match bitcoin, but practically, it is not possible because individuals converge on a single medium, and bitcoin beat every other currency to the punch. Every other currency is ultimately competing against the ideal constant; one that will not change and that does not rely on trust.



All forms of money compete with each other for every exchange. If the primary (or sole) utility of an asset is the exchange for other goods and services, and if it does not have a claim on the income stream of a productive asset (such as a stock or bond), it must compete as a form of money. As a consequence, any such asset is directly competing with bitcoin for the exact same use case, and no other currency will ever provide a more reliable constant because bitcoin already exists

and it is finite. Because individuals converge on a single medium, scarcity in bitcoin will perpetually be reinforced on both the supply and demand side, whereas the opposite force will be in effect for all other currencies due to the reflexive nature of monetary competition. The distinction between two monetary goods is never marginal, and neither is the consequence of individual decisions to exchange in one medium rather than another. Money is an intersubjective problem, and a choice to opt into one monetary medium is an explicit opt out of the other, which in turn causes one network to gain value (and utility) at the direct expense of another. As bitcoin becomes more scarce and more reliable as a constant, other currencies become less scarce and more variable. Monetary competition is zero sum, and relative scarcity, a dynamic function of both supply and demand, creates the fundamental differentiation between two monetary mediums that only increases and becomes more apparent over time.

But remember that scarcity for scarcity sake is not the goal of any money. Instead, the money that provides the greatest constant will facilitate exchange most effectively. The monetary good with the greatest relative scarcity will best preserve value between present and future exchanges over time. Relative price and relative value of all other goods is the information actually desired from the coordination function of money, and in every exchange, each individual is incentivized to maximize present value into the future. Finite scarcity in bitcoin provides the greatest assurance that value exchanged in the present will be preserved into the future, and as more and more individuals collectively identify that bitcoin is the monetary good with the greatest relative scarcity, stability in its price will become an emergent property (see Bitcoin is Not Too Volatile).

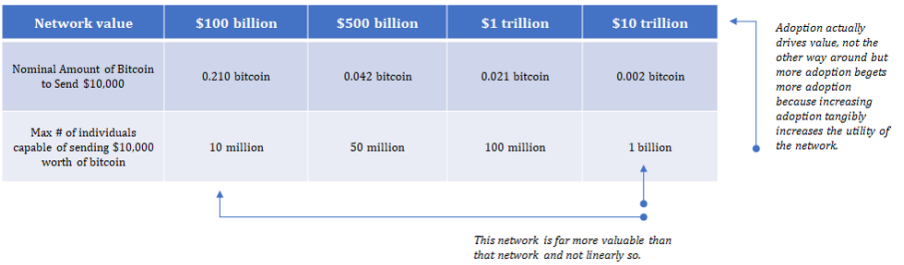
The Greatest Measurement Tool – Divisibility

While scarcity is the bedrock, not all scarce goods are functional as money. In order to be functional as a tool to communicate value, a monetary good must be a relative constant, easy to measure and functional in exchange. A ruler may be an effective measurement tool, but rulers are not scarce, nor is it easy to carve up pieces of a ruler

into larger and smaller units to facilitate exchange. In exchange, a monetary good being scarce and measurable allows for the measurement of all other goods; the ability to easily subdivide and transfer a monetary unit provides for practical utility in exchange. Bitcoin combines finite scarcity with the ability to subdivide each whole unit down to 8 decimal points (0.00000001 or one 100,000,000th of a bitcoin) and transfer any amount of value, however large or small. Just as scarcity for scarcity sake is not necessarily valuable in the context of money, neither is the property of divisibility. It is the combination that becomes valuable in the context of money, particularly when each subdivided unit is fungible – when each individual unit is essentially interchangeable and each of its parts is indistinguishable from another part. It is these properties together that allow bitcoin to not only be a perfect constant but also an effective measure of value to facilitate exchange.

In the code, one bitcoin is actually represented as 100,000,000 sub-units, with the smallest unit referred to as a satoshi (or sat for short). Technically, one bitcoin is 100,000,000 sats. While one bitcoin equates to approximately $9,000 today, one satoshi is equal to one-twentieth of a penny. In essence, anyone can exchange any amount of value into bitcoin. Bitcoin, as with any money, is functional for one purpose, to store value between a series of exchanges. Receive bitcoin for value produced today, save, spend bitcoin in the future in return for value produced by others. It will perform the same function regardless of amount. The practical consequence of divisibility is that bitcoin is capable of measuring any and all value which allows it to support any and all adoption. Individuals produce a wide range of value, and divisibility allows all individuals to utilize bitcoin as a savings mechanism regardless of whether it be to store $50 or $50,000 in value. For a monetary good to be an effective communication tool, it must be able to measure the range of value produced by all individuals, and bitcoin does this flawlessly. The ability to divide and transfer any amount of bitcoin makes it accessible to all individuals and ultimately all goods produced, regardless of how much value is attributable to each.

In the A/B test of monetary competition, if A > B, any amount of A will perform the function of money better than any amount of B. Over time, A will increase in purchasing power relative to B whether it be for $50 or $50,000-worth of value. Never be confused by a list of cryptocurrencies trading on Coinbase that look like a "better deal" because the price is "cheap" whereas bitcoin appears "expensive." Always remember that bitcoin is capable of being divided into smaller or larger units to store more or less value. One bitcoin is an inherently arbitrary unit, as is one unit of any currency. The market test is whether A is more functional as money than B. It is an intersubjective decision, and while the market is communicating which network it believes performs the monetary function more effectively through price and value, network value is the output, not the input. The input is each individual evaluating the properties of the monetary good itself relative to others. If bitcoin is A in your evaluation, then there is no "too expensive." Bitcoin may be over or undervalued at any point in time, but each individual that adopts bitcoin increases the value of the network (recall the discussion on trading partners + network connections). And the ability to be divided easily into very small units allows for a practically limitless number of individuals to convert and communicate value through the network. If A is greater than B, and if A can support unlimited adoption, it eventually obsoletes the need for network B.



As individuals independently evaluate this A/B test, more people ultimately adopt bitcoin, and bitcoin becomes divided into smaller and smaller units (on average). This is the result of increasing demand

combined with a fixed supply, and the value of the network actually increases as a function of this process. As a network, bitcoin becomes more valuable as it is valued by more people. Essentially, 0.1 bitcoin = $1,000 is more valuable than 1.0 bitcoin = $1,000, despite each being worth the same measured in dollar terms. More exchange (and ultimately more commerce) becomes possible the more valuable bitcoin becomes in total, but value is really an output of more and more people choosing to adopt bitcoin as an exchange intermediary. Each individual owns a smaller and smaller nominal amount of the currency, but the purchasing power of each equivalent unit increases over time. With each exchange, every individual is conveying his or her own value onto the network and is doing so at the direct expense of a competing monetary network. Through this process, a new price is determined specific to the value created and measured by each individual, and as a result, bitcoin accumulates more information derived from a more diverse set of trading partners.

While prices today may not yet be quoted in bitcoin terms, a pricing system is forming every time an individual converts value into bitcoin. Even if dollars are an indirect intermediary, value produced somewhere in the world, distinct to a particular individual, is expressed as a unit of bitcoin; as more and more people choose to do so and increasingly on a per-individual basis, that value converts to a smaller and smaller unit of bitcoin (on average). The consequence is that a smaller and smaller denomination of bitcoin can be used by more people to transfer an equivalent amount of value, and as bitcoin is measured by more people, its ability to measure relative value only increases. Since bitcoin can measure all value and can be adopted by a limitless number of individuals, it practically obsoletes the need for any other value transfer network over the long-term because the form of money with the lowest rate of change ultimately communicates more perfect information. Finite scarcity combined with divisibility creates an extremely powerful exchange intermediary. Bitcoin has the lowest terminal rate of change possible due to its absolute scarcity, and it can be divided to a fraction of a penny, which will allow it to measure value far more precisely than any other currency.

The Greatest Exchange Tool – Transferability

With this baseline, the real knockout punch becomes the fact that bitcoin can be irrevocably transferred over a communication channel without the need for any trusted third-party as an intermediary. This is fundamentally different than digital payments in fiat systems, which are dependent on trusted intermediaries. In aggregate, bitcoin is a greater constant than any other form of money and is highly divisible (and measurable), while also capable of being transferred over the internet. Try to identify a single other good that could possibly share these properties: finite scarcity (greatest constant) + divisibility and fungibility (measurement) + ability to send over a communication channel (ease of transfer). This is what every other monetary good is up against as it competes for the convergent role of money.

Practically, the only way to really appreciate the power of such a rare dynamic is through experiencing it firsthand. Any individual can access the network on a permissionless basis by running a bitcoin node on a home computer. The ability to power up a computer anywhere in the world and transfer a finitely scarce resource to any other individual, without permission or reliance on a trusted third-party is empowering. That hundreds of millions of people can do this in unison without anyone needing to trust other participants in the network is near-impossible to fully comprehend.

Bitcoin is often described as digital gold, but really, this does not do it justice. Bitcoin combines the strengths of physical gold with the strengths of the digital dollar without the limitations of either. Gold is scarce but difficult to divide and transfer, while the dollar is easy to transfer but not scarce. Bitcoin is finitely scarce, easy to divide, and easy to transfer. In their current forms, both gold and all fiat monetary systems are dependent on trust, whereas bitcoin is trustless. Bitcoin optimized for the strengths and weaknesses of both, which is fundamentally why the market is converging (and will continue to converge) on bitcoin to fulfill the function of money.

Bitcoin Obsoletes All Other Money

If any individual comes to three principal conclusions: i) money is a basic necessity, ii) money is not a collective hallucination and iii) economic systems converge on a single medium, that individual is going to more consciously seek out the best form of money. It is money that preserves value into the future, and ultimately, allows individuals to convert their own time and their own skills into a range of choice so great that prior generations would find it difficult to imagine. Freedom is ultimately what a reliable form of money provides: the freedom to pursue individual interests (specialization) and the ability to convert the output of that value into the value created by others (trade). Whether individuals consciously ask themselves these questions or not, they will naturally be forced to answer them through their actions. They will also arrive at the same answer as those that do. The conscious and the subconscious arrive at the same place because the fundamental truths do not change, and the function of money is singular: to intermediate a series of present and future exchanges and to provide the very baseline to communicate subjective value among a wide group of individuals that stand to benefit from trade and specialization. Money is a necessity. There are discernible properties that make certain goods more or less functional in exchange, and exchange is an inherently intersubjective problem.

Owning bitcoin is becoming the cost of entry to what will likely be the largest and most diverse economy that has ever existed. Bitcoin is global and it is accessible on a permissionless basis. Because bitcoin becomes the common language of value for all participants, anyone that is a part of the network will be able to communicate and ultimately trade with other network participants. The more trading partners, the greater the value each unit provides to the individuals holding the currency. While there will likely always be jurisdictional friction that impedes trade, access to the same common currency removes the root source of friction in the communication of value, and bitcoin's fixed supply will allow its pricing mechanism to accumulate and communicate more perfect information with the least amount of distortion relative to any other form of money. And as

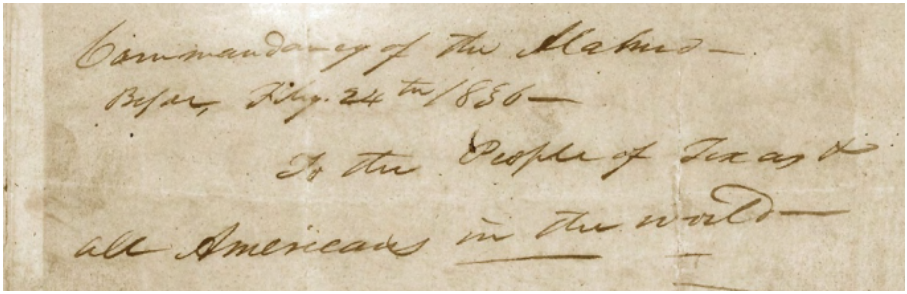
more individuals choose to store value in bitcoin, its fixed supply becomes more credible and its pricing mechanism more reliable and relevant. New adopters of a monetary network both contribute value and realize value as a function of adoption, which is why it is not possible to be late to bitcoin, nor will bitcoin ever be too expensive.

It does not matter how complex bitcoin is. At the end of the day, bitcoin becomes an A/B test. The need for money is real and individuals will converge on the form of money that best fulfills the function of exchange. No other currency in the world can ever be more scarce than bitcoin, and scarcity will act like a gravitational force driving adoption and communication of value. Today, most billionaires do not understand bitcoin. Bitcoin is an equal opportunity mind-bender. But even those who do not understand bitcoin will come to rely upon it. There are many fundamental questions. Bitcoin is volatile, seemingly slow, challenges to scaling, not commonly used for payments, consumes a lot of energy, etc. Stability is an emergent property that follows adoption, and all other perceived limitations will be solved as a function of the value that is derived from finite scarcity combined with the ability to measure, divide and transfer value. That is the innovation of bitcoin. Currency A has a fixed supply. Currency B does not. Currency A keeps increasing in value relative to Currency B. Currency A continues to increase in purchasing power relative to goods and services while Currency B does the opposite. Which one do I want? A or B? Make the right choice because the opportunity cost is your time and value. All of the rest simply explains why individuals will increasingly opt for A over B, but in practice, it all comes down to basic common sense and survival instincts. Bitcoin obsoletes all other money because economic systems converge on a single currency, and bitcoin has the most credible monetary properties.

“I don’t believe we shall ever have a good money again before we take the thing out of the hands of government, that is, we can’t take it violently out of the hands of government, all we can do is by some sly roundabout way introduce something that they can’t stop.” – F.A. Hayek.

BITCOIN IS A RALLY CRY - MARCH 26, 2020

“To the People of Texas and all Americans in the world.” In his open call to arms from the Alamo, Lt. Colonel William B. Travis began with an expression of America as an idea extending beyond borders, to all Americans in the world. It was a plea to all those that valued the fight for liberty and freedom. Outnumbered ten-to-one, Travis responded to a demand for surrender with a cannon shot. He was no more than 27 years old at the time. Texas declared its independence a week later, but within days, the Alamo fell. The Travis letter became the rallying cry of a revolution. Remember the Alamo. Ultimately, Texas won its independence. Always outnumbered, it is a reminder that the endless pursuit of freedom is a most powerful equalizer. And it is something inherent to the character of Americans in all the world.

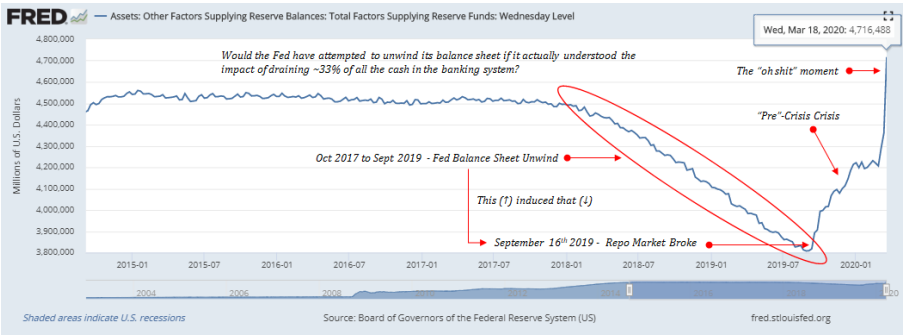

Commandancy of the Alamo—
Bejar Feby. 24th 1836—
To the People of Texas &
all Americans in the world—

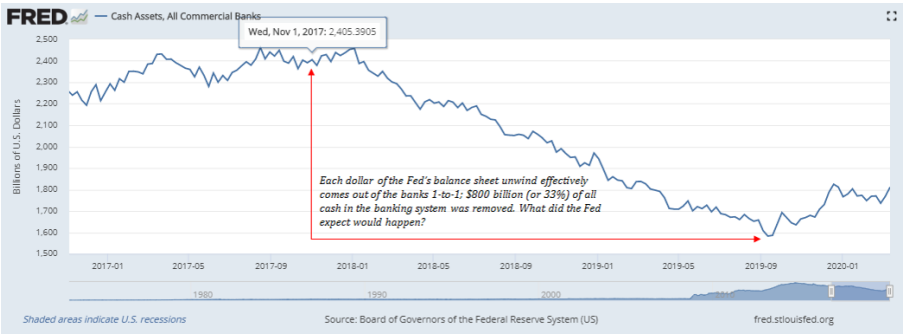
(Opening of the Travis Letter from the Alamo, February 24, 1836)

Minus the lionized heroes and a literal declaration of independence, bitcoin is still very much a fight for freedom, and it is similarly becoming a rally cry to all those that refuse to sit back and accept the fate of our tenuous financial system. The very idea of freedom may be the single most important tenet underpinning the monetary revolution to which bitcoin is giving rise. When the war is won, it will likely find its way directly into a constitutional amendment (even though it’s already covered by the first amendment). The right of the people to keep and bear bitcoin. Prior to bitcoin, everyone had no practical choice but to opt into a flawed currency system. That changed when

bitcoin was released into the wild in 2009. Bitcoin is completely voluntary, it is controlled by no one, and it affords everyone the ability to store and transfer value in a form of currency that cannot be manipulated. Bitcoin may not be synonymous with the right to life, liberty and the pursuit of happiness but for those that choose to rely upon it as a better path forward, it is a fundamental and inalienable right.

While bitcoin is valued for different reasons by different people, it consistently appeals to those that have identified the inherent level of freedom afforded by such a powerful tool, particularly in a world full of never-ending economic calamities. As the fragility and instability of the global financial system becomes more apparent by the day, central bankers and politicians scramble in a race to see who can provide more stimulus to an economy that is flatlining. Lest we not forget, the instability in the financial system is not just appearing; it is reappearing. The structural issues resurfacing are the same that existed during the 2008 financial crisis. Before the oil war and the global pandemic, the repo funding markets broke in September 2019. The writing was not just on the wall, it was in the repo markets. If it were not these recent events acting as the accelerant, it would have been some other random "act of god" which would have made evident what remained under the surface all along: a highly-levered financial system primed to break at the first signs of any material stress.





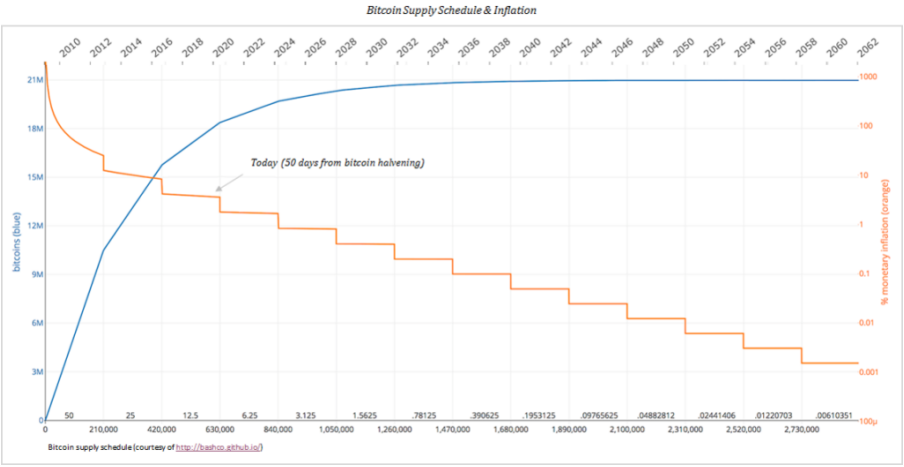
Even before the global shutdown (i.e. government-accelerated panic), the Fed had already supplied ~$500 billion in emergency funding to the repo markets. Now the fuel is really being dumped on the fire. But it is not just the scale that is alarming; it is the clear demonstration of control being lost through a meandering path of incrementalism. After the stock market crashed initially, the Fed issued an emergency 50bps interest rate cut; the market crashed some more and the Fed then announced an incremental $1.5 trillion in short-term funding (1-3 months) to be supplied in the repo markets. The market crashed again and three days later, a formal $700 billion "quantitative easing" program was announced to outright purchase $500 billion in U.S. government treasuries and $200 billion in mortgage-backed securities. Coinciding with this move, short-term rates were cut 100bps (all the way to zero).

Yep, the market crashed again, credit markets dislocated and the Fed followed with its "whatever it takes" response, announcing an

unlimited QE program. Its three most aggressive moves to date all transpired within a 10-day window. And in its latest unprecedented act, the Fed will begin buying corporate bonds on the secondary market as well as participate in primary issuances of corporate credit. It also expanded its purchases of mortgage backed securities to include commercial mortgage backed securities (commercial real estate). In addition, the Fed established a facility to issue asset backed securities to purchase student loans, auto loans, credit card loans, etc. All of this without a price tag, and just a promise to do whatever it takes. It would be funny if it weren't so serious, but the real question is, if the Fed were in control, why was it so reactionary? Why did its plans change so drastically in a ten-day period if it ever understood the extent of the issue? Never mind the unintended consequences, it is merely a demonstration that the Fed is not in control. Why would it have announced a $700 billion program if it didn't expect it to work? It's a classic game of guess and check, except the consequences can never be checked (only the immediate market reactions). The problem is our economy is at stake.

> *"There's an infinite amount of cash at the Federal Reserve" – Neel Kashkari, Minneapolis Fed President – March 22, 2020 (60 Minutes)*

> *"To lend to a bank, we simply use the computer to mark up the size of the account they have with the Fed […] it's much more akin to printing money than it is borrowing." – Ben Bernanke, Former Fed Chair – March 15, 2009 (60 Minutes)*



Make no mistake, the $1.5 trillion supplied to the repo markets will be converted to increment the Fed's formal quantitative easing program, and the entire unquantified program should conservatively be expected to exceed $4 trillion when all is said and done. The Fed cannot put out the fire that is a liquidity crisis through short-term funding, and it will have no other choice but to monetize a larger share of the credit system than it did in 2008 because the problem is now larger. In addition, while not yet passed, Congress is working on an initial $2.0 trillion stimulus package in response to the global pandemic. With a market already suffering a liquidity crisis, the banking system does not magically have this cash on hand to finance a massive expansion of the Federal government's deficit. There is a liquidity crisis unfolding after all. As a result, the Fed will be forced to finance any fiscal response through an ever-expanding quantitative easing program. It is the only way for the banks to get the cash needed to finance such a fiscal stimulus. All roads lead back to the Fed and endless QE.

This is the new normal and there is nothing sustainable about it. It is also not a reality we have to accept. There is a better way. As the world looks on, amidst the fear and panic, it often seems that there is no alternative. It is unclear when so many began to view the

government's role as one of fighting global pandemics (rather than the free market) but that is the world for which so many seem to aggressively demand. It is a symptom of failing to understand the root problem. It is misdiagnosing the fallout of a global pandemic and falsely believing the only hope is to allocate money created out of thin air by central banks and governments. It is predictably irrational. There is no reason even a few-month, complete economic shutdown should put the world on the brink of a global depression. Instead, it is the output of an inherently fragile financial system, one dependent on perpetual credit expansion necessary to sustain itself and without which it would begin to collapse. It is the fragility of the global financial system itself that is the problem, not a global pandemic. Do not be fooled. This isn't a pandemic induced failure of the financial system. This was a 100% eventuality, pandemic or not. If not for its heavy dependence on credit and an unsustainable degree of leverage, the world would not be waking up to the S&P 500 futures locked limit down with seeming regularity.

And the economic dependence on credit as well as the high degree of system leverage are not a natural function of either capitalism or a free market. This market setup is a function of central banks everywhere. The instability is not by design but the market structure is. In response to every economic slow down (or crisis) which has appeared over the last four decades, central banks (including the Fed) have responded by increasing the money supply and reducing interest rates, such that existing debt levels could be sustained and such that more credit could be created. Every time the system as a whole attempted to deleverage, central banks worked to prevent it through monetary stimulus, ultimately kicking the can down the road and allowing decades of economic imbalance to accumulate in the credit system. This is the root cause of the inherent fragility in the financial system (see here). And it is why each time an economic disruption surfaces, the monetary response from central banks need be larger and more extreme. With greater imbalance comes the need for a bigger boat.

In doing so, the entire system is pushed further and further out onto the same ledge. The terminal risk to the system (the stability of the underlying currency) becomes greater and greater. Everyone is unwittingly forced to be along for this most unnerving of rides, but for those paying attention to the real game that is being played, bitcoin is increasingly becoming the clearest path to opt out of the insanity. Simplified down to the least common denominator, quantitative easing is a forced debasement (or devaluation) of monetary savings. It distorts every pricing mechanism within an economy and its intended goal is the expansion of credit. When history books are written of this pre-bitcoin era, the failure to understand the consequence of distorting global pricing mechanisms will be identified as the source of all other critically flawed assumptions in modern central banking doctrine. There is no escaping it. You can only hope to manage the fallout. But where don't-tread-on-me meets the come-and-take-it mentality, freedom loving Americans of all the world and of all walks of life are beginning to say enough is enough. There has to be a better way because there always is.

That is core to the very idea of hope and the very nature of human ingenuity. It is an unwillingness to accept the new normal as a fait accompli. If quantitative easing can be simplified down to a debasement of monetary savings; bitcoin can be simplified down to the freedom to convert value into a form of currency that cannot be manipulated. In *the Road to Serfdom*, Hayek describes the function of money most aptly: "It would be much truer to say that money is one of the greatest instruments of freedom ever invented by man." As he

goes on to further explain, it is money that ultimately affords people a range of choice far greater than could otherwise be imaginable. It does so by distributing knowledge through its pricing mechanism, the single most important market signal (in aggregate) which facilitates economic coordination and the allocation of resources. However, as the freedoms afforded by one monetary medium become impaired, it should be no surprise that human ingenuity would find a way to route around and spawn a new creation that performs that same function more effectively. That is bitcoin and there is no going back. The proverbial cat is out of the bag and the distribution of knowledge is naturally exponential.

The promise of bitcoin is a more stable monetary system. There are no promises of what its value will be on any given day; the only assurance it provides is that its supply is not subject to manipulation or systematic debasement by a central bank (or anyone else). There is the seemingly constant question as to whether bitcoin is a "safe-haven" and more recently, why bitcoin has become correlated to the broader (collapsing) financial markets. The simple reality is that bitcoin is not a safe-haven, at least not as commonly defined in the mainstream. It is not held widely enough for it to possibly be a safe-haven. It remains nascent and it is perfectly predictable that at the onset of a global deleveraging event, a liquid asset would be sold along with everything else.

> *However, what remains true is that bitcoin is the antifragile competitor to the inherently fragile financial system.*

In his book under the same name, Nassim Taleb describes antifragility as not just robust or resilient, but as the opposite of fragile. Antifragile systems actually gain strength and feed on volatility. The recent volatility in bitcoin is likely just the beginning but what it really represents is uninterrupted and unceasing price discovery. There are no circuit breakers in bitcoin and there are no bailouts. Each individual participant is maximally accountable and it is a market

devoid of moral hazard. When the dust settles, what does not kill bitcoin only makes it stronger. In a literal sense. It is surviving and thriving in the wild, without any central coordination. It is not for the faint of heart, but it is the land of the free and the home of the brave. When it survives, there will still only be 21 million bitcoin, and its very survival will reinforce its place in the world. Increasingly, with each monetary stimulus injected into the legacy financial system, bitcoin's core value function will become more apparent and more intuitive to more people. It will not just be by chance; it will be so because of the stark contrast bitcoin provides. Even with all its volatility, it is laying the foundation of a more stable monetary system.

Bitcoin Price Chart (Source: Coinbase Pro Exchange, 6 hour intervals)

Because the supply of bitcoin cannot be manipulated, its price and its supply of credit will similarly and forever be unmanipulable. Both will be determined on the market. As a result, the size of the bitcoin credit system will never sustain otherwise unsustainable imbalances. Beyond the nature of its fixed supply, this is where the contrast lies in practical application. The accumulation of sustained credit system imbalances (induced by central banks) is the inherent source of fragility in the global economy today. In a market built on the foundation of a currency that cannot be manipulated, as soon as imbalances arise, economic forces will naturally course correct, preventing the system-wide and systemic credit risk that plagues the legacy financial system. Rather than impair the future by allowing

imbalances to accumulate beneath the surface, the unmanipulable supply of bitcoin will act as a governor to stamp out fires as soon as they appear. The fragile individual components of the system will be sacrificed and the system as a whole will become more antifragile by that very function.

For Joe Squawk (your modern-day average joe), it was Facebook's Libra that made bitcoin more intuitive. For others, it is hyperinflation in Venezuela. And now for many, it will increasingly become the incessant reality that financial crises and QE are a recurring fact of life. No matter how many cycles of quantitative easing the Fed and its global counterparts have in their bag of tricks, bitcoin is inevitably becoming a rallying cry for all those that see the train wreck coming and are unwilling to stand idly by. It is not just a collective act of civil disobedience; it is an individual recognition of the need to act in self-preservation. There is a point in time for most everyone when common sense and survival instinct naturally take the reins. The avenue may be different for each individual, but at the end of the day, bitcoin is a means to preserve some form of freedom that is otherwise being impaired or infringed. Whether governments attempt to ban bitcoin or it is mistakenly blamed for the failures of the legacy system, always remember the simplicity of what bitcoin represents. It is nothing more than the individual freedom to convert real world value into a form of money that cannot be manipulated. It is a most basic and fundamental freedom but one that must be earned. So to all Americans in the world, stay humble, stack sats, and hold the damn line. Whatever it takes.

"The enemy has demanded a surrender […] I have answered the demand with a cannon shot"
– Lt. Colonel William B. Travis (February 24, 1836)
Link to Full Travis Letter

BITCOIN IS COMMON SENSE - MAY 1, 2020

> *"Perhaps the sentiments contained in the following pages, are not yet sufficiently fashionable to procure them general favor; a long habit of not thinking a thing wrong, gives it a superficial appearance of being right, and raises at first a formidable outcry in defense of custom. But the tumult soon subsides. Time makes more converts than reason." – Thomas Paine, Common Sense (February 24, 1776).*

These were the opening remarks of Thomas Paine's call for American independence in early 1776. At the time, a declaration of independence was far from a certainty, but in Paine's view, there was no question. It wasn't a debate; there was only one path forward. Still, he understood that public opinion had not yet caught up and naturally remained anchored to the status quo, with a preference for reconciliation rather than independence. Old habits die hard. The status quo has a tendency of being defended, regardless of merit, merely by its anchoring in time to the way things have always been. However, truths have a way of becoming self-evident in time, more often due to common sense rather than any amount of reason or logic. One day, the truth is more likely to smack you in the face, becoming painfully obvious through some firsthand experience which opens up a perspective that otherwise would not have existed. While Paine was undoubtedly attempting to persuade an undecided populous with reason and logic, it was at the same time an appeal to not overthink that which stands in opposition to what is already self-evident.

In Paine's view, independence was not a modern-day IQ test, nor was its relevance confined to the American colonies; instead, it was a common sense test and its interest was universal to "the cause of all mankind," as Paine put it. In many ways, the same is true of bitcoin. It is not an IQ test; instead, bitcoin is common sense and its implications are near universal. Few people have ever stopped to question or

understand the function of money. It facilitates practically every transaction anyone has ever made, yet no one really knows the why of that equation, nor the properties that allow money to effectively coordinate economic activity. Its function is taken for granted, and as a result, it is a subject not widely taught or explored. Yet despite a limited baseline of knowledge, there is often a visceral reaction to the very idea of bitcoin as money. The default position is predictably no. Bitcoin is an anathema to all notions of existing custom. On the surface, it is entirely inconsistent with what folks know money to be. For most, money is just money because it always has been. In general, for any individual, the construction of money is anchored in time and it is very naturally not questioned.

But enter bitcoin, and everyone suddenly becomes an expert in what is and isn't money, and to the fly-by-night expert, it certainly is not bitcoin. Bitcoin is natively digital, it is not tied to a government or central bank, it is volatile and perceived to be "slow," it is not used en masse to facilitate commerce, and it is not inflationary. This is one of those rare instances when a thing does not walk like a duck or quack like a duck but it's actually a duck, and what you thought was a duck all along was mistakenly something entirely different. When it comes to modern money, *the long habit of not thinking a thing wrong, gives it a superficial appearance of being right*.

In all perceived-to-be successful applications today, money is issued by a central bank; it is relatively stable and capable of near infinite transaction throughput; it facilitates day-to-day commerce; and by the grace of god, its supply can be rapidly inflated to meet the needs of an ever-changing economy. Bitcoin has none of these traits (some not presently, others not ever), and as a result, it is most often dismissed as not meeting the standards of modern-day money. This is where overthinking a problem can cripple the highest of IQs. Pattern recognition fails because the game fundamentally changed, but the players do not yet realize it. It is akin to getting lost in the weeds or failing to see the forest through the trees. Bitcoin is finitely scarce, it is highly divisible and it is capable of being sent over a

communication channel (and on a permissionless basis). There will only ever be 21 million bitcoin. Rocket scientists and the most revered investors of our time could look at this equation relative to other applications in the market and be confounded, not seeing its value. While at the same time, if posed with a very simple question, would you rather be paid either in a currency with a fixed supply that cannot be manipulated or in a currency that is subject to persistent, systemic and significant debasement, an overwhelming majority of individuals would choose the former all day, every day.

> On bitcoin: "It's probably rat poison squared"
> – Warren Buffett

> "Bitcoin – there's even less you can do with it […] I'd rather have bananas, I can eat bananas" – Mark Cuban

Money Doesn't Grow On Trees

As kids, we all learn that *money doesn't grow on trees* but on a societal level, or as a country, any remnant of common sense seems to have left the building. Just in the last two months, central banks in the United States, Europe and Japan (the Fed, ECB and BOJ) have collectively inflated the supply of their respective currencies by $3.3 trillion in aggregate – an increase of over 20% in just eight weeks. The Fed alone has accounted for the majority, minting $2.5 trillion dollars and increasing the base money supply by over 60%. And it's far from over; trillions more will be created. It is not a possibility; it is a certainty. Common sense is that deep feeling of uncertainty many are experiencing that says, "this doesn't make any sense" or "this doesn't end well." Few carry that thought process out to its logical conclusion, often because it is uncomfortable to think about, but it is reverberating throughout the country and the world. While not everyone is connecting the equation to 21 million bitcoin, a growing number of people are. Time makes more converts than reason. Individuals don't have to understand how or why there will only ever be 21 million bitcoin; all that has to be recognized in practical experience is that dollars are going to be worth significantly less in

the future, and then the idea of having a currency with a fixed supply begins to make sense. Understanding how it is possible that bitcoin has a fixed supply comes after making that initial connection, but even still, no one needs to understand the how to understand that it is valuable. It is the light bulb turning on.

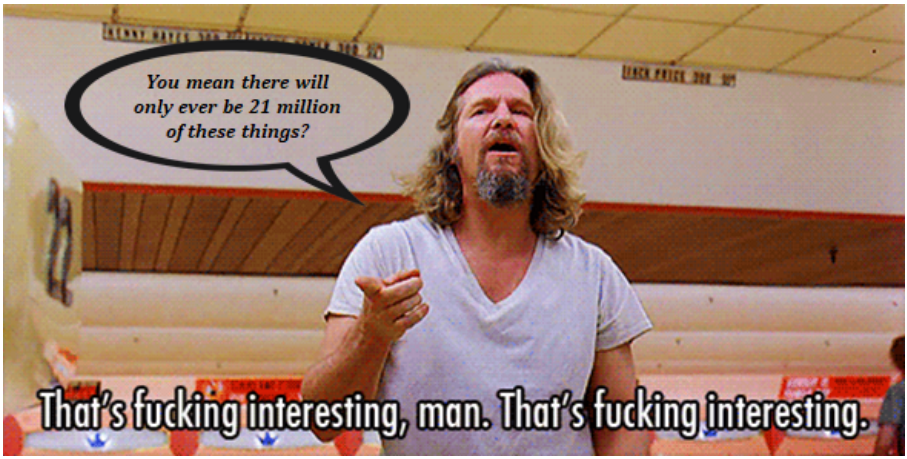
For each individual, there is a choice to either exist in a world in which someone gets to produce new units of money for free (but just not them) or a world where no one gets to do that (including them). From an individual perspective, there is not a marginal difference in those two worlds; it is night and day, and anyone conscious of the decision very intuitively opts for the latter, recognizing that the former is neither sustainable, nor to his or her advantage. Imagine there were 100 individuals in an economy, each with different skills. All have determined to use a common form of money to facilitate trade in exchange for goods and services produced by others. With the one exception that a single individual has a superpower to print money, requiring no investment of time and at practically no cost. Given human time is an inherently scarce resource and that it is a required input in the production of any good or service demanded in trade, such a scenario would mean that one person would get to purchase the output of all the others for free. Why would anyone agree to such an arrangement? That the individual is an enterprise, and more specifically, a central bank expected to act in the public interest does not change the fundamental operation. If it does not make sense on a micro level, it does not magically transform into a different fundamental fact merely because there are greater degrees of separation. If no individual would bestow that power in another, neither would a conscious decision be made to bestow it in a central bank.

Everything beyond this fundamental reality strays into abstract theory, relying on leaps of faith, hypotheticals and big words that no one understands, all while divorced from individual decision points. It is not that one individual is more trusted than another or one central bank relative to another; it is simply that, on an individual level, no individual is advantaged by someone else having the ability to print money, regardless of identity or interests. That this is true leaves only one alternative, that each individual would be advantaged by ensuring that no other individual or entity has this power. The Fed may have the ability to create dollars at zero cost, but money still doesn't grow on trees. It is more likely that a particular form of money is not actually money than it is that money miraculously started growing on trees. And at an individual level, everyone is incentivized to ensure that is not the case. While there is a long habit of not thinking this particular thing wrong, the errant defense of custom can only stray so far. Time converts everyone back into reality. At present, it is the Fed's "shock and awe" campaign contrasted by the simplicity in bitcoin's fixed supply of 21 million. There is no amount of reason that can replace an observed divergence in two distinct paths.

Defending Existing Custom

"There's money and there's credit. The only thing that matters is spending and you can spend money and you can spend credit. And when credit goes down, you better put money into the system so you can have the same level of spending. That's what they did through the financial system (referencing QE in response to the past crisis) and that thing worked." – Ray Dalio, CNBC September 19, 2017

Basic Bitcoin Common Sense



There is No Such Thing as a Free Lunch

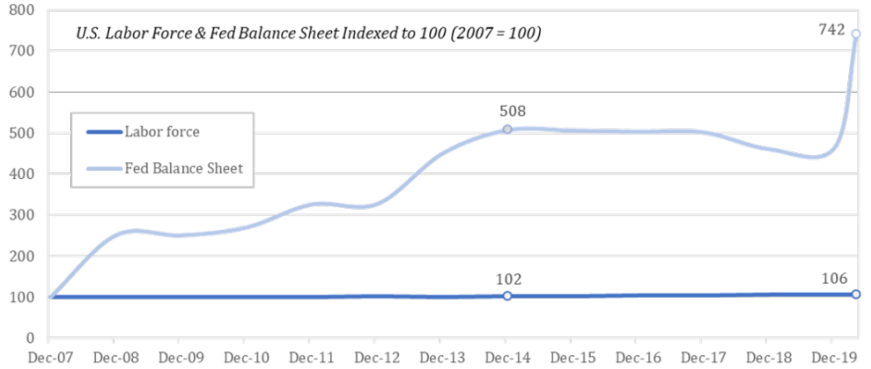
As more people become aware of the Fed's activities, it only begins to raise more questions. $2,500,000,000,000 is a big number, but what is actually happening? Who gets the money? What will the effects be and when? What are the consequences? Why is this even possible? How does it make any sense? All very valid questions, but none of these questions change the fact that many more dollars exist and that each dollar will be worth materially less in the future. That is intuitive. However, at an even more fundamental level, recognize that the operation of printing money (or creating digital dollars) does nothing to generate economic activity. To really simplify it, imagine a printing press just running on a loop. Or, imagine keying in an amount of dollars on a computer (which is technically all that the Fed does when it creates "money"). That very operation can definitionally do nothing to produce anything of value in the real world. Instead, that action can only induce an individual to take some other action.

Recognize that any tangible good or service produced is produced by some individual. Human time is the input, capital production is the output. Whether it is software applications, manufacturing equipment, a service or an end consumer good, all along the value chain, an

individual contributed time to produce some good or service. That time and value is ultimately what money tracks and prices. Entering a large number into the computer does not produce software, hardware, cars or homes. People produce those things and money coordinates the preferences of all individuals within an economy, compensating value to varying degrees for time spent.

When the Fed creates $2.5 trillion in a matter of weeks, it is consolidating the power to price and value human time. Seems cryptic but it is not a suggestion that the individuals at the Fed are consciously or deliberately operating maliciously. It is just the root level consequence of the Fed's actions, even if well intentioned. Again, the Fed's operation (arbitrarily adding zeros to various bank account balances) cannot actually generate economic activity; all it can do is determine how to allocate new dollars. By doing so, it is advantaging some individual, enterprise or segment of the economy over another. In allocating new dollars that it creates, it is replacing a market function, one priced by billions of people, with a centralized function, greatly influencing the balance of power as to who controls the monetary capital that coordinates economic activity. Think about the distribution of money as the balance of control influencing and ultimately determining what gets built, by whom and at what price. At the moment of creation, there exists more money but there exists no more human time or goods and services as a consequence of that action. Similarly, over time, the Fed's actions do not create more jobs, there are just more dollars to distribute across the labor force, but with a different distribution of those holding the currency. The Fed can print money (technically, create digital dollars), but it can't print time nor can it do anything but artificially manipulate the allocation of resources within an economy.

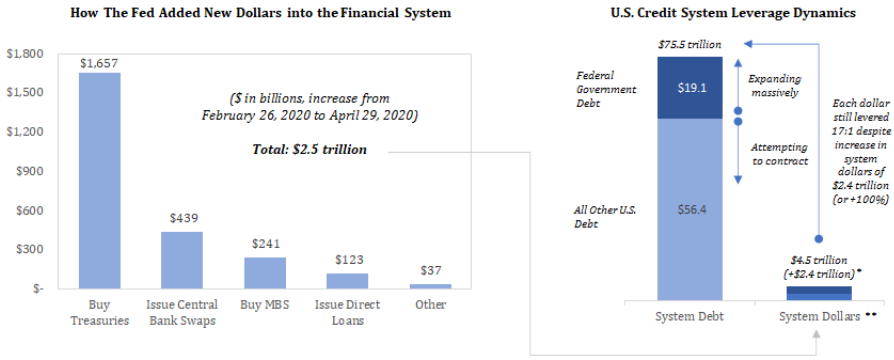
No Free Lunches, Just More Dollars



Since 2007, the Fed balance sheet has increased seven-fold, but the labor force has only increased 6%. There are roughly the same number of people contributing output (human time) but far more dollars to compensate for that time. Do not be confused by impossible-to-quantify theory concerning the idea of a job saved versus a job lost; this is the U.S. labor force, defined by the Bureau of Labor Statistics as all persons 16 years of age and older, both employed and unemployed. The inevitable result is that the value of each dollar declines, but it does not create more workers, and all prices do not adjust ratably to the increase in the money supply, including the price of labor.

In a theoretical world, if the Fed were to distribute the money in equal proportion to each individual that held the currency previously, it would not shift the balance of power. In practical application, the distribution of ownership shifts dramatically, heavily favoring the holders of financial assets (which is what the Fed buys in the process of creating new dollars) as well as those with cheap access to credit (the government, large corporations, high net-worth individuals, etc.). In aggregate, the purchasing power of every dollar declines, just not immediately, while a small subset benefits at the cost of the whole (see the Cantillon Effect). Despite the consequences, the Fed takes these actions in an attempt to support a credit system that would

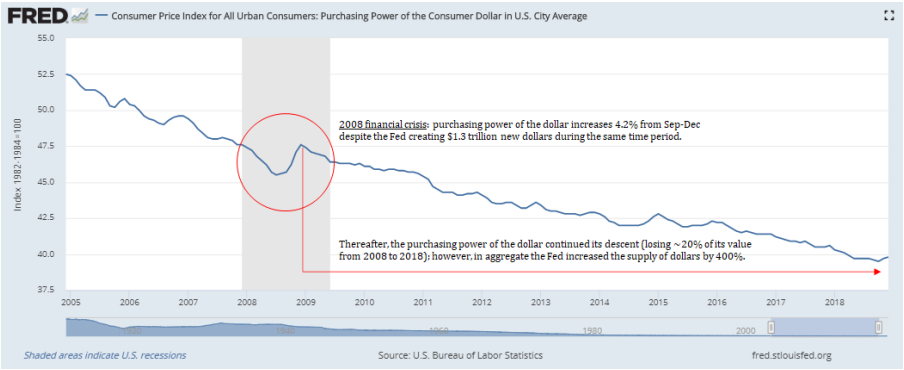
otherwise collapse without the supply of more dollars. In the Fed's economy, the credit system is the price setting mechanism as the amount of dollar-denominated debt far outstrips the supply of dollars, which is also why the purchasing power of each dollar does not immediately respond to the increase in the money supply.

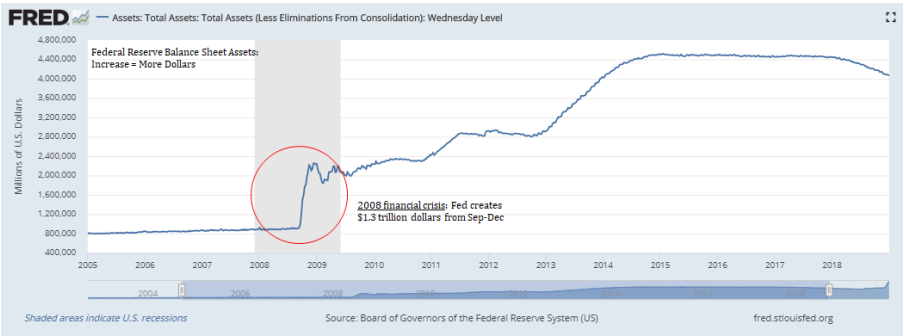


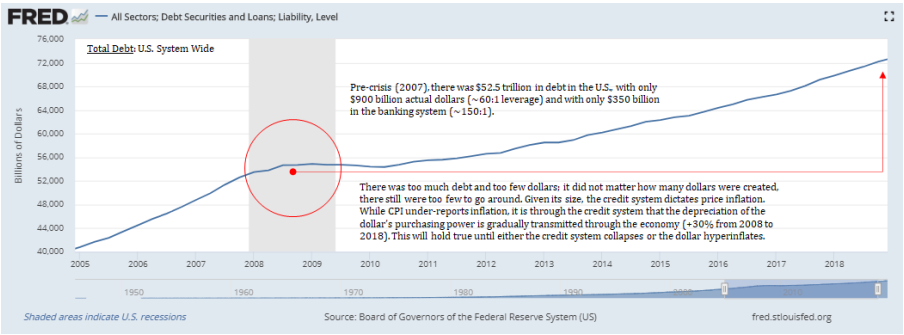
* Difference of ~$100 billion relative to $2.5 trillion dollars created reflects net physical currency withdrawals which have left the banking system.
**System dollars defined as dollars in the banking system, dollars held by the Treasury and dollars held by Foreign institutions; excludes physical currency in circulation as these are dollars that exist outside the banking system and are generally not available to satisfy banking system liabilities (dollar denominated debt).

Instead, the effects of increasing the money supply are transmitted, over time, through an expansion of the credit system. The credit system attempting to contract is the market and the individuals within an economy adjusting and re-pricing value; the Fed attempting to reverse that natural course by flooding the market with dollars is, by definition, overriding the market's price setting function, fundamentally altering the structure of the economy. The market solution to the problem is to reduce debt (expression of preference) and the Fed's solution is to increase the supply of dollars such that existing debt levels can be sustained. The goal is to stabilize the credit system such that it can then expand, and it is a redux to the 2008 financial crisis, which provides a historical roadmap. In the immediate aftermath of the prior crisis, the Fed created $1.3 trillion new dollars in a matter of months. Despite this, the dollar initially strengthened as deflationary pressures in the credit system overwhelmed the increase in the money supply, but then, as the credit system began to expand, the dollar's purchasing power resumed its gradual decline. At present,

the cause and effect of the Fed's monetary stimulus is principally transmitted through the credit system. It was the case in the years following the 2008 crisis, and it will hold true this time so long as the credit system remains intact.

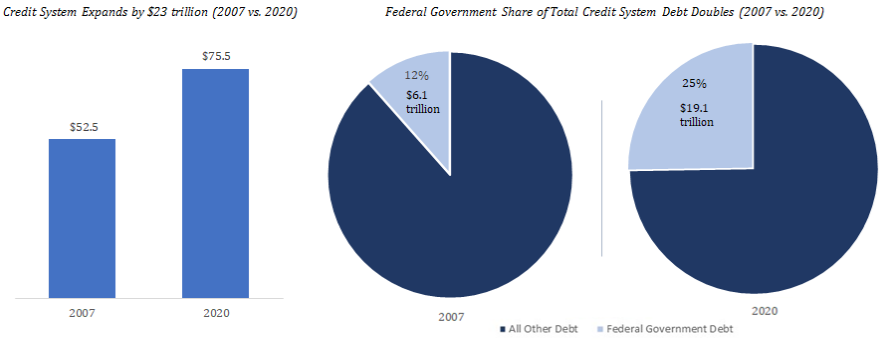






How the effects manifest in the real economy is very complicated, but it does not take any sophistication to recognize the general direction of the end game or its foundational flaws. More dollars result in each dollar becoming worth less, and the value of any good naturally trends toward its cost to produce. The marginal cost for the Fed to produce a dollar is zero. With all the bailouts from both the Fed and Congress, whether to individuals or companies, someone is paying for everything. It is axiomatic that *printing money (or creating digital dollars) does nothing to generate economic activity*; it only shifts the balance of powers as to who allocates the money and prices risk. It strips power from the people and centralizes it to the government. It also fundamentally impairs the economy's ability to function as it distorts prices everywhere. But most importantly, it puts the stability of the underlying currency at risk, which is the cost that everyone collectively pays. The Fed may be able to create dollars for free and the Treasury may be able to borrow at near-zero interest rates as a direct result, but there is still no such thing as a free lunch. Someone still has to do the work, and all printing money does is shift who has the dollars to coordinate and price that work.

> *"The emitting of paper money by the authority of Government is wisely prohibited by the individual States, by the national constitution; and the spirit of that prohibition ought not be disregarded by the Government of the United States. Though paper emissions, under a general authority, might have some advantages not applicable, and be free from some disadvantages which are applicable to the like emissions by the States, separately, yet they are of a nature so liable to abuse – and it may even be affirmed, so certain of being abused – that the wisdom of the Government will be shown in never trusting itself with the use of so seducing and dangerous an expedient. In times of tranquility, it might have no ill consequences; it might even be managed in a way to be productive of good; but, in great and trying emergencies, there is almost a moral certainty of its becoming mischievous. The stamping of paper is an operation so much easier than the laying of taxes, that a government, in the practice of paper emissions, would rarely fail, in any such emergency, to indulge itself too far in the employment of that resource, to avoid, as much as possible, one less auspicious to present popularity. If it should not even be carried so far to be rendered an absolute bubble, it would at least be likely to be extended to a degree which would occasion an inflated and artificial state of things, incompatible with the regular and prosperous course of the political economy. – Alexander Hamilton, The Writings 590-91.*



The Moon is a Harsh Mistress, by Robert Heinlein

"Gospodin," he said presently, "you used an odd word earlier–odd to me, I mean…"

"Oh, tanstaafl. Means there ain't no such thing as a free lunch. And isn't," I added, pointing to a FREE LUNCH sign across room, "or these drinks would cost half as much. Was reminding her that anything free costs twice as much in long run or turns out worthless."

"An interesting philosophy."

"Not philosophy, fact. One way or other, what you get, you pay for."

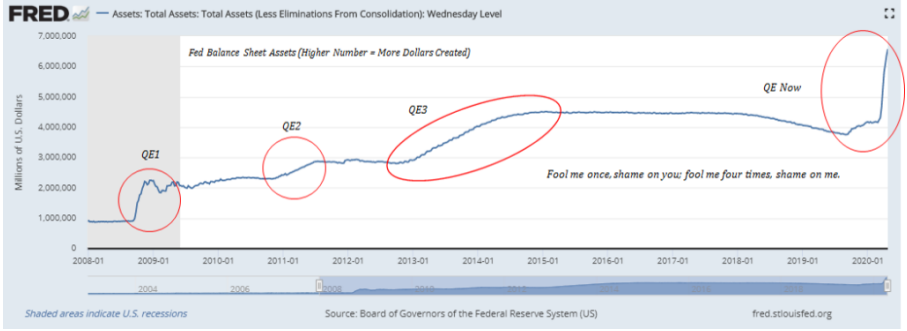
Bitcoin is Common Sense

Among its perceived flaws as a currency, bitcoin is viewed by many to be too complicated to ever achieve widespread adoption. In reality, the dollar is complicated; bitcoin is not. It becomes very simple when abstracted to the least common denominator: 21 million bitcoin; and who controls the money supply: no one. Not the Fed or anyone else. At the end of the day, that is all that matters. Bitcoin is in fact

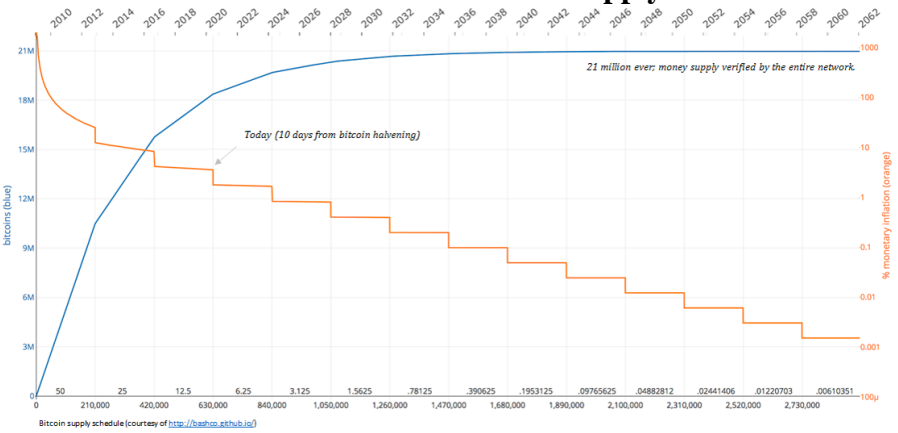
complicated at a technical level. It involves higher level mathematics and cryptography and it relies on a "mining" process that makes very little sense on the surface. There are blocks, nodes, keys, elliptic curves, digital signatures, difficulty adjustments, hashes, nonces, merkle trees, addresses and more.

But with all this, bitcoin is very simple. If the supply of bitcoin remains fixed at 21 million, more people will demand it and its purchasing power will increase; there is nothing about the complexity underneath the hood that will prevent adoption. Most participants in the dollar economy, even the most sophisticated, have no practical understanding of the dollar system at a technical level. Not only is the dollar system far more complex than bitcoin, it is far less transparent. Similar degrees of complexity and many of the same primitives that exist in bitcoin underly an iPhone, yet individuals manage to successfully use the application without understanding how it actually works at a technical level. The same is true of bitcoin; the innovation in bitcoin is that it achieved finite digital scarcity, while being easy to divide and transfer. 21 million bitcoin ever, period. That compared to $2.5 trillion new dollars created in two months, by one central bank, is the only common sense application anyone really needs to know.

Exhibit A – Dollar Supply



Plus Exhibit B – Bitcoin Supply



Equals Exhibit C – Purchasing Power of Bitcoin Relative to Dollars

There is a lot happening in the background, but these three charts are what drives everything. People all over the world are connecting these dots. The Fed is creating trillions of dollars at the same time the rate of issuance in bitcoin is about to be cut in half (see the bitcoin halvening). While most may not be aware of these two divergent paths, a growing number are (knowledge distributes with time) and even a small number of people figuring it out ultimately puts a significant imbalance between the demand for bitcoin and its supply.

When this happens, the value of bitcoin goes up. It is that simple and that is what draws everyone else in: price. Price is what communicates information. All those otherwise not paying attention react to price signals. The underlying demand is ultimately dictated by fundamentals (even if speculation exists), but the majority do not need to understand those fundamentals to recognize that the market is sending a signal.

Once that signal is communicated, then it becomes clear that bitcoin is easy. Download an app, link a bank account, buy bitcoin. Get a piece of hardware, hardware generates address, send money to address. No one can take it from you and no one can print more. In that moment, bitcoin becomes far more intuitive. Seems complicated from the periphery, but it is that easy, and anyone with common sense and something to lose will figure it out; the benefit is so great and money is such a basic necessity that the bar on a relative basis only gets lower and lower in time. Self-preservation is the only motivation necessary; it ultimately breaks down any barriers that otherwise exist.

The stable foundation that underpins everything is a fixed supply which cannot be forged, capable of being secured without any counterparty risk and resistant to censorship and seizure. With that bedrock, it does not require a lot of imagination to see how bitcoin evolves from a volatile novelty into a stable economic juggernaut. A hard-capped monetary supply versus endless debasement; a currency that becomes exponentially more expensive to produce compared to a currency whose cost to produce is anchored forever at zero by its very nature. At the end of the day, a currency whose supply (and derivatively its price system) cannot be manipulated. Fundamental demand for bitcoin begins and ends at this singular cross-section. One by one, people wake up and recognize that a bill of goods has been sold, always by some far away expert and never reconciling with day-to-day economic reality.

With bitcoin as a backdrop, it becomes self-evident that there is no advantage either in ceding the power to print money or in allowing a

central bank to allocate resources within an economy, and in the stead of the people themselves that make up that economy. As each domino falls, bitcoin adoption grows. As a function of that adoption, bitcoin will transition from volatile, clunky and novel to stable, seamless and ubiquitous. But the entire transition will be dictated by value, and value is derived from the foundation that there will only ever be 21 million bitcoin. It is impossible to predict exactly how bitcoin will evolve because most of the minds that will contribute to that future are not yet even thinking about bitcoin. As bitcoin captures more mindshare, its capabilities will expand exponentially beyond the span of resources that currently exist. But those resources will come at the direct expense of the legacy system. It is ultimately a competition between two monetary systems and the paths could not be more divergent.

Bananas grow on trees. Money does not, and bitcoin is the force that reawakens everyone to the reality that was always the case. Similarly, there is no such thing as a free lunch. Everything is being paid for by someone. When governments and central banks can no longer create money out of thin air, it will become crystal clear that backdoor monetary inflation was always just a ruse to allocate resources for which no one was actually willing to be taxed. In common sense, there is no question. There may be debate but bitcoin is the inevitable path forward. Time makes more converts than reason.

> *"You can fool all the people some of the time, and some of the people all the time, but you cannot fool all the people all the time."*
> *– Abraham Lincoln*

> *"These proceedings may at first seem strange and difficult, but like all other steps which we have already passed over, will in a little time become familiar and agreeable: and until an independance is declared, the Continent will feel itself like a man who continues putting off some unpleasant business from day to day,*

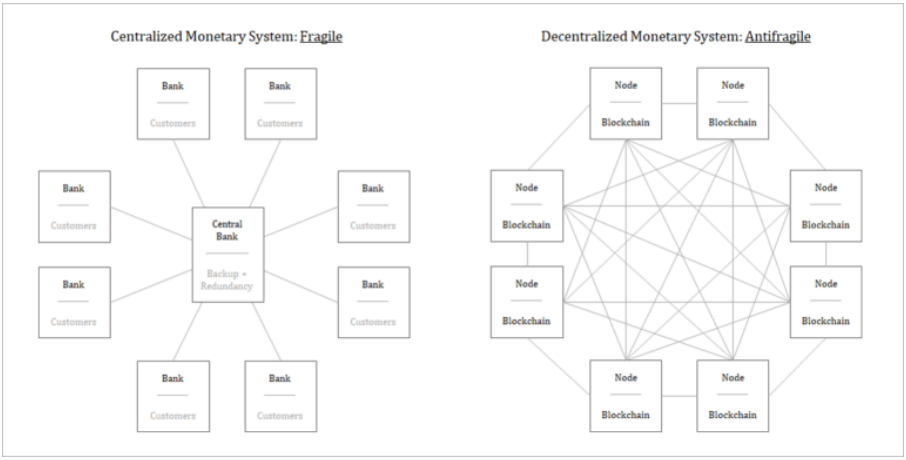
yet knows it must be done, hates to set about it, wishes it over, and is continually haunted with the thoughts of its necessity." – Thomas Paine, Common Sense

BITCOIN IS ANTIFRAGILE - JUNE 12, 2020

If one thing is certain, it is that bitcoin is humbling. It humbles everyone. Some sooner than others, but everyone eventually. Individuals you respect may have called bitcoin a fraud or compared it to rat poison but if it hasn't been walked back yet, it will in time. For most everyone first considering bitcoin, the reality is that the proper context to evaluate it is practically non-existent, even for the most revered financiers of our time. Is bitcoin like a stock, bond, tech startup, the internet or merely a figment of everyone's imagination? At first glance, bitcoin admittedly makes very little sense. It is very reasonably believed by many to be one massive collective hallucination. There exist two fundamental problems. Almost everyone lacks the baseline to evaluate bitcoin because there has never been anything like it, and very few, prior to bitcoin, have ever consciously considered what money is. Every day, people evaluate whether to invest in stocks, bonds or real estate, or whether or not to buy a home or car, or whether to purchase some consumer good, or conversely, whether to save. While there are exceptions to every rule, practically everyone is unequipped to evaluate bitcoin because it does not fit any prior mental framework. It is like asking someone with no concept of mathematics what 2 + 2 equals. It may be obvious to those that know math, but if not, it's unrelatable. To make it even more difficult, bitcoin is so abstract an application and so far from a tangible phenomenon, that it is like staring into the abyss. Bitcoin is both difficult to see and impossible to unsee once discovered. But often the path from one end of the extreme to the other is a journey, where the impossible first becomes possible, then probable and ultimately inevitable.

Eventually, some chord is struck or some dot connected. As the fog begins to lift, there naturally remains the idea that, while bitcoin is possible, it is surely subject to high degrees of chance and more likely to fail than succeed. It is perceived to be inherently fragile and risky. Many believe that bitcoin could vanish as quickly as it appeared on

scene. At the beginning of the journey, it seems to live somewhere between an aspiring long-shot and just one unidentified silver bullet away from complete and utter collapse. Bitcoin is novel and it is often thought of as untested and unproven. Launched in 2009, bitcoin seemingly lacks permanence. It is not yet anchored in time. But on the other hand, bitcoin has been around for going on twelve years and has a total purchasing power (or value) of $180 billion. Twelve years of operating history and hundreds of billions in value may still be an upstart, but it is far from untested and unproven. Instead, it is thriving in the wild without any central coordination, and it is the lack of central coordination that gives bitcoin its lifeblood; decentralization not only allows bitcoin to function, but it is also what causes it to gain strength rather than falter when stressed.

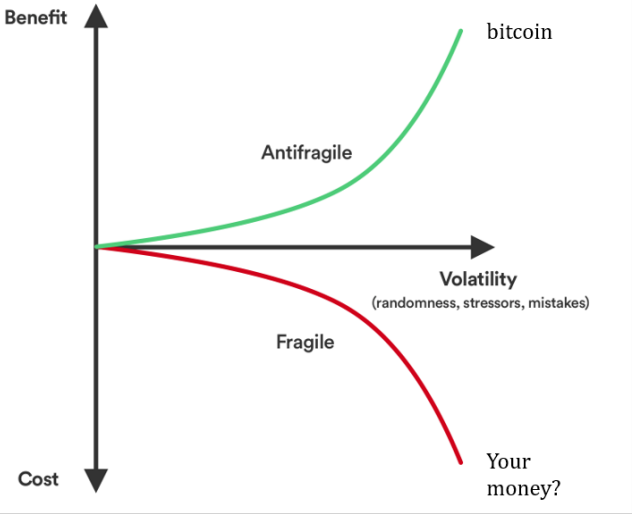


That bitcoin is natively digital and powered by computers running software capable of being shut down lends to the default impression that bitcoin is inherently fragile. The mental image of a computer network being unplugged creates the false sense that one day and suddenly, somehow bitcoin as a system could cease to exist when the opposite is true for the very same reason. That bitcoin both exists everywhere and nowhere, that it is controlled by no one, that anyone is capable of running the open source software from anywhere, and

that hundreds of thousands of people do, relied upon by tens of millions (and growing) is what gives bitcoin permanence. With no single point of failure, bitcoin is practically impossible to stop because it is impossible to control, and it is a dynamic system that only becomes more redundant and further decentralized in time and with increasing adoption. In short, bitcoin is more permanent than risky because it is an antifragile system. An idea popularized by Nassim Taleb, antifragility describes systems or phenomena that gain strength from disorder, which is bitcoin to its core. There is no silver-bullet that kills bitcoin; there is no competitor that can magically overtake it; there is no government that can shut it down. But it does not stop there; each attack vector and shock to the system actually causes bitcoin to become stronger.

> *"Some things benefit from shocks; they thrive and grow when exposed to volatility, randomness, disorder, and stressors and love adventure, risk, and uncertainty. Yet, in spite of the ubiquity of the phenomenon, there is no word for the exact opposite of fragile. Let us call it antifragile. Antifragility is beyond resilience or robustness. The resilient resists shocks and stays the same; the antifragile gets better. This property is behind everything that has changed with time: evolution, culture, ideas, revolutions, political systems, technological innovation, cultural and economic success, corporate survival, good recipes (say, chicken soup or steak tartare with a drop of cognac), the rise of cities, cultures, legal systems, equatorial forests, bacterial resistance … even our own existence as a species on this planet. And antifragility determines the boundary between what is living and organic (or complex), say, the human body, and what is inert, say, a physical object like the stapler on your desk. […] The antifragile loves randomness and uncertainty, which also means—crucially—a love of errors, a certain class of errors."* – Nassim Taleb, Antifragile

Bitcoin is an adaptive and evolving system; it is not static. No one controls the network and there are no leaders capable of forcing changes onto the network. It is decentralized at every layer, and as a result, it has shown to be immune to any type of attack. However, it is not just immune to attack or errors, bitcoin actually becomes stronger as: i) external forces attempt to influence or coopt the network; ii) as individuals within the network make errors; and, iii) as a very function of its volatility, which is often perceived to be a limiting, if not critical, flaw. As bitcoin survives shocks and as individuals learn from errors and adapt to its volatility, bitcoin becomes tangibly more reliable; its demonstration of resilience and immunity causes trust to be reinforced in the network, which increases adoption and makes bitcoin more resistant to future attack or individual errors. It is a positive, self-reinforcing feedback loop. With every failed attempt to coopt or coerce the network, the bitcoin protocol hardens and confidence increases. Every time bitcoin doesn't die, that very event propels bitcoin forward, and in a fundamentally stronger state than previously existed.



Each exogenous shock to the network provides learnings that cause bitcoin to adapt in a spontaneous way, which can only be endemic to a decentralized system.

Because bitcoin is decentralized and because it becomes increasingly decentralized as a function of time (and adoption), not only is there no

single point of failure, but the increasing levels of redundancy ensure network survival and fortify it against future attacks. There is a positive correlation between time and the degree of network decentralization. Similarly, there is a positive correlation between the degree of decentralization and the network's ability to fend off more formidable attacks. Essentially, as the network becomes more decentralized over time, it also becomes resistant to threats it may not have been capable of surviving in prior states.

Separately, each error within the system is isolated to the responsible parties, and as bitcoin grows, each potential point of failure becomes less critical to the proper functioning of the network as a whole. Weak points in the network are sacrificed and the system strengthens in aggregate. The entire process is made more effective and efficient because it is never a conscious decision. It is simply structural to the system architecture. No one picks winners and losers. Decentralization eliminates moral hazard and ensures system survival at the same time. At all times, network participants are maximally accountable for their own errors. There are no bailouts. Incentives and accountability optimize for innovation and naturally drive toward consistently better outcomes in aggregate. It doesn't eliminate error, but it ensures that errors are productive, as the mere fact of survival affords that the network as a whole has the opportunity to adapt to threats and to immunize around them. Whether borne from exogenous shocks or internal errors, bitcoin feeds on disorder, stressors, volatility and randomness, collectively a hallmark of an antifragile system.

Bitcoin Benefits from Disorder

The lack of social order in bitcoin may be its single greatest asset. There is no CEO of bitcoin nor is there a centralized authority that controls it. There is no person or organization to drag in front of Congress, whether to answer questions or demand action. In fact, there is no Congress or legislative body with any influence over bitcoin, preferential or otherwise. It does not mean that any individual or company is immune from influence; nor does it prevent any country from attempting to regulate (or ban) bitcoin, but disorder

insulates the network from external threats. While Facebook's Libra is fundamentally plagued as a currency for reasons independent of government influence, the CEO and other top executives were quickly brought before Congress soon after its announcement to answer questions and with key legislators demanding the project be delayed, if not scrapped, over concerns of "national security" and other regulatory issues. It is not that CEOs and companies cannot coexist with government; instead, it is that the mere existence creates influence that could never exist in bitcoin at a protocol level, and the absence of which allows bitcoin to be viable as a currency.

> *"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." – Satoshi Nakamoto (February 11th, 2009)*

With no central counterparties controlling the network, bitcoin functions on a decentralized basis and in a state that eliminates the need for, and dependence on, trust. Its distributed architecture reduces the network's attack surface by eliminating central points of failure that would otherwise expose the system to critical risk. By being built on a foundation of social disorder and only in the absence of control is bitcoin able to function on a secure basis. It is the precise opposite

of the trust-based central bank model. Bitcoin is a monetary system built on a market consensus mechanism, rather than centralized control. There are certain consensus rules that govern the network. Each participant opts in voluntarily and everyone can independently verify (and enforce) that the rules are being followed. If any market participant changes a rule that is inconsistent with the rest of the network, that participant falls out of consensus. The network consensus rules ultimately define what is and what is not a bitcoin, and because each participant is capable of enforcing the rules independently, it is the aggregate function of enforcement on a decentralized basis that ensures there will only ever be 21 million bitcoin. By eliminating trust in centralized counterparties, all network participants are able to rely upon and ultimately trust that the monetary policy is secure and that it will not be subject to arbitrary change. It may seem like a paradox but it is perfectly rational. The system is trusted because it is trustless and it would not be trustless without high degrees of social disorder. Ultimately, a spontaneous order emerges out of disorder and strengthens as each exogenous system shock is absorbed.

For example, in 2017, there was a civil war of sorts that emerged in bitcoin. Many of the largest companies that provide bitcoin custody and exchange services aligned with large bitcoin miners that controlled 85%+ of the network's mining capacity (or hash rate) in an attempt to force a change to the consensus rules. This group of power brokers wanted to double the bitcoin block size as a means to increase the network's transaction capacity. However, an increase to the block size would have required a change to the network consensus rules, which would have split (or hard-forked) the network. As part of a negotiated "agreement," the group proposed to activate a significant network upgrade (referred to as Segwit – an upgrade that would not change the consensus rules) at the same time the block size would be doubled (which would have changed the consensus rules). With most all large service providers and miners onboard, plans were set in motion to effect the changes. However, a curve ball was thrown when a user-led effort prompted the activation of the Segwit network

upgrade without changing the network consensus rules and without increasing the block size (read more here). The effort to change the network's consensus rules failed miserably and bitcoin steadily marched forward undisturbed. In practice, it often cannot be known whether bitcoin is resistant to various threats until the threats present themselves. In this case, it was disorder that prevented coordinated forces from influencing the network, and at the same time, everyone learned the extent to which bitcoin was resistant to censorship, which further strengthened the network.

Before Segwit2x Failure – Industry Executive

Editors Note: This is not criticism of Ted Rogers, but rather a recognition of leadership in articulating a perspective that changed following the Segwit2x hard-fork fail, helping to educate others.

After Segwit2x Failure – Industry Executive

This episode in bitcoin's history demonstrated that no one was in control of the network. Not even the most powerful companies and miners, practically all aligned, could change bitcoin. It was an incontrovertible demonstration of the network's resistance to censorship. It may have seemed like an inconsequential change. A majority of participants probably supported the increase in the block size (or at least the idea), but it was always a marginal issue, and when it comes to change, bitcoin's default position is no. Only an overwhelming majority of all participants (naturally with competing priorities) can change the network's consensus rules. And it really was never a debate about block size or transaction capacity. What was at stake was whether or not bitcoin was sufficiently decentralized to prevent external and powerful forces from influencing the network and changing the consensus rules. See, it's a slippery slope. If bitcoin were susceptible to change by the dictate of a few centralized companies and miners, it would have established that bitcoin were

censorable. And if bitcoin were censorable, then all bets would be off. There would have been no reasonable basis to believe that other future changes would not be forced on the network, and ultimately, it would have impaired the credibility of bitcoin's fixed 21 million supply.

That the most powerful players in bitcoin could not influence the network reinforced its viability, and it was only possible because of the disorder inherent to the system itself. It was impossible to collude or to coopt the network because of decentralization. And it did not just show bitcoin to be resilient, the failure itself made the network stronger. It educated the entire network on the importance of censorship resistance and demonstrated just how uncensorable bitcoin had become. It also informs future behavior as the economic costs and consequences are both real and permanent. Resources to support the effort turned into sunk costs, reputations were damaged, and costly trades were made. All said, confidence in bitcoin increased as a function of the failed attempts to control the network, and confidence is not just a passive descriptor. It dissuades future attempts to coopt the network and drives adoption. Increasing adoption further decentralizes the network, making it even more resistant to censorship and outside influence. It may seem like chaos, but really, social disorder was and will continue to be an asset that secures the network from unpredictable and undesired change.

Bitcoin Benefits from Stressors

Attempts to influence the network consensus rules may be the most acute stressor, as it is these rules that underpin the entire system and create order out of disorder, but bitcoin is consistently exposed to a myriad of smaller stressors that similarly strengthen the network as a whole and over time. There are many different forms of stress, but because bitcoin is exposed to stress on a consistent basis and of a wide variety, it forces the network to constantly adapt and evolve while also building its immune system from the outside in.

Type of Stressor	Example	Impact / Outcome
Consensus Rules	– Segwit2x Civil War – Bitcoin Cash Hard-Fork	– Bitcoin proves to be censorship resistant – Bitcoin wins, strengthens
Government action	– Indian central bank banning banks ability to service bitcoin companies – China clamping down on exchanges and mining activities – U.S. Congress representatives calling for bans or restrictions – Bitcoin addresses being put on OFAC list	– Network continues to function uninterrupted – Network adapts and immunizes threat – Bitcoin wins, strengthens
Competing protocols	– Bitcoin hard forks and copies – World Computer – Utility Tokens – Stablecoins – Facebook's Libra	– Competing currencies fail – Bitcoin remains dominant – Market tests provide information – Bitcoin wins, strengthens
Company or service provider error	– Mt. Gox hack – stolen bitcoin – Bitfinex hack – stolen bitcoin – Binance hack – stolen bitcoin – BlockFi hack – stolen personal information – Hardware wallet vulnerabilities	– Errors owned by responsible parties – No bailouts – Accountability eliminates moral hazard – Companies adapt or fail – Bitcoin wins, strengthens
Individual user error	– Individual exchange accounts getting hacked – Accounts being frozen or terminated – SIM Swaps – Bitcoin wallets being lost or stolen – Forgetting passphrases to private keys – Malicious browser extensions or malware	– Errors owned by responsible parties – No bailouts – Accountability eliminates moral hazard – Individuals adapt or lose money – Bitcoin wins, strengthens

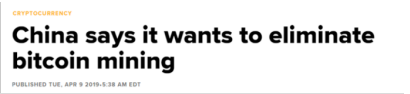
Each form of stress hardens the bitcoin network and often for different reasons. Whenever governments take action in an attempt to ban bitcoin or otherwise restrict its use, the network continues to

function unperturbed. China and India, countries with a combined population of 2.7 billion people, have both taken material actions to curb the spread of bitcoin. Despite this, the network as a whole continues to function without flaw, and bitcoin continues to be used in both countries. After the RBI (Central Bank of India) restricted the ability for banks to service bitcoin or cryptocurrency-related companies, the Supreme Court in India ultimately overturned the ban as unconstitutional. It sets precedent in more ways than one. First, that the central bank was overruled; second, that the ban was ultimately unsuccessful as people continued to find ways to access bitcoin; and third, that despite these actions, the network was unphased. Separately, China has taken measures to restrict the ability of exchanges to facilitate bitcoin trading and has expressed an interest in eliminating bitcoin mining. Similar to India, people continue to use bitcoin in China and the bitcoin network has been undeterred. Naturally, as government regulation in China has become more restrictive, miners have begun to look to more stable jurisdictions. Bitcoin mining in the United States (among other regions) continues to grow, and Peter Thiel recently backed a startup that is building out mining operations in West Texas. Regardless of the threat, bitcoin exists beyond countries (and governments). The network adapts to jurisdictional risks and continues to function without interruption. As network participants observe the failed attempts to inhibit bitcoin's growth and witness how it adapts, bitcoin does not merely remain static; it actually becomes more resilient through this process by routing around and immunizing each passing threat.


Cryptocurrencies

Cryptocurrency Virtually Outlawed in India as Top Court Backs Ban

By Upmanyu Trivedi and Rahul Satija
July 3, 2018, 4:10 AM CDT *Updated on July 3, 2018, 5:55 AM CDT*


CRYPTOCURRENCY

China says it wants to eliminate bitcoin mining

PUBLISHED TUE, APR 9 2019-5:38 AM EDT


Technology

Cryptocurrency Bourses Win India Case Against Central Bank Curbs

By Upmanyu Trivedi
March 3, 2020, 11:27 PM CST *Updated on March 4, 2020, 1:41 AM CST*

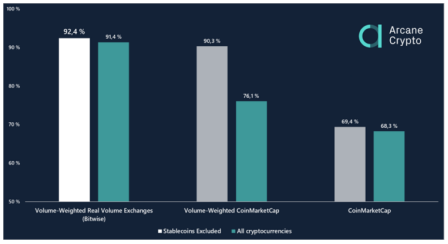
- RBI had barred banking services from using digital currencies
- Supreme court ruling on Wednesday struck down the RBI's curbs


THE LEDGER • BITCOIN MINING

Texas Bitcoin Mining Startup Gets $50 Million From Peter Thiel to Steal China's Crypto Crown

BY JEFF JOHN ROBERTS
October 15, 2019 7:52 AM CDT

An entirely different type of stress comes in the form of competing cryptocurrencies. Since bitcoin was launched in 2009, there have been no fewer than a thousand competing digital currencies. While often (but not always) espousing different purposes and "use cases," in each instance, every single one has in reality been competing with bitcoin as money. In many cases, the creators do in fact call out perceived flaws in bitcoin and how a particular competing protocol intends to improve on its "limitations". Despite thousands of competitors, bitcoin accounts for ~70% of all cryptocurrencies in terms of market value, and when adjusted for liquidity, the estimate is closer to ~90%. Whereas one currency accounts for 70% to 90% of value depending on the metric, thousands of competing cryptocurrencies account for 10% to 30%. That is the market distinguishing between bitcoin and the field. Competition is inherently good for bitcoin. Not only does each attempt to create a better bitcoin fail, the repeated failures actually inform market participants that there is something which distinguishes bitcoin from the rest of the field. Even if the what or why is not immediately self-evident, the market provides useful information. Bitcoin does not just withstand the competition; it beats the competition. While bitcoin cannot be copied, that fact is more easily learned through market functions and market tests than any amount of reason and logic. Through the failed experiences of competing currencies, bitcoin accumulates more human capital, and the network grows as a direct result. If bitcoin were never tested or challenged, it would not have the opportunity to benefit from stress. That it is constantly challenged and stressed through competition creates a more resilient network and a larger holder base.



Insight. News

Bitcoin's reported market dominance is approaching 70%, but in reality it is above 90%

An analysis by Arcane Research shows how the real market dominance of bitcoin is way higher than what is traditionally reported.

While stress exposed to the network from external threats creates positive externalities, bitcoin also benefits from more regular and consistent stressors from within the network, typically arising in the form of malicious attacks or unintentional error. Attacks aimed at participants within the network, whether companies or individuals, occur practically at a constant clip. Each participant is maximally and independently responsible for the security of their bitcoin holdings, whether choosing to trust a third-party or whether taking on that responsibility directly. Many of the largest exchanges in the world have been hacked as have many individuals within the network. For those that have not, the threat always exists. As participants are compromised, hacked or otherwise have access to bitcoin restricted, it does not impact the functioning of the network, but like all stressors, the attack vectors directly cause the network to adapt and become stronger.

With numerous critical exchange failures, market participants increasingly shift to taking on the responsibility of holding their own bitcoin, independent from third-party service providers. The same is true in response to individual accounts at exchanges getting hacked. Not dissimilarly, as threats are identified for those that secure their own bitcoin, more secure wallets are developed and users opt toward more secure ways to safely secure their bitcoin by reducing or eliminating single points of failure. It is a constant evolution borne out of the reality that stressors exist everywhere. The network is not exposed to any critical failures because the entire network iterates through trial and error around the clock, with free competition and endless market opportunity incentivizing innovation. And, with each failure, everyone is on their own and personally accountable. The incentive structure dictates that everyone constantly seeks out better ways of securing bitcoin. Through this process of stress, the network very naturally and organically strengthens.

Bitcoin Benefits from Volatility

Similar to the benefit provided by consistent stressors, volatility tangibly builds the immunity of the system. While it is often lamented as a critical flaw, volatility is really a feature and not a bug. Volatility is price discovery and in bitcoin, it is unceasing and uninterrupted. There are no Fed market operations to rescue investors, nor are there circuit breakers. Everyone is individually responsible for managing volatility and if caught offsides, no one is there to offer bailouts. Because there are no bailouts, moral hazard is eliminated network-wide. Bitcoin may be volatile, but in a world without bailouts, the market function of price discovery is far more true because it cannot be directly manipulated by external forces. It is akin to a child touching a hot stove; that mistake will likely not be made more than once, and it is through experience that market participants quickly learn how unforgiving the volatility can be. And, should the lesson not be learned, the individual is sacrificed for the benefit of the whole. There is no “too big to fail” in bitcoin. Ultimately, price communicates information and all market participants observe the

market forces independently, each adapting or individually paying the price.

But information is not just communicated through price volatility. Volatility is also how bitcoin gets distributed and how the network becomes further decentralized. Every time a bitcoin is sold, someone else is buying. Consistently over time, the ownership of the network becomes more decentralized, and this occurs most acutely in bouts of volatility. In very tangible ways, the volatility strengthens bitcoin by decentralizing it and reinforcing that while tulips may die, bitcoin never does. As the network becomes more decentralized, it similarly becomes more censorship resistant and each individual within the network holds a smaller and smaller share of the currency (on average) resulting in a dynamic in which, over time, price is less exposed to the preferences of a few large holders. It is not to say that there do not remain large holders that can singularly influence price and volatility, but as a directional trend, the impact of any individual on price diminishes over time and often directly through the distributive function of volatility itself.

And when network participants, individually and as a whole, observe that bitcoin survives, even after extreme downside volatility, that mere fact strengthens confidence in the network. At some price, individuals were willing to step in and catch the falling knife. Through these episodes, bitcoin accumulates more human capital. The weak hands are shaken out and the strongest hands always survive (often in the form of new holders), causing the network to become more resilient and not merely remaining static or simply absorbing the

disruption. Bitcoin actually feeds on the chaos. In the end, near-term volatility directly contributes to long-term stability. By maintaining a fixed supply with highly variable present demand, the market performs price discovery 24 hours a day, 7 days a week. It is the intermittent stress that trains and hardens all individual owners and which prevents the network from being exposed to systemic risk. All while the opposite is true of fiat currencies. Central banks manage currencies to maintain short-term stability but ultimately, by suppressing volatility, imbalances accumulate below the surface leading to fragility and greater systemic shocks in the long-term, as has been witnessed with increasing regularity over the last two decades. The contrast between the two competing systems could not be more extreme and it is volatility in bitcoin that communicates information with the least distortion, and without which long-term stability would not be possible.

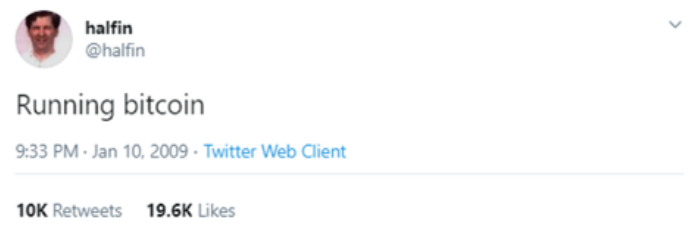
> *"Complex systems that have artificially suppressed volatility tend to become extremely fragile, while at the same time exhibiting no visible risks […] Such environments eventually experience massive blowups, catching everyone off-guard and undoing years of stability"*
>
> *"Variation is information. When there is no variation, there is no information […] there is no freedom without noise—and no stability without volatility." – Taleb & Blythe, Foreign Affairs, May/June 2011 Issue*

Bitcoin Benefits from Randomness

> *"Many of the greatest things man has achieved are the result not of consciously directed thought, and still less the product of a deliberately coordinated effort of many individuals, but of a process in which the individual plays a part which he can never fully understand. They are greater than any individual precisely because they result from the combination of*

knowledge more extensive than a single mind can master." – Hayek, The Counter-Revolution of Science

Lastly, randomness. While most people recognize that there is intelligent design in bitcoin's foundation, what is often missed is the randomness through which it evolved and that what it became (money) was largely a function of that randomness. Lightning was caught in a bottle; it was a result of thousands of people making thousands of independent decisions very early on. But the process also continues to this day. From cryptographers and developers contributing time and energy, to companies and investors building infrastructure, and to users just wanting to find a better way to store value. If the reset button was hit going all the way back to 2008 when the bitcoin white paper was released, and the same initial code was released, placing the same people in the same rooms, bitcoin would very likely not be what it is today. It may be "better" or "worse," but ultimately it was and continues to be a product of randomness. It is not the product of consciously directed thought, and it expands beyond the resources of individual minds because of that fact. For those that perceive flaws in bitcoin and have (or had) ideas of how to make a better bitcoin, the intelligence of bitcoin's design is often observed and acknowledged. Design can be copied and individual features can be changed out, but randomness cannot be replicated.



One week after bitcoin was launched, Hal Finney famously tweeted to the world that he was "running bitcoin." In 2011, Ross Ulbricht was alleged to have launched the Silk Road website which ultimately leveraged bitcoin to facilitate online payments for drugs, establishing one of the earliest

widespread uses of bitcoin in commerce and undoubtedly playing a material role in the expansion of early adoption and awareness. In 2014, Mt. Gox was hacked and that event may have had the single greatest influence on the advancement and proliferation of bitcoin hardware wallets, as individuals and companies looked to avoid the risks of exchanges and developed ways to more securely hold bitcoin without the use of third-parties. In 2017, after a bitcoin service provider drew the ire of Nicolas Dorier, he set out to build a product that would obsolete that provider and service, spawning one of the most exciting open source projects within bitcoin, BTCPay Server. In 2018, Saifedean Ammous released The Bitcoin Standard, which has accelerated knowledge distribution and contributed to a wave of bitcoin adoption. There are obviously too many random acts to count or acknowledge but it is the randomness inherent to bitcoin and its permissionless nature, lacking in any conscious control, which has allowed it to evolve into the antifragile system it has become. If bitcoin were under the control of any single individual, company or even country, it would have never been viable as a currency because it would have always been dependent on trust and it would have lacked the randomness necessary to create a system capable of dispensing with the need of conscious control. Randomness is irreplicable and the foundation of bitcoin was built on it.

Bitcoin is Antifragile

In aggregate, as a currency and economic system, bitcoin benefits from disorder. It is the constant exposure to stressors, volatility and randomness which causes bitcoin to evolve, adapt and ultimately to become stronger in near-uniform fashion and in a way that would not

be possible in the absence of disorder. Bitcoin may still be young, but it is not temporary. It was released into the wild, and what has spawned is a system that cannot be controlled or shut down. It's both everywhere and nowhere, all at the same time. It is like an elusive ghost. Its decentralized and permissionless state eliminates single points of failure and drives innovation, ultimately ensuring both its survival and a constant strengthening of its immune system as a function of time, trial and error. Bitcoin is beyond resilient. The resilient resists shocks and stays the same; bitcoin gets better. While it is easy to fall into a trap, believing bitcoin to be untested, unproven and not permanent, it is precisely the opposite. Bitcoin has been constantly tested for going on 12 years, each time proving to be up to the challenge and emerging from each test in a stronger state. At the end of the day, bitcoin is more permanent than it is risky because of antifragility. As a currency system, it manages to extend the utilization of resources beyond the control of deliberately coordinated effort, entirely dispensing with the need of conscious control all together. Bitcoin is the antifragile competitor to the inherently fragile legacy monetary system. On the one hand, a legacy system crippled by moral hazard, dependent on trust and centralized control. One that accumulates imbalance and fragility when exposed to stress and disorder, principally as a function of trillions in bailouts with each passing shock, which only further weakens its immune system. That compared to bitcoin which is a system devoid of moral hazard and which operates flawlessly on a decentralized basis, without trust and without bailouts. It eliminates imbalance and sources of fragility as a constant process, further strengthening the currency system as a whole and as a function of time. What doesn't kill the legacy monetary system only makes it weaker. What doesn't kill bitcoin only makes it stronger.

> *"Antifragility is beyond resilience or robustness. The resilient resists shocks and stays the same; the antifragile gets better." – Nassim Taleb, Antifragile*

“But those who clamor for “conscious direction”—and who cannot believe that anything which has evolved without design (and even without our understanding it) should solve problems which we should not be able to solve consciously—should remember this: The problem is precisely how to extend the span of our utilization of resources beyond the span of the control of any one mind; and therefore, how to dispense with the need of conscious control, and how to provide inducements which will make the individuals do the desirable things without anyone having to tell them what to do.” – Hayek, The Use of Knowledge in Society.

APPENDIX: ENDERS GAME

For context, the following research piece was written just before the Fed began to unwind its balance sheet (October 2017) and it hasn't been revised or altered since. At the time, I had set out to better understand the financial crisis and the impact of quantitative easing (QE) in an effort to then forecast what to reasonably expect when the Fed began to subsequently unwind QE. I was working independently at the time and crafted the ending to be a recommendation for traditional macro investors of how best to hedge based on my research.

I have not updated the paper since but my fundamental views also have not changed. Separately, I believe there is value in it being a static piece; anyone reading today has the benefit of more history and knowledge than I had based on the subsequent 18-24 months from the time of writing. During this period, the Fed pursued an initial unwind of its balance sheet only to signal a reversal in March 2019. I generally have a dislike for research that constantly shifts the narrative to fit new data points which often results in revisionist history and also why I have chosen to leave this piece static, though I will write on the subject as part of a new weekly series that I just began to publish (Gradually, Then Suddenly).

We'll see if my views stand the test of time; I don't believe I will be right on everything but on the core thesis, I think I'm on track. I make the point in the paper that the Fed would shift course more quickly than most people think (or thought) but if I could re-write the ending, I'd incorporate bitcoin because really, where this story ends, bitcoin begins. One of the takeaways and principal conclusions that can be drawn is that future QE (by the Fed and globally) is a certainty and that's really why bitcoin exists.

I recently appeared on Marty Bent's Tales from the Crypt podcast and we discussed this piece which I had previously shared with him

privately. Many listeners requested to read it which is why I'm only now making it public. It took me a few months but I finally got around to it. Despite being written in the Fall of 2017, it remains very topical both as the President actively jawbones Chairman Powell concerning the Fed's balance sheet policy and as the Fed figures out what to do about its Catch 22. I hope it provides readers with a better understanding of the financial crisis, the operations of the Fed, the impact of QE and what comes next.

ENDERS GAME

THE STORY OF THE LAST AND NEXT DOLLAR CRISIS

Understanding the fundamental impacts of quantitative easing and the Fed's psychology (including its limitations, deficiencies and inconsistencies) serves as a guide to what the Fed's next moves will be and what the impact will be on financial markets. A black swan event is difficult to predict but often rationalized in hindsight as being more predictable than it actually was. Subprime was so obvious in hindsight. Not dissimilarly, the Fed digitally created $3.6 trillion dollars, which increased the dollar value of financial assets and allowed for a significant expansion of the U.S. credit system (25% net increase from pre-crisis to today). It will seem obvious in hindsight that when the Fed begins to remove that $3.6 trillion of "temporary" accommodation, the value of financial assets will fall (reverse order of operations) and the instability of the credit system will reappear, far quicker than the market expects. The risk is misunderstood and mispriced.

The following pages explain these risks and why the market believes this time is different. The analysis begins with a more in-depth review of relevant historical periods, beginning with the period known as the Great Moderation, continuing with an assessment of the current economic landscape and concluding with a recommendation of how best to protect wealth.

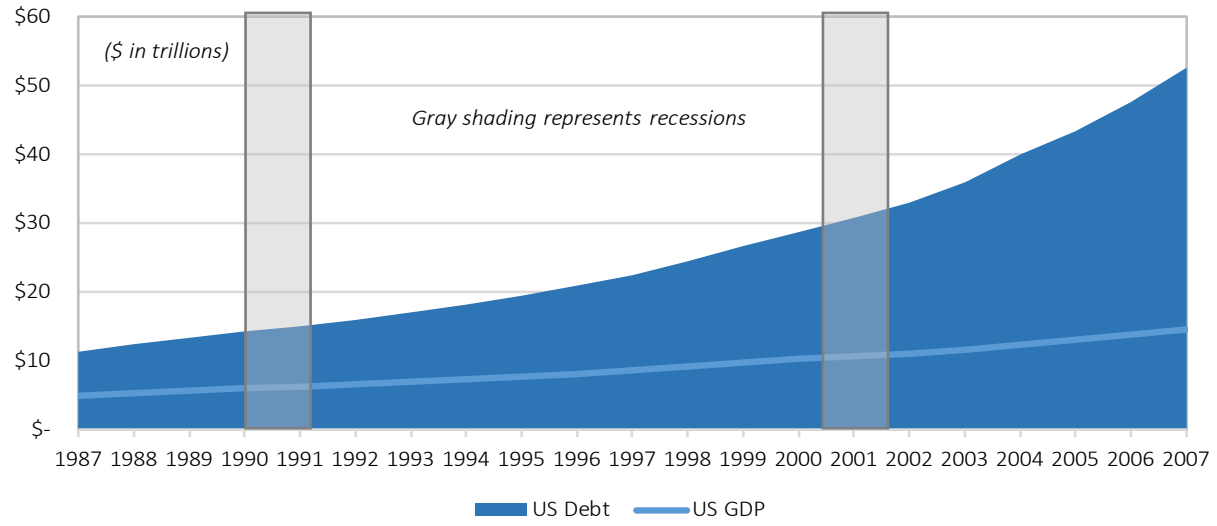
White Paper Table of Contents:

Authored in October 2017

THE LEAD UP TO THE GREAT FINANCIAL CRISIS OF 2008

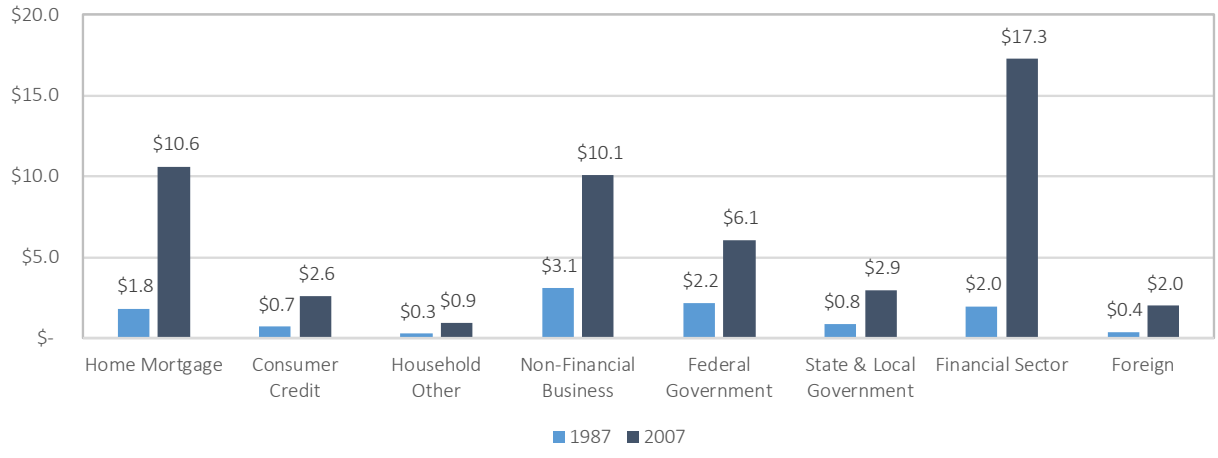
In the two decades leading up to the Great Financial Crisis, total debt in the United States nearly quintupled, increasing from $11.2 trillion in 1987 to $52.5 trillion in 2007. Over the same period, nominal GDP significantly lagged the massive credit expansion (despite still tripling), resulting in system-wide debt to GDP increasing from 230% in 1987 to 360% in 2007.

FIGURE 1. *U.S. System Wide Debt (Shaded Area) vs. Nominal GDP (Line) – 1987-2007*
U.S. Dollars in Trillions, Source: Federal Reserve data



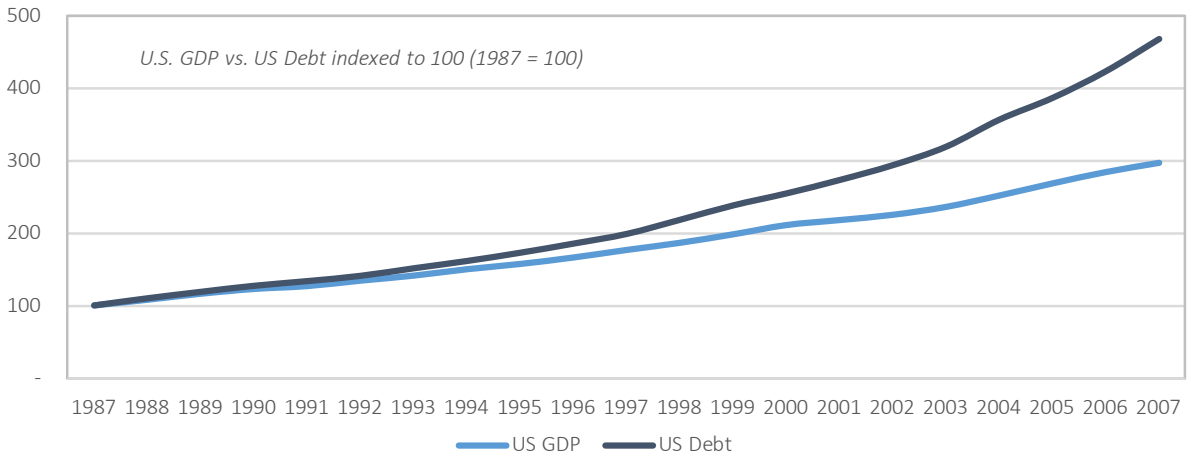
While the credit expansion was broad-based, it was primarily fueled by households (specifically home mortgages) and the financial sector. Debt for these segments outpaced the overall average with household home mortgages and financial sector debt increasing by factors of 5.8x and 8.8x from 1987 to 2007, respectively, compared to the net increase system-wide of 4.7x.

FIGURE 2. *Debt by Economic Sector: Home Mortgage & Financial Sector Debt Outpace, 1987 vs. 2007*
U.S. Dollars in Trillions, Source: Federal Reserve data



Despite recessions in the early 1990s and the early 2000s, the credit-fueled expansion persisted without any net deleveraging. During this period, the credit creation was largely non-productive, on average, with less than 20% being driven by the non-financial business sector. Diminishing returns were evident as each dollar of credit expansion resulted in a fraction of GDP growth (credit growth outpacing GDP growth).

FIGURE 3. *Diminishing Returns: Growth in Debt (Dark Blue) Outpaces GDP (Light Blue)*
Values Indexed to 100, 1987 = 100, Source: Federal Reserve data

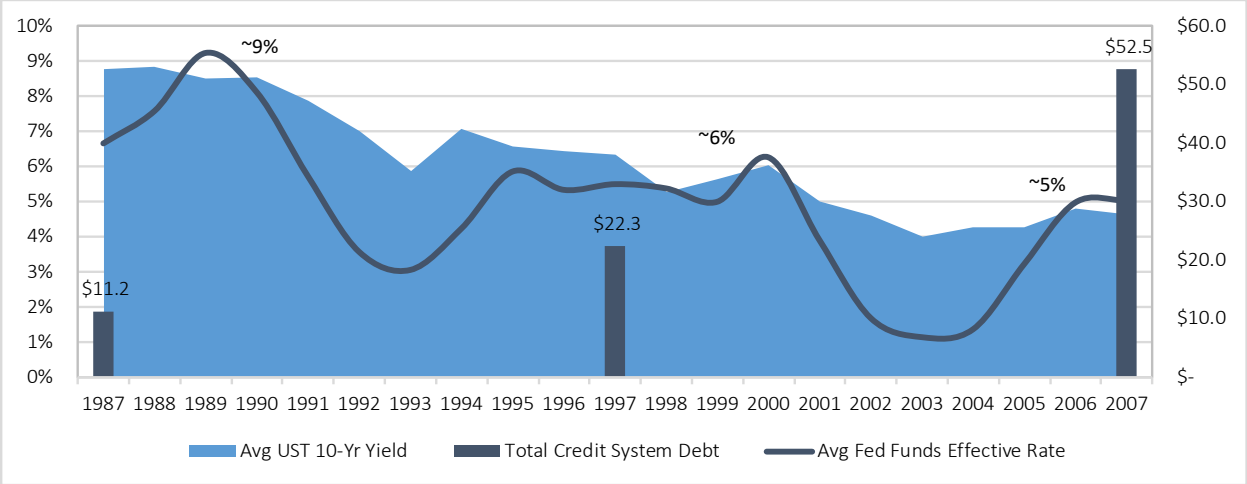


As recessionary business cycles hit the economy, the Fed aggressively lowered interest rates; since the mid-1980s, the Fed has had one policy response: lower interest rates to spur demand. Rather than allowing the credit system to naturally restructure, the Fed has consistently created an environment in which more credit could be created so that the level of existing debt could be sustained. Despite the fact that the credit which the Fed was fueling was producing diminishing returns, the Fed's answer was more (not less) of the same. In each recession between 1987 and 2007, the Fed aggressively reduced short-term policy rates, from 9% to 3% in 1991 and from 6% to 1% in 2001. With each passing cycle, interest rates (Fed funds) never reached the levels prior to the previous lowering cycle. **Because the credit system was now larger and more demand had been pulled forward, a higher maintenance burden could not be sustained.**

Each time the Fed lowered short-term interest rates to stimulate the economy, it effected this policy by increasing the amount of bank reserves (cash) in the system. Increase supply and price should come down; in this case, the Fed increased the supply of dollars and the price of dollars (borrowing rates) came down. The mechanism by which the Fed increased the supply of dollars was, primarily, to purchase U.S. government securities (treasuries). With more liquidity (dollar supply) and tepid economic growth, U.S. treasuries (the global risk-free benchmark) became more attractive on a risk-adjusted basis, driving longer-duration yields lower. Because risk assets are all, to varying degrees, priced off of risk-free rates and because there was an ever-increasing supply of dollars provided by the Fed, the cost of credit was made cheaper across the board, inducing the credit fueled expansion to continue in a broad-based manner.

FIGURE 4. *Volatility Suppression: Lower Interest Rates, More and More Debt*

Interest Rates (Percent, Left-Axis), System-wide Debt ($ in trillions, Right-Axis), Source: Federal Reserve data



The new Fed regime in the 1980s had determined that its price stability mandate was a directive to reverse business cycles, or at least the boom and busts of those cycles. In order to do so, the Fed had one tool: supply more dollars to reduce interest rates to induce credit expansion. Despite the intermittent recessions, nominal GDP did not decline in any individual year during this period on an annual basis, largely a function of the Fed's quick and aggressive responses to lower interest rates.

While prior to 2008 nominal GDP in the U.S. had not declined on a year-over-year basis since 1947 (a period that spanned over 60 years), the period from the mid-1980s to 2007 was different because of the rate at which credit growth outpaced GDP growth. During the significant expansionary period from the 1950s to the 1980s, GDP and credit grew at comparable rates. Something changed in the 1980s and it was largely a function of a shifting Fed doctrine as well as a departure from sound monetary policy. U.S. system-wide debt to GDP remained relatively stable at approximately 1.5x (or 150%) from the mid-1940s to the mid-1980s. During the 1980s, a housing and financial sector fueled credit expansion began a period of two decades which saw system wide debt to GDP increase to nearly 3.5x GDP (or 350%).

FIGURE 5. *Something Changed in the Mid-1980s: Productive or Non-Productive Credit Expansion?*

U.S. System-Wide Debt (Blue Line) vs. U.S. Nominal GDP (Gray Line) Indexed to 1946 = 100, Source: Federal Reserve

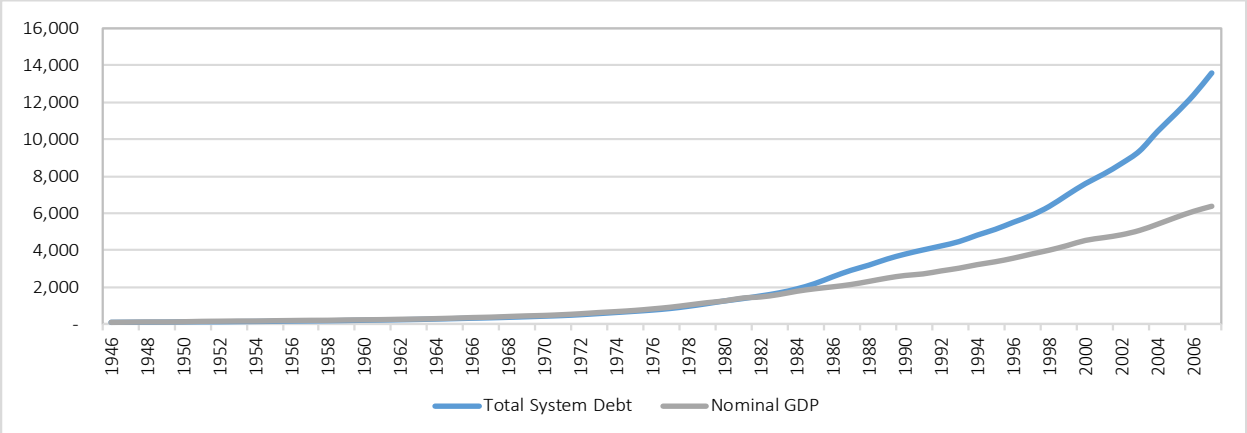
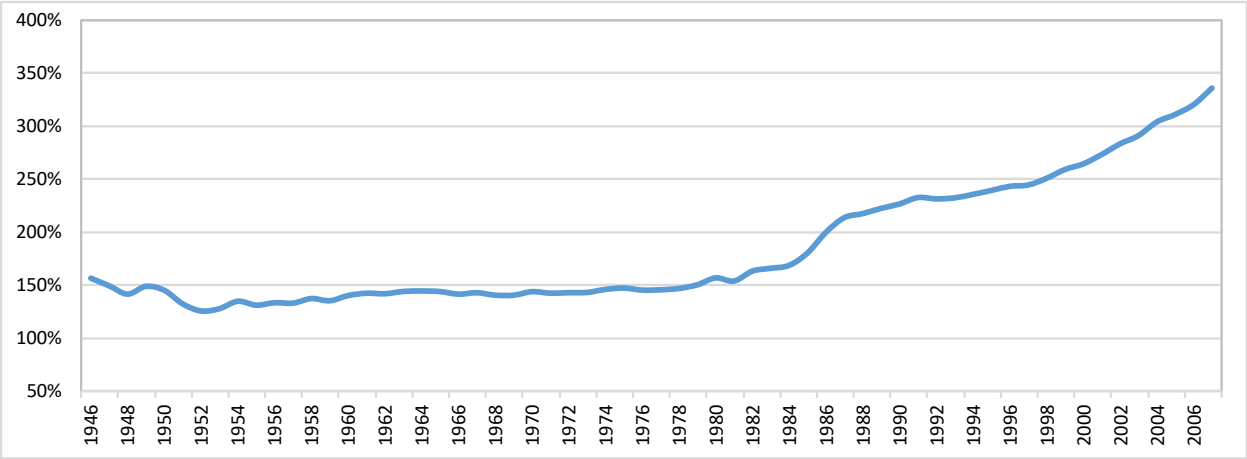


FIGURE 6. *System-wide Debt to GDP Increases from 1.5x in 1980 to Nearly 3.5x in 2007*
Source: Federal Reserve data



Over the past several decades, individual companies and industries have restructured; many companies and even industries have gone away completely as new industries and new companies have emerged. However, the economy as a whole has never been allowed to restructure following periods when the credit system has expanded too quickly. By not allowing smaller, system-wide restructurings, the Fed promoted imbalances, wittingly or unwittingly. Over time, these imbalances grew, on net, and the credit system became even more unsustainable as the underlying economic engine broke down, masked by deficit financed tax cuts, an artificial housing boom and a Fed willing to spike the punch bowl. By 2007, after two recessions and two recoveries, interest rates were 50% lower than 20 years earlier. Because credit growth had significantly outpaced GDP growth, **the only practical way to sustain inflated credit levels was to artificially suppress interest rates; the consequential bi-product of artificially low interest rates: credit-fueled asset bubbles.**

Despite creating an unsustainable environment, the Fed's monetary policy during this period is often credited for sustaining lower volatility. Because of both low inflation volatility and low volatility in output that was experienced, the period came to be known as the Great Moderation. In reality, the Great Moderation was really just the Great Suppression. Central bankers suppressed volatility by progressively lowering interest rates and going back to the well time after time. The Fed believed that more "effective" monetary policy meant creating an environment of lower volatility which supported healthy economic expansion.

Ironically, the Fed's policy to suppress volatility through lower and lower interest rates actually contributed significantly to future volatility, leading directly to the Great Financial Crisis, a period of violent volatility. Unfortunately, most economists and central bankers do not accept this reality and are still blind to the causal link between the Great Suppression of the false moderation and the great volatility of the 2008 crisis. The following excerpt from a representative of the Federal Reserve Bank of Kansas City describes how the period from the mid-1980s to 2007 is viewed in most mainstream circles.

FIGURE 7. *The Great Moderation or the Great Suppression: View from the Kansas City Fed*
Source: Federal Reserve Bank of Kansas City, Craig S. Haikkio (Senior VP, Economic Polity), Link Below

> *The Great Moderation from the mid-1980s to 2007 was a welcome period of relative calm after the volatility of the Great Inflation.1 Under the chairmanships of Volcker (ending in 1987), Greenspan (1987-2006) and Bernanke (starting in 2006), inflation was low and relatively stable, while the period contained the longest economic expansion since World War II. Looking back,* ***economists may differ on what roles were played by the different factors in contributing to the Great Moderation, but one thing is sure: Better monetary policy was key.*** *Unfortunately, the financial crisis of 2007-08 and the ensuing Great Recession broke the calm of the Great Moderation. An important question for Federal Reserve policymakers—and for other policymakers in the United States and worldwide—is whether the disruption beginning in 2007 was a temporary blip or reflects a shift to a more volatile economy going forward. The significant decline in macroeconomic volatility that began in the mid-1980s and came to be known as the Great Moderation has been documented by many, including Stock and Watson (2003), Bernanke (2004), and Clark (2009). (TheGreatModeration).*

The prevailing economic debate regarding this period is not whether the Great Moderation caused the Great Financial Crisis; instead, the debate is whether the Great Financial Crisis marked the ending of the Great Moderation. While central bankers and economists debate to what degree "better monetary policy" deserved credit for the period of sustained lower volatility prior to the crisis, the debate should be whether this policy contributed to the violent volatility and instability experienced during the crisis. In 2004, prior to becoming the Fed Chairman and prior to the crisis, Ben Bernanke argued that improved monetary policy deserved more credit than it had received.

FIGURE 8. *Bernanke on the Great Moderation: Thank the Federal Reserve*
Source: Remarks by Governor Ben Bernanke, Speech at meetings of Eastern Economics Association, February 2004

> *"Whether the dominant cause of the Great Moderation is structural change, improved monetary policy, or simply good luck is an important question about which no consensus has yet formed.* ***I have argued today that improved monetary policy has likely made an important contribution not only to the reduced volatility of inflation*** *(which is not particularly controversial)* ***but to the reduced volatility of output as well****. Moreover, because a change in the monetary policy regime has pervasive effects, I have suggested that some of the effects of improved monetary policies may have been misidentified as exogenous changes in economic structure or in the distribution of economic shocks. This conclusion on my part makes me optimistic for the future, because I am confident that monetary policymakers will not forget the lessons of the 1970s.* ***I have put my case for better monetary policy rather forcefully today, because I think it likely that the policy explanation for the Great Moderation deserves more credit*** *than it has received in the literature."*

At the time, Bernanke was without the benefit of hindsight; however, it remains telling that the future Fed Chairman thought that the Fed was creating an environment of financial stability when in fact the opposite was true. In the midst of the crisis, the Fed responded with more of the same policy (lower rates), further establishing that the Fed did not recognize that it was that very same failed policy of the Great Moderation which had contributed to the instability in the financial system leading up to the crisis.

Nassim Nicholas Taleb, author of *the Black Swan (2007),* and Mark Blyth argue that suppressing volatility makes the world less predictable and less safe in an essay comparing the circumstances of the financial crisis to the Arab Spring (the Black Swan of Cairo, 2010). Whether financial or political, modern social systems are increasingly complex and interconnected; such systems are made inherently less stable and more fragile by inhibiting fluctuations, according to Taleb and Blyth. While central bankers should have

debated to what extent **suppressed volatility increased instability and future volatility** prior to charting the unprecedented course of quantitative easing, that debate has been left to contrarians, the market and the future of the American economy.

FIGURE 9. *The Black Swan of Cairo: Suppressing Volatility Increases Risk, No Stability Without Volatility*
Source: Taleb & Blythe, Foreign Affairs, May/June 2011 Issue

> ***Complex systems that have artificially suppressed volatility tend to become extremely fragile, while at the same time exhibiting no visible risks.*** *In fact, they tend to be too calm and exhibit minimal variability as silent risks accumulate beneath the surface. Although the stated intention of political leaders and economic policymakers is to stabilize the system by inhibiting fluctuations, the result tends to be the opposite. These artificially constrained systems become prone to "Black Swans"—that is, they become extremely vulnerable to large-scale events that lie far from the statistical norm and were largely unpredictable to a given set of observers.* ***Such environments eventually experience massive blowups, catching everyone off-guard and undoing years of stability*** *or, in some cases, ending up far worse than they were in their initial volatile state. Indeed, the longer it takes for the blowup to occur, the worse the resulting harm in both economic and political systems. […]*
>
> ***Variation is information. When there is no variation, there is no information*** *[…] As Jean-Jacques Rousseau put it, "A little bit of agitation gives motivation to the soul, and what really makes the species prosper is not peace so much as freedom." With freedom comes some unpredictable fluctuation. This is one of life's packages:* ***there is no freedom without noise—and no stability without volatility.*** *(Foreign Affairs, May/June 2011 Issue)*

There is a credible case to be made, upon review of history, that the Fed created instability by suppressing volatility. In an effort to smooth out the boom and bust of economic cycles, the Fed stimulated artificial demand by lowering interest rates. On the margin, this demand came initially from sources sensitive to interest rates: long-term capital-intensive projects and durable goods (housing, plants, autos, etc.). As a function of this, future demand was pulled forward, naturally creating excess supply in many cases or driving consumption that could otherwise not be afforded, both limiting future capital investment and future consumer expenditures. Rather than allow excess supply to broadly be restructured and for bad-debts to be written-off, the Fed continued to reduce interest-rates further and further at the slightest sign of economic slowdown, perpetuating similar cycles.

Just prior to the onset of the financial crisis, total debt outstanding in the U.S. credit system had grown to $53 trillion (system wide, including public + private sector). At the time, the banking system and its $53 trillion in debt liabilities were supported by only $350 billion of bank liquidity (a ratio of approximately 150:1, debt-to-cash system-wide excluding derivatives). The unstable and fragile nature of this system was supported by overnight and short-term funding markets. Each day, every dollar available was wrung out of the financial system to provide liquidity where funding was needed most. During periods of calm in the markets, market participants maintain a high willingness to lend in overnight and short-term markets as most do not need (or demand) 100% of cash holdings on any given day and short-term risk is limited. In short-term funding markets, lenders are typically banks or other financial institutions that hold excess cash balances; cash holdings of banks largely represent consumer and business deposits (i.e. banks are lending customer deposits overnight or on a short-term basis). This system works until a very small percentage of counterparties default on short-term funding or until a very small percentage of

lenders stop providing liquidity to overnight and short-term markets because of fears of broad-based insolvency.

It is because of the structure of the financial system that the subprime crisis was the match that lit the fire and not the fire itself. The fire was a massively levered financial system with too much debt funded by too few dollars. Each dollar had been levered and lent 150 times over. When credit begins to contract, heightened value is placed on liquidity and the demand for dollars increases. Consumers spend less and save more. Businesses cut costs and reduce investments. The velocity of money slows and slowing velocity is problematic for a highly levered credit system which is dependent on money flowing freely and quickly through the financial system. It becomes evident that there will never be enough dollars to repay all the dollar denominated debt which exists. The downward cycle is both vicious and procyclical as defaults lead to more defaults and credit contraction leads to more credit contraction. Because the deleveraging event is sudden and largely uncontrollable, unemployment rises sharply which further fuels the procyclicality of the fire. This is the Armageddon scenario which the Fed faced in 2008.

THE GREAT FINANCIAL CRISIS aka THE DOLLAR CRISIS

The troubling part is that at the onset of the crisis, throughout the term of the crisis and ever since, the Fed has shown time and again that it does not fully understand the problems or the implications of its policy responses. Importantly, this is not an expression of an opinion; it is a fact that is proven out by a review of history and the test of time. Despite not fully understanding the consequences, the Fed pursued the extreme measures of reducing short-term target rates to 0% for seven years and creating $3.6 trillion dollars, quintupling the size of its balance sheet and increasing bank liquidity by nearly 10x. The extreme policy response did not happen all at once and along the way, there was evidence that it was not working.

Despite recognition that its policy prescription was both unprecedented and experimental, and with empirical evidence that aggressive monetary easing measures were not working, the Fed's response was to do more of the same: print more money, buy more mortgaged backed securities (propping up the housing market) and buy more treasuries (distorting every risk asset in the world). In doing so, the Fed not only pursued policy which it did not and could not fully understand; it also created an environment in which an unstable $53 trillion credit system could expand by 25%.

Despite the credit crisis, the credit system (excluding derivatives) has since ballooned to $66 trillion in outstanding debt as of the end of 2016 – $13 trillion larger than it was pre-crisis. In the decade since the crisis, more debt was created than existed prior to 1987 ($11 trillion), a scenario and an equation that is simply not possible without the intervention of the Fed. **The Fed pursued these policies because it has no other tool.** Printing money, primarily through the creation of bank reserves, is all the Fed can do to stop a panic or to stem a system-wide procyclical credit contraction. The Fed may use opaque and veiled terms like federal funds target rate, open market operations, interest on overnight excess reserves, large scale asset purchases, reverse repo and quantitative easing. But, in reality, the only way the Fed achieves its policy objective of easing monetary conditions is by increasing the money supply. The Fed's tools are deficient and its knowledge and understanding of the implications are both limited and wanting.

Understanding the implications of the Fed's current policy decisions and the psychology of its governing body related to future decisions is critical in navigating the unintended consequences that lie ahead.

While there is 30 years of history from which to choose, understanding the Fed's deficiency over the course of the past decade beginning at the onset of the crisis, before most everyone even knew a crisis was imminent, best illuminates the path forward. In February 2007, subprime had become a concern and the S&P 500 index dropped 5%. In the subsequent March 2007 Fed meeting, Chairman Bernanke was admittedly puzzled by the link between subprime and the stock market.

FIGURE 10. *Puzzled: Estimated Subprime Loss of $50 Billion Would Lead to a $10 Trillion Market Sell-Off*
Source: Federal Reserve Transcripts, March 2007 meeting of Board of Governors

> *CHAIRMAN BERNANKE. I had been puzzled about the quantitative relationship between the subprime problems and the stock market. I think that the actual money at risk is on the order of $50 billion from defaults on subprimes, which is very small compared with the capitalization of the stock market. It looks as though a lot of the problem is coming from bad underwriting as opposed to some fundamentals in the economy. So I guess I'm a bit puzzled about whether it's a signal about fundamentals or how it's linked to the stock market.*

The Fed did not (and still does not) regulate individual derivative markets but it did regulate the financial institutions which dealt in derivatives. Despite overseeing these institutions and the risks to which their balance sheets were exposed, Bernanke had no reliable measure of the derivatives linked to subprime, and at the onset of the crisis, he continually failed to recognize that the crisis was one of liquidity; over time, he failed to understand the extent of the liquidity crisis. This failure was a function of a wholesale misunderstanding of why a credit system with $53 trillion in debt (excluding derivatives) supported by only $350 billion in liquidity was unstable and why it was susceptible to a bank run at the strike of any match (whether subprime or otherwise).

After famously saying that problems in the subprime market seemed likely to be contained in March 2007, more cracks in the facade appeared over the summer and fall of 2007. Bernanke's misunderstanding of both the potential systemic risk and the poor liquidity profile of the financial markets were highlighted in 2008 as market turmoil accelerated. The Fed Chairman failed to identify the then present dollar crisis in the lead up and in the midst of the turmoil.

FIGURE 11. *Bernanke Misses the Systemic Risk and the Extent of the Liquidity Crisis in 2008*
Source: Fed Chairman, comments from various meetings, speeches and press conferences, January - July 2008

> *"The Federal Reserve is not currently forecasting a recession." – January 10, 2008*
>
> *"[The U.S. economy] has a strong labor force, excellent productivity and technology, and **a deep and liquid financial market** that is in the process of repairing itself." – January 18, 2008*
>
> *"The risk that the economy has entered a substantial downturn appears to have diminished over the past month or so." – June 9, 2008*
>
> *"The **GSEs are adequately capitalized**. They are in no danger of failing." – July 20, 2008*

From peak to trough, the U.S. stock market lost $10 trillion in value, corporate bonds were sold, gold was sold, foreign currency was sold. As the following charts show, **everything was a source of funding for dollars** because everyone was short dollars and there was a global shortage.

FIGURE 12. *Equities Sold: The Stock Market Lost $10 Trillion in Value from Peak to Trough*
Source: Bloomberg, S&P 500 (Light Blue), Dow Jones Industrial Average (Dark Blue), Indexed Price Chart (0 = 2006)

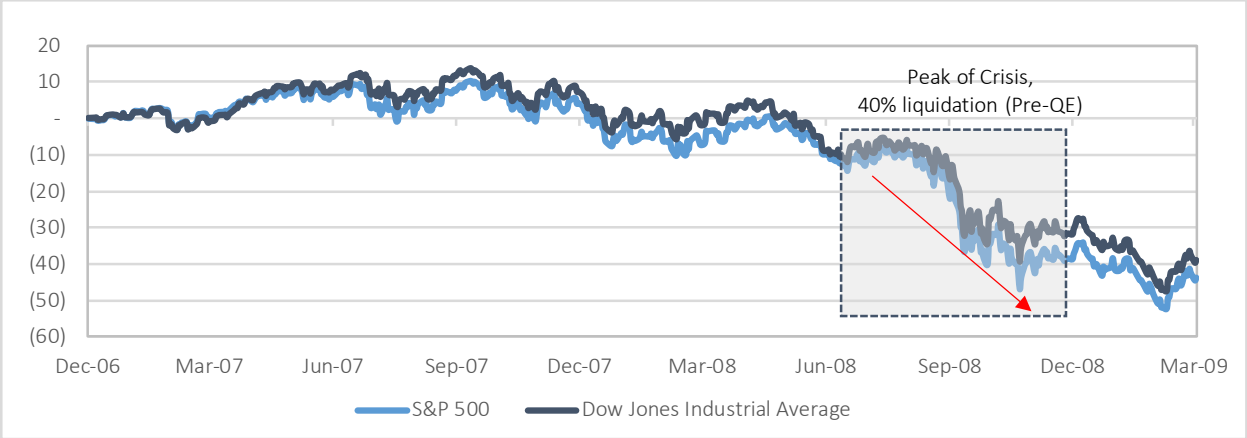


FIGURE 13. *High Yield Bonds Sold, Treasuries (Dollars) Bought: Junk Bond Yields More Than Doubled*
Source: JP Morgan, 10-YR Treasury Yield (Light Blue), High Yield Index Yield (Dark Blue), Indexed Yield (0 = 2006)

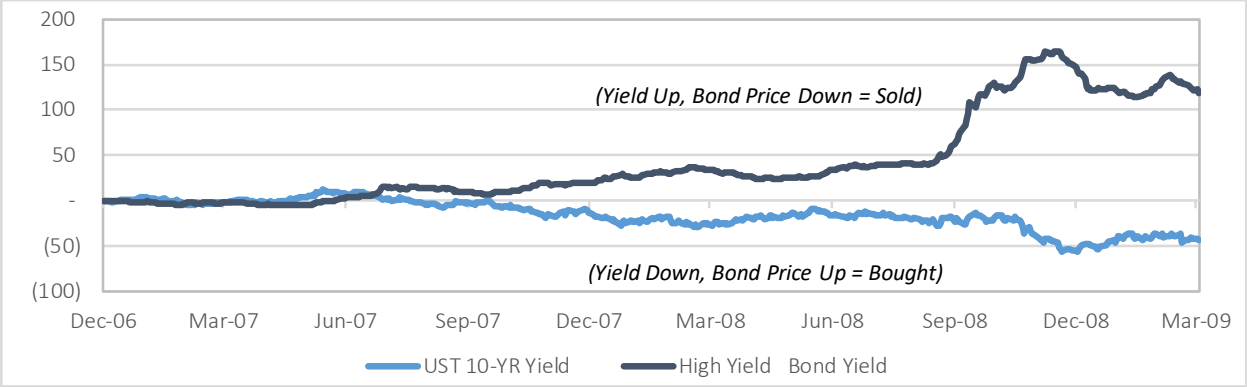
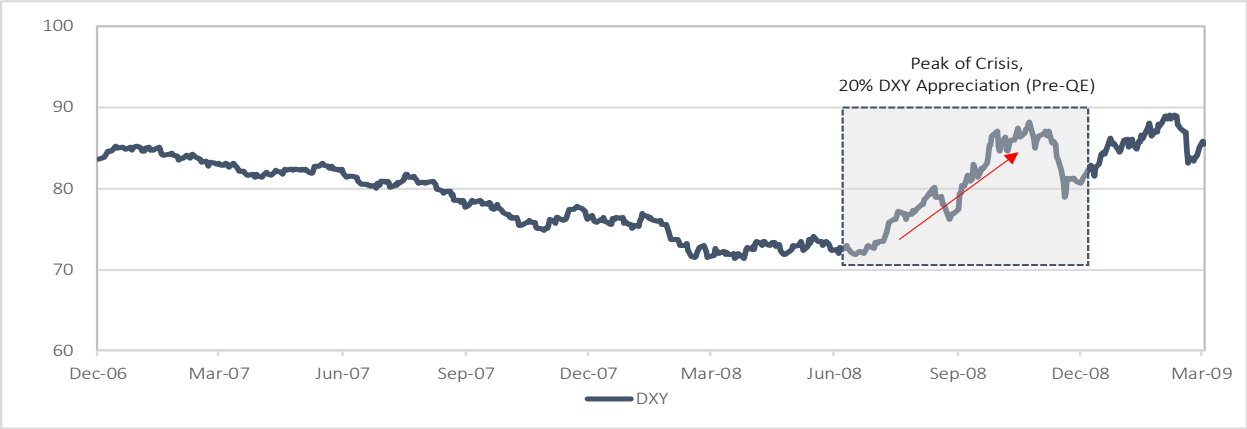


FIGURE 14. *Gold Sold: Historical Flight to Safety Lost Approximately $1.25 Trillion in Purchasing Power*
Source: Bloomberg, Gold Spot (Dark Blue), Price per Troy Oz ($), 2006-2009

FIGURE 15. *Dollar Index Appreciated 20%: FX Sold to Acquire Dollars*
Source: Bloomberg, DXY Index (Dark Blue), Nominal Level, 2006-2009



Everything was sold to acquire dollars in order to fund dollar denominated liabilities. Estimated subprime mortgage losses amounted to less than half of 1% of the loss in stock market value. It was a dollar crisis that began with subprime. As Nassim Taleb would argue, the system was complex and fragile; attributing the crisis to subprime is similar to blaming an avalanche on the singular disturbance that exposes the fragility of the unstable system.

Bernanke and the Fed fundamentally misunderstood why the system as constructed was experiencing such significant strains in liquidity. What seems obvious in hindsight was not to the Fed, nor was it to the vast majority of all market participants that blindly ignored the risks of a highly levered financial system dependent on wholesale short-term funding. With $53 trillion in debt and only $350 billion of liquidity, how could the Fed Chairman view the financial markets as deep, liquid or stable? The Fed believed the $350 billion in liquidity was sufficient because it was looking at the financial markets through the status quo lens of short-term funding needs and perpetual refinancing and re-leveraging of the debt stock. It had failed to recognize the unsustainable monster that it had created. **Because every dollar that existed in the banking system had been leveraged 150 times to create bank and shadow bank liabilities, it was a mathematical impossibility that all the debts could be repaid** and, the Fed had not seriously considered the possibility or consequence of a system-wide deleveraging event.

The banking system was a massive game of musical chairs and when the music stopped, everyone finally realized that the system was far more than one chair short. Not every dollar of debt is due on a given day, or in the next 30 days or in the next six months or even in a year. Far from it, in fact. However, as market participants figured out the reality of the dollar scarcity, it did not matter when debts were due. Everyone needed to source dollars to pay future maturing debts and to protect against insolvency. At the same time, everyone was fearful of counterparty risk and insolvent borrowers. The consequence was a run on dollars and short-term funding markets stopped functioning. The liquidity which the Fed thought was deep and liquid evaporated because it was always an illusion. Short-term funding is only a reliable source of liquidity when the demand is limited. When a system-wide need arises, short-term funding is never a reliable source of liquidity because there could never be enough and the fear of insolvency is legitimately broad-based. It follows that, any time there is a system wide deleveraging event, a system-wide need for liquidity arises. By the transitive property, there will almost assuredly be a liquidity crisis in response to a system-wide deleveraging event, no matter how deep or liquid the Fed perceives the banking system.

THE QUANTITATIVE EASING (QE) RESPONSE

The consequences of a system-wide deleveraging event are extremely severe because of the leverage profile of the financial system and the risk of such an event is present today because of the Fed's response to the last crisis. In response to the 2008 crisis, despite being caught by surprise, the Fed recognized that, in order to prevent a massive credit cycle, it needed to take extreme measures to spur "aggregate demand" in order to reverse the contractionary tidal wave. While it had already taken measures to inject term-liquidity into the financial system to address the liquidity crisis, the Fed maintained the misguided view that, to solve the longer-term problem, it just needed to reduce interest rates low enough to restart the economic engine. That meant not just lowering short-term rates; this time, it meant manipulating long-term rates as well and in order to effect this, the Fed pursued large-scale asset purchases (QE).

There is a saying about the definition of insanity. In the Fed's case, it is guided by two principal philosophies that prevent it from changing course. First: the Fed is dominated by monetarists that believe, in response to contractionary periods, the path to full employment is to increase the money supply (printing money) which is aimed at reducing the value of each dollar relative to goods and services with the goal of inducing an increase in dollar spending (aggregate demand). Second: the Fed created the problem through failed policy; if it does nothing, it will become apparent that the emperor has no clothes and it is easier to do something rather than nothing. The insanity is emboldened by the popular delusion that debts will be inflated away (or made to be sustainable) as money is printed when in reality such a policy only serves to create an environment in which more unsustainable debt will be created.

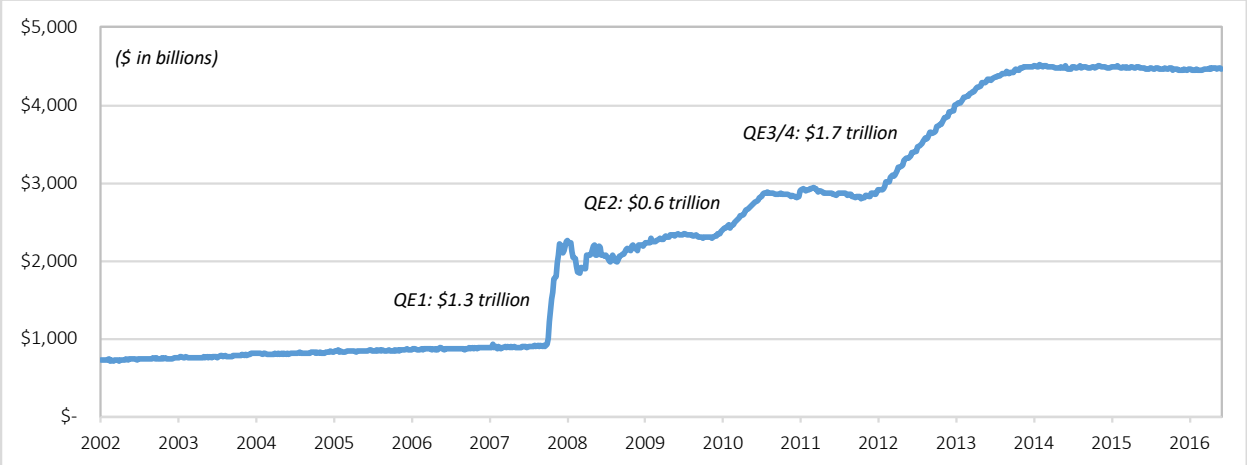
Accordingly, and in response to the 2008 crisis, the Fed did what it had been doing over the past two decades. It just did so on a massive scale. When the United States terminated the convertibility of the U.S. dollar to gold on August 15, 1971, effectively ending the Bretton Woods system, the checks and balances on an otherwise independent Federal Reserve were removed. With it, the door was opened for unfettered, and unchecked, money printing by the Fed. Alexander Hamilton, one of the founding fathers of the national central bank, supported the formation of a common national currency but warned, presciently, of the risks posed if that currency was not backed by physical money, specifically gold.

FIGURE 16. *Alexander Hamilton Musing on the Federal Government and the Emission of Paper Currency*
Source: Hamilton Writings, 590-591, Hamilton speaking to the House in Congress

> *"The emitting of paper money by the authority of Government is wisely prohibited by the individual States, by the national constitution; and the spirit of that prohibition ought not be disregarded by the Government of the United States. Though paper emissions, under a general authority, might have some advantages not applicable, and be free from some disadvantages which are applicable to the like emissions by the States, separately, yet they are of a nature so liable to abuse – and it may even be affirmed, so certain of being abused – that the wisdom of the Government will be shown in never trusting itself with the use of so seducing and dangerous an expedient. In times of tranquility, it might have no ill consequences; it might even be managed in a way to be productive of good; but, in great and trying emergencies, there is almost a moral certainty of its becoming mischievous. The stamping of paper is an operation so much easier than the laying of taxes, that a government, in the practice of paper emissions, would rarely fail, in any such emergency, to indulge itself too far in the employment of that resource, to avoid, as much as possible, one less auspicious to present popularity. If it should not even be carried so far to be rendered an absolute bubble, it would at least be likely to be extended to a degree which would occasion an inflated and artificial state of things, incompatible with the regular and prosperous course of the political economy. – Alexander Hamilton, The Writings 590-91.*

While Hamilton could not have envisioned the complexities of the modern financial system or the extent of the Federal Reserves' active role in financial markets, this founding father clearly understood the foundational risk of an unchecked Federal Government and national central bank. The Fed's response to the financial crisis in 2008 was the culmination of a century long deterioration in foundational principles and the ultimate deviation from sound monetary policy. At the height of the liquidity crisis, quantitative easing officially began with the oft-romanticized bank bailout engineered by Ben Bernanke and Hank Paulson in October 2008. Over the course of the subsequent five years, the Federal Reserve would pursue three quantitative easing programs, increasing the Fed's balance sheet from $900 billion to $4.5 trillion.

FIGURE 17. *Federal Reserve Quantitative Easing Programs Quintuple the Size of the Fed's Balance Sheet*
Total Assets of the Federal Reserve Banks, U.S. Dollars in Billions, Source: Federal Reserve Data.



The evolution of the Fed's emergency policy makes self-evident just how unprecedented and experimental its actions really were. The Fed cut its target policy rate seven times over the course of 2008, from 4.25% to 0%. It offered up to $400 billion in term liquidity to banks. As the crisis spread throughout the globe, it expanded existing dollar swap lines to the European Central Bank and the central banks of Switzerland, Japan, Canada, and England. It created new swap lines for the central banks of Australia, Norway, Sweden, Denmark, New Zealand, Brazil, South Korea and Mexico. After allowing Lehman Brothers to fail, it provided a bailout loan to AIG in the amount of $85 billion and worked with the Federal Government to engineer a $250 bailout of nine Wall Street banks and to implement a $700 billion troubled asset relief program (TARP). After all the extreme bailout measures coordinated with the Treasury Department and passed by Congress, the economy remained in turmoil and the Fed then decided it appropriate and necessary to pursue the first of three quantitative easing programs.

Through QE1, the Fed committed to buy $600 billion in mortgage-backed securities (MBS) and to expand its purchases of treasury securities and bank debt. After halting asset purchases in June 2010, the Fed resumed purchases in August 2010 in order to maintain the total size of its balance sheet as loans held by the Fed matured. With the recovery at risk, the Fed subsequently authorized a second QE program to further expand its balance sheet through the purchase of $600 billion in incremental treasury securities. If the emergency bailout measures and QE1 had been successful in stabilizing markets and the economy, why was a second QE necessary? If the actions taken during the course of 2008 and 2009 established that

the financial system was unstable and unsustainable, the need for QE2 led to questions regarding the efficacy of the Fed's various policy responses.

The operation of increasing the money supply through the creation of bank reserves should have been recognized for what it was, creating an environment incompatible with the regular and prosperous course of the economy (in Hamilton's words). Instead, guided by monetarists, the Fed believed that the most effective way to achieve its policy mandate of full employment was to continue to stimulate aggregate demand through monetary easing and the lowering of interest rates. After approving QE2 in November 2010, Ben Bernanke appeared on 60 Minutes to reassure the nation that the Fed had everything under control and that its latest round of balance sheet expansion was prudent and necessary. In this interview, Bernanke communicated exactly what the Fed was aiming to achieve through QE2: to further lower interest rates. Often mocked, Bernanke also explained that it was a myth that what the Fed was doing amounted to printing money.

FIGURE 18. *Ben Bernanke: The Fed is Not Printing Money Through QE, It Is Lowering Interest Rates*
Source: 60 Minutes Interview, December 2010

> *"One myth that's out there is that what we're doing is printing money. We're not printing money. The amount of currency in circulation is not changing. The money supply is not changing in any significant way. What we're doing is lowering interest rates by buying Treasury securities. And by lowering interest rates, we hope to stimulate the economy to grow faster. So, the trick is to find the appropriate moment to begin to unwind this policy. And that's what we're going to do." – Ben Bernanke, 60 Minutes Interview, December 2010*

While nuanced, the Fed was not physically printing money. When Bernanke explained that currency in circulation was not changing, it actually was not. The Fed's balance sheet is comprised of two primary forms of liabilities: currency in circulation and bank reserves. The former is physical currency (paper cash and coin) that exists largely outside the control of the banking system; the latter represents bank claims held by various banking institutions within the Federal Reserve system. The Fed, through QE, was increasing the amount of bank reserves; so long as those reserves were not converted to physical currency, the liquidity created by the Fed would remain in the banking system. While the vast majority of market participants view Bernanke's infamous comments as either intentionally misleading or a flat out lie, what if, however simplistic, the Fed really did not consider what it was doing as printing money?

As Bernanke stated, the Fed's goal was to stimulate the economy by lowering interest rates. With its short-term policy rate already at 0%, the only way to effect such an end was to purchase longer duration securities to influence longer-term interest rates. **The Fed recognized that it was increasing the amount of bank reserves, and as a direct consequence, dollar liquidity in the banking system; however, its goal was to lower interest rates, not provide incremental liquidity.** The liquidity crisis had passed and so had the need for more liquidity (as viewed by the Fed); QE2 was all about interest rate targeting. And, the Fed viewed its measures as temporary. Regardless of how extended a period the Fed's balance sheet would remain at elevated levels, the Fed could drain bank reserves as quickly as it created bank reserves, notably by either allowing securities which it held to mature without reinvesting proceeds

or by actively selling securities in the open market. The same is not true for currency in circulation (physical cash) and likely why the Fed viewed its operations as different, and temporary.

The distinction is nuanced but critical. A goal of interest rate targeting vs. injecting liquidity. The order of operations may be confusingly similar and the lines are certainly blurred; but, it speaks to the psychology of the Fed's decision making: QE2 was about a continuation of the policies of the Great Moderation, signaling that despite the volatile course of 2008 and 2009, the Fed did not see the need to chart a new course. If ever a time for introspection, the years subsequent to the financial crisis should have been it but the Fed was either too blind or too stubborn to recognize the failures of its policy. The deployment of QE2 certified this conclusion and set up the sequence of events that would transpire in 2011, events that would turn out to significantly damage the Fed's credibility.

While 2008 and 2009 are remembered for the height of the crisis, 2011 turned out to be the most critical marker in the last decade for what comes next. During this critical but often overlooked year, the conditions of the real economy deteriorated; the Fed's QE programs were proven to be ineffective; and the instability of the financial system once again became evident. A comprehensive review of the Fed transcripts from 2011 (which were just made available in January 2017) shows that the Fed had a limited understanding of why. After 2011, any baseline assumption that the Fed reasonably understands the implications of its policy decisions on financial markets or the real economy is willingly ignorant of history.

With QE2 underway, the Fed met in January 2011 and the consensus, at the time, was that the economy was improving with the risks to the Fed's economic projections being balanced or to the upside (i.e. downside risk was seen as limited). QE2 was working much to the satisfaction of the Fed. When the Fed next met in March 2011, the members viewed the economy as still improving but at a lower than expected pace. By the subsequent meeting in April, the economic outlook was mixed; there were members concerned about downside risks and others concerned about the inflationary impact of QE. However, the sentiment regarding the economic recovery was positive enough to justify a lengthy debate on how the Fed would sequence the tightening of monetary policy when the appropriate time came. By the June meeting, members took note of recent weakness in the economy as incoming data had almost uniformly disappointed. While most believed a moderate recovery was still underway, sentiment had become notably more pessimistic and the perception of downside risks to the Fed's projections had increased. Despite the deterioration in the economic outlook, the recovery was still intact and the Fed concluded round 2 of QE at the end of June 2011 as planned, halting further expansion of the Fed's balance sheet.

During the short period between the conclusion of QE2 at the end of June and the subsequent Fed meeting in August, financial conditions became significantly more turbulent. During the Summer months, the U.S. economy was slowing and there were increasing concerns about long-term and short-term growth. The Fed recognized that "leverage and debt" were "retarding growth over a longer period" and noted weak consumer spending as a particular concern. At the same time, a confluence of global events further impaired financial conditions: Europe was on the brink of a sovereign debt crisis, Congress struggled to authorize an increase in the debt ceiling and S&P downgraded the U.S. credit rating amidst the budget and debt-ceiling turmoil. Conditions in financial markets had deteriorated so significantly and so quickly that liquidity became an issue.

In just eight short months, the economy went from improving steadily, to moderating, to deteriorating rapidly. What was particularly extraordinary was that this rapid shift in economic conditions occurred as the Fed was actively purchasing $600 billion in U.S. treasuries through QE2. The extraordinary nature of what occurred and when it occurred was not lost on the Fed. While the liquidity pressures and concerns ultimately subsided without the Fed having to take emergency measures, the issues were severe enough to prompt debate regarding the stability of financial markets and the effectiveness of QE. The head of the Fed's open market operations, on multiple occasions, noted how concerning and unexpected it was that there would be liquidity issues given the Fed had increased bank reserves to $1.6 trillion through QE1 and QE2. Prior to QE, there were only $10 billion in bank reserves held with the Fed and the banking system had approximately $350 billion in total cash. By August 2011, the banking system was supported by $1.7 trillion in cash, of which $1.6 trillion in bank reserves were held at the Fed; yet somehow, liquidity issues suddenly became evident. Prior to the crisis, Bernanke mistakenly viewed the financial system as deep and liquid; after QE1 and QE2, the previously misunderstood liquidity problem should have been solved by the Fed's response.

FIGURE 19. *Head of Fed's Open Market Account: Why is Liquidity an Issue with Reserves of $1.6 trillion*
Source: Federal Reserve Transcript, August 2011, Brian Sack – Head of System Open Market Account (SOMA)

> *"MR. SACK. Can I add a comment? In terms of your question about reserves, as I noted in the briefing, we are seeing funding pressures emerge. We are seeing a lot more discussion about the potential need for liquidity facilities. I mentioned in my briefing that the FX swap lines could be used, but we've seen discussions of TAF-type facilities in market write-ups.* ***So the liquidity pressures are pretty substantial. And I think it's worth pointing out that this is all happening with $1.6 trillion of reserves in the system****."*
>
> *"MR. SACK. As I noted on the videoconference,* ***the spike in short-term funding rates left the Desk on alert*** *to the possibility of having to conduct repurchase agreements to keep the federal funds rate within the FOMC's target range.* ***This was an extraordinary outcome, given that the financial system has about $1.6 trillion in excess reserves.*** *In the end, we did not conduct any such operations, as the federal funds rate remained within the FOMC's target range."*

Once again, the stability of the financial system was called into question, even after extreme measures taken by the Fed. This stress further substantiates two conclusions: 1) the perceived liquidity in the financial markets is and will always be insufficient so long as the leverage profile remains at unsustainable levels (at this point, debt-to-cash was approximately 32:1, $55 trillion in debt vs. $1.7 trillion in banking system cash); and 2) the Fed fundamentally struggles with the inherent liquidity risk present in financial markets because it views liquidity through the status quo lens of short-term funding needs.

Not only was the shock severe and sudden enough to raise questions about how short-term liquidity could possibly be an issue; it also led Chairman Bernanke to admit that there was reason to question the efficacy of the Fed's policy. Despite admitting that the Fed could not solve fiscal and structural problems through monetary policy and that the monetary base was not the main problem with the economy, Chairman Bernanke still viewed it as the Fed's responsibility to be "palliative" – to relieve pain without dealing with the cause of the condition. Even when the Fed is introspective and honest concerning its limitations, it finds itself trapped between two bad options: do something or do nothing. What happens when an unstoppable force meets an immovable object? In the case of the Fed, the answer is to stay the course: pursue more and not less. It is partly a function of human nature (survival instincts) and partly a

function of an unchecked and unelected central bank rationalizing irrational decisions. The consequence is short-term stability at the expense of long-term sustainability.

FIGURE 20. *Bernanke at a Crossroads: Monetary Policy is Not the Issue but It Can Still Be the Solution*
Source: Federal Reserve Transcript, August 2011, Ben Bernanke – Fed Chairman

> *"CHAIRMAN BERNANKE. I'm perfectly willing to accept the argument that monetary policy is not the main tool, that this is not the main thing wrong with the economy, but it's our duty to do what we can, to be palliative, to help where we can, even if we can't solve fiscal, structural, and other problems."*

At the same meeting, there were at least a few rational participants willing to admit, in an unqualified and unapologetic manner, that the Fed was pursuing extreme and experimental policy without sufficient understanding of the links between the financial sector and the real economy and of the impact of overall deleveraging on the economy.

FIGURE 21. *Fed Economist: Gaps in Understanding Link Between Financial and Real Sector Are Profound*
Source: Federal Reserve Transcript, August 2011, David Wilcox – Fed Economist

> *"MR. WILCOX. We've been marching determinedly in a negative direction. John Stevens had a nice exhibit in yesterday's Board briefing that showed just how much we'd taken the forecast down over the course of this year.* ***Also, I want to just emphasize that I think the gaps in our understanding of the interactions between the financial sector and the real sector are profound****, and they have, over the past few years, deeply affected our ability to anticipate how the real economy would respond, and they are continuing to do so now. This is an ignorance that we share with the entire rest of the profession, and I think one thing that is good to see is the enormous amount of work that's going on at the Board, in the System, and in the profession at large in an attempt to develop a better understanding of the interactions between the real sector and the financial sector, operating in both directions.* ***But boy, I don't know whether that literature is in its infancy, but I would not put it at any more beyond toddlerhood.*** *We've got just an enormous amount yet to learn and incorporate in that regard."*

FIGURE 22. *Fed Governor: Limited Understanding of How Overall Deleveraging Impacts the Economy*
Source: Federal Reserve Transcript, August 2011, Richard Fisher – Fed Governor

> *"MR. FISHER. In terms of our outlook for the economy. And we're constantly asking ourselves,* ***what have we been missing****, or* ***what did we miss****, and how useful are our various models, depending on their degree of sophistication, in terms of being of assistance to us in trying to get a sense of what's developing in the economy? I wonder if, at some point—we may not do it now, but* ***it strikes me that one of the issues that I don't think we understand very well—this is my working hypothesis—is how our models are affected by overall deleveraging****. Consumer sector deleveraging, for sure. Certainly a releveraging has taken place in the business sector amongst corporate credits, and, right now, what I expect to be a significant deleveraging is happening in the fiscal sector—that is, with the federal, state, and local governments. This is just really a request that we pursue this a little bit more. I see by your nodding of your head, I think I may be correct.* ***But I do think it's something that's inhibiting our understanding—a better understanding of this would probably enhance our understanding of what's going on with the economy****."*

After a long discussion in April 2011 of how the tightening of monetary policy would be sequenced and after the completion of QE2 in June 2011, the market and, importantly, the economy deteriorated to

such an extent that by August 2011 the Fed was discussing liquidity issues and the potential need for more accommodative Fed policy to support the economic recovery. By September of that year, Bernanke was evoking comparisons to 2008 and the Fed determined to execute Operation Twist, an accommodative policy through which the Fed would sell $400 billion in short duration assets (less than 3 years) to buy longer-dated assets (6 to 30 years) in order to extend the maturity profile of the Fed's balance sheet, intending to have the impact of both lowering longer-term interest rates and to signal to the market that policy would remain accommodative for a longer period of time.

FIGURE 23. *Bernanke Puzzled: 2011 Is Starting to Look a Lot Like 2008*
Source: Federal Reserve Transcript, September 2011, Ben Bernanke – Fed Chairman

> *"CHAIRMAN BERNANKE. Financial conditions have continued to be strained—even reminiscent of 2008 in some dimensions. European sovereign debt and banking problems have the potential to worsen significantly, with potentially serious implications for the U.S. financial system and economy."*
>
> *"I think the most important development over the summer is that financial instability looks to be rearing its ugly head once again. We are not yet, of course, at the level of 2008, but some of the same adverse feedback loop between the economy and financial conditions looks to be in operation."*
>
> *"My own assessment is that the instability in financial markets, increase in spreads, decline in stock prices, increased stock volatility—all of those things taken together are at least one important reason why the bounce back in the second half that we were anticipating has been weaker than we had hoped. Not only have financial conditions affected household wealth and the cost of credit by increasing spreads, for example, but they have led to increased risk aversion, both in markets, I think, and in the real economy, and have affected sentiment as well."*

While the conditions in the Fall of 2011 also led to consideration of additional QE, the Fed avoided the temptation of any further balance sheet expansion as it executed its strategy to increase the duration of its portfolio, hoping that this policy would be accommodative enough to stimulate the economy, despite increasing pessimism concerning the recovery.

FIGURE 24. *The Art of the Argument: Bernanke Logic Planting the Seed for QE3*
Source: Federal Reserve Transcript, September 2011, Ben Bernanke – Fed Chairman

> *"CHAIRMAN BERNANKE. I don't think it is literally the case that monetary policy is completely ineffective. I think we can see the effects on financial markets, which in turn must be affecting wealth, confidence, and some other determinants of spending and production. To the extent that transmission is weaker, that could be used to argue for more stimulus rather than less stimulus."*

It was not until September 2012 that the Fed decided that a third round of QE was necessary to revive the recovery, through which it approved the purchase of $40 billion in mortgage-backed securities (per month) for an indefinite period of time. In December 2012, QE3 was expanded to $85 billion of additional purchases per month ($40 billion MBS + $45 billion treasuries), again for an indefinite period of time. The Fed finally began to taper QE3 asset purchases in January 2014; as a consequence, it gradually reduced the amount of securities it purchased each month until incremental purchases were halted completely in October 2014. **From September 2012 to October 2014, the Fed effectively created $1.7 trillion dollars, increasing its balance sheet by approximately 60% from $2.8 trillion to $4.5 trillion.**

QE3 was not remarkable because of its size. More noteworthy was what the existence of QE3 said about the Fed's decision-making process, its broad judgment, its temperament, policy inconsistencies and its ability to forecast – both in terms of economic projections and how its policy would affect the real economy. In March 2011, QE2 was a success in the Fed's mind, with almost unanimous agreement among the Fed's governing body that a moderate recovery was intact and that QE2's accommodation was having the intended effects. By the fall of that year, it became evident that the Fed was wrong; the economic recovery was at risk and the financial markets were once again unstable, reconfirming the Fed's inability to forecast policy impact or economic conditions.

Many members of the Fed's governing body, including Bernanke, admitted that monetary policy was not the main problem ailing the economy and that monetary policy could not solve fiscal and structural problems. And, many of these same members also questioned whether additional asset purchases would have any meaningful impact in reviving the economy. Despite the historical scoreboard, a recognition of its limitations and open concerns of policy efficacy, the Fed decided that it was better to be "palliative" than logical or rational; its decision was guided by fear of the unknown rather than a firm understanding of the implications, only leading to more questions concerning the Fed's judgment.

Not only did the evolution of 2011 reaffirm that the Fed put was alive; the 2011 transcripts proved out the Fed's underlying psychology: something is better than nothing (almost literally Bernanke's words). The Fed certainly recognized that its policy came with uncertainty and that there would likely be unintended consequences. However, beyond a broad fear of inflationary impacts and an admission of uncertainty and unintended consequences, the Fed did not rigorously debate or quantify the range of possible negative outcomes (at least not at the time or in the record). It did not debate the consequences of encouraging a credit system which had expanded at a rate of 200% in excess of GDP to expand by 25%. It failed to identify all of the economic imbalances which its policies would allow to be sustained and likely cause to grow. It never quantified why QE1 and QE2 were ineffective; nor has it ever been able to enumerate why QE3 was different. The principal reason why? Because it does not and cannot know. In its own eyes, it was the Fed or Armageddon, more or nothing. Pursuing more of the same policy without first understanding the reasons for its failures and, consequently, the expectations for its future success, demonstrates the Fed collectively lacks the required discretion and temperament for the job it possesses. Its general disposition has proven inconsistent with that of a board of a multi-billion corporation yet it is authorized, and actually managed, to spend trillions of dollars.

Moreover, the Fed's decision to expand purchases of mortgage-backed securities shined a bright light on the extent of the inconsistencies in its policy. The Fed justified its original expansion into MBS during QE1 by arguing it was necessary in order to improve market functioning in a critical non-functioning market. Many Fed members expressed concerns during 2011 about the Fed being in the business of credit allocation rather than simply interest rate targeting and argued for a transition as quickly as possible to a balance sheet only comprised of treasuries. With varying degree of concern, most agreed. Without the transcripts yet available for 2012, it is impossible to fully know what changed and the nature of the debate. The minutes from the September 2012 Fed meeting only serve to further highlight the policy inconsistency and the gap between the concerns regarding the Fed holding MBS in 2011 and its decision in 2012 to expand purchases of MBS massively.

Despite longer-term inflation expectations being "stable" and improvement in the labor market, the Fed used the excuse of "medium-term" inflation being below an arbitrary 2% threshold and the "slow pace" in labor market improvement to justify incremental purchases of $40 billion per month in MBS for an indefinite period of time. This decision led to the aggregate purchase of an incremental $1.1 trillion in MBS, adding to the $600 billion purchased through QE1. While it was noted that one voting member (Richmond Fed President Jeffrey Lacker) dissented "because he viewed it as inappropriate for the Committee to choose a particular sector of the economy to support," the committee as a whole never justified why in fact it was appropriate nor did it disclose that the concern was more broad-based.

FIGURE 25. *A Wanting Justification for an Inconsistent Policy Stance Leads to $1.7 Trillion More QE*
Source: Federal Reserve Minutes, September 2012 Meeting

> *"Members generally continued to anticipate that, with **longer-term inflation expectations stable** and given the existing slack in resource utilization, inflation over the medium term would run at or below the Committee's longer-run objective of 2 percent."*
>
> *"In their discussion of monetary policy for the period ahead, members generally expressed concerns about the slow pace of **improvement in labor market conditions** and all members but one agreed that the outlook for economic activity and inflation called for additional monetary accommodation. Members agreed that such accommodation should be provided through both a strengthening of the forward guidance regarding the federal funds rate **and purchases of additional agency MBS at a pace of $40 billion per month.** Along with the ongoing purchases of $45 billion per month of longer-term Treasury securities under the maturity extension program announced in June, these purchases will increase the Committee's holdings of longer-term securities by about $85 billion each month through the end of the year, and should put downward pressure on longer-term interest rates, support mortgage markets, and help make broader financial conditions more accommodative."*

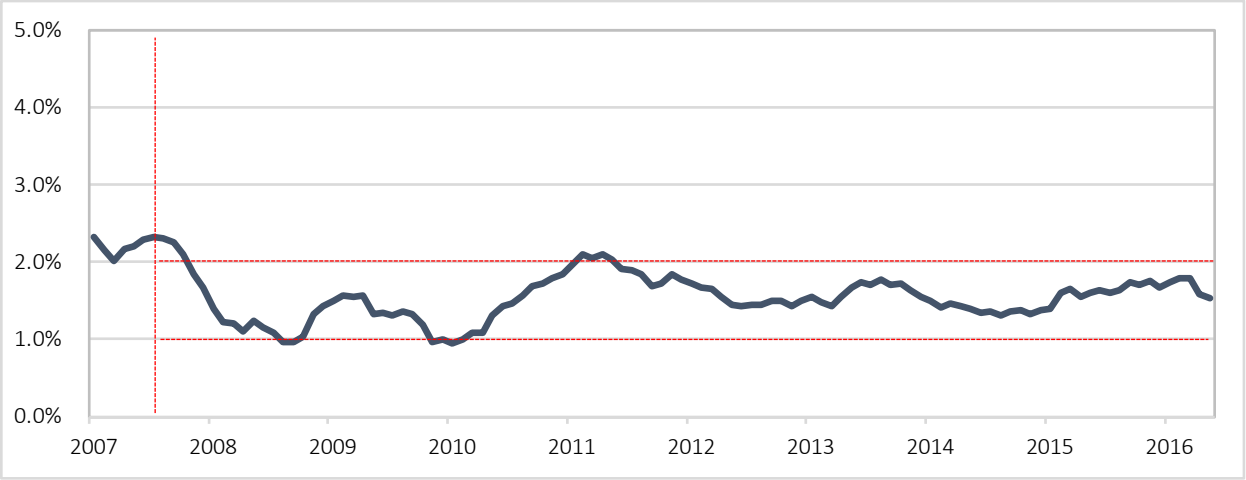
The Fed ultimately believed that direct purchases of MBS would be more effective in the transmission of its monetary policy. The English version: household wealth is significantly tied to home values, so if the Fed manipulated the housing market to prop up home prices, the perception of household wealth would increase as would consumer confidence which would stimulate credit creation, consumer spending and aggregate demand which is the Fed's religiously held view of how best to achieve full or maximum employment. In its totality, the Fed has manipulated markets that could otherwise not be self-sustained. It has done so with poor judgment, an ill-suited temperament, a flawed decision-making process, inconsistent policies and an inability to accurately forecast or measure the impact of QE.

THE CURRENT UNSUSTAINABLE STATE OF PLAY

Throughout the Fed's extreme policy experiment over the course of the last decade, inflation was the one clear and present danger of which the Fed was constantly conscious. With each additional accommodative policy decision, there were always members of the Fed concerned with impacts on inflation. **How could the Fed lower interest rates to 0% for seven years and print $3.6 trillion dollars without creating rampant inflation?** Despite all of the Fed's herculean efforts, the Core PCE (personal

consumption expenditures) inflation measure stubbornly stayed in a tight corridor between 1-2%: low inflation volatility, just what the Fed wanted and had intended. Never mind the extreme measures that everyone thought would be more inflationary or why QE had not been.

FIGURE 26. *The Great Moderation Returns: Core PCE Goods and Services Y-o-Y Stays in Tight Corridor*
Source: Bureau of Economic Analysis.

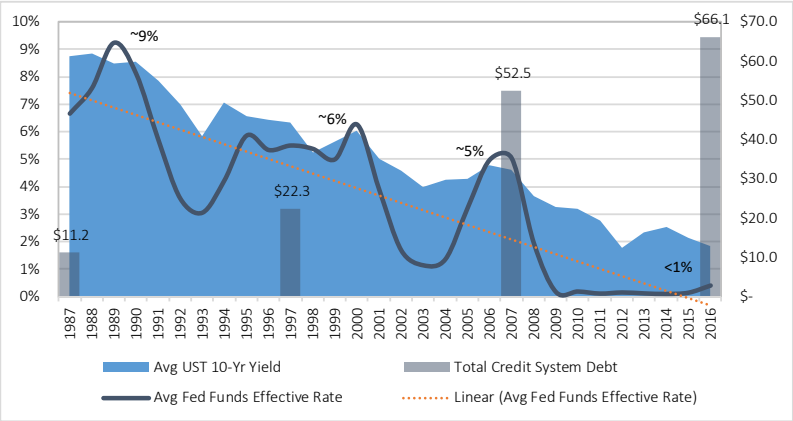


A primary reason why: debt and leverage. While there was an occasional comment about debt levels impeding growth, the Fed and the market never seem to make the direct connection between the credit system leverage and the lack of elevated inflation in response to the Fed's policy decisions. The link between the system leverage and lack of success of Fed policy in driving higher rates of growth was also never directly made. For two decades leading up the 2008 crisis, **the Fed had induced excessive leverage which not only pulled forward a massive amount of future demand but it also caused households, governments and corporations to take on debt that could not be afforded or sustained.**

As the Fed engaged in creating bank reserves to ease financial conditions, its policy was designed to induce the creation of additional credit (debt) and it was successful to the tune of $13 trillion in incremental net debt issued from 2007 to 2016. Unfortunately, non-productive government debt expansion accounted for over 70% of the net credit created, as domestic private sector demand for credit was predictably weak because households and corporations were already over levered entering the crisis, owing debts that could not be repaid.

The Fed effectively prevented these pre-crisis debts from being restructured through its reflationary policies. In response to the Fed's extreme measures to stimulate credit demand and aggregate demand, the entire domestic private sector only created $2.4 trillion in net new credit while the public sector allowed government debt to explode by $10 trillion. The private sector was rational, responding to the reality of the imbalances that existed pre-crisis due to unsustainable debts that never went away while the public sector, with the help of the Fed and money dealers, borrowed to the hilt, something only an irrational economic actor could or would do.

FIGURE 27. *Lower Interest Rates = Expanded Credit System: Government Debt Leads the Way*
Source: Federal Reserve Data. Total Credit System (Gray Bars, $ in trillions, right axis), Interest Rates (Left-Axis)

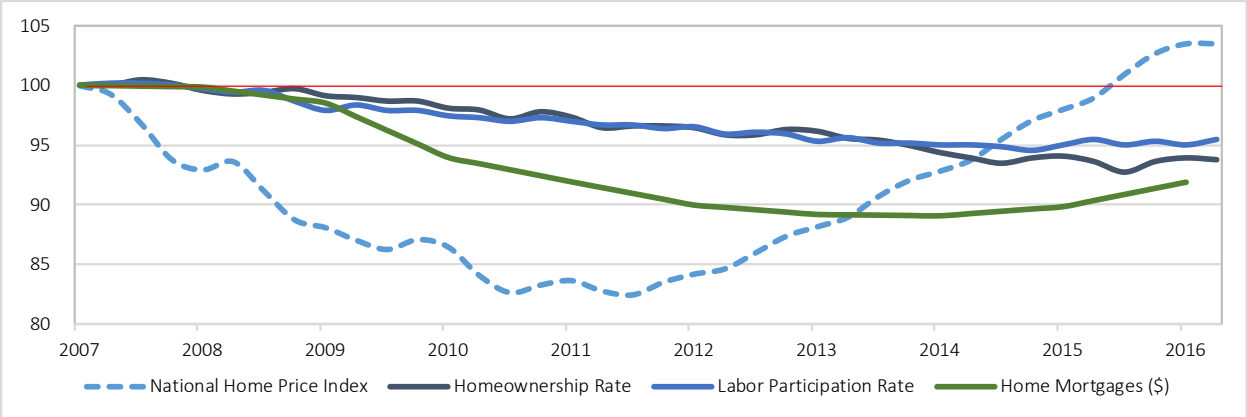


($ in trillions)	2007A	2016A	Increase
Home Mortgage	$ 10.6	$ 9.8	$ (0.9)
Consumer Credit	2.6	3.8	1.2
Household Other	0.9	1.2	0.3
Household Total	**14.2**	**14.8**	**0.6**
Non-Financial Business	10.1	13.5	3.4
Federal Government	6.1	16.0	9.9
State & Local Government	2.9	3.1	0.1
Non-Financial Sector	**33.3**	**47.3**	**14.0**
Financial Sector	17.3	15.7	(1.6)
Foreign	2.0	3.1	1.1
Total Debt	**$ 52.5**	**$ 66.1**	**$ 13.6**
GDP	**$ 14.5**	**$ 18.6**	**$ 4.1**

The net unintended consequence of the Fed's policy has been to sustain and exacerbate existing imbalances and to create new imbalances by expanding a credit system that was clearly unstable in 2008. Most notable are the imbalances in the housing market and the labor market. Prior to the onset of the crisis, the home ownership rate according to the U.S. Census Bureau was 69%, compared to 64% in 2017. While the Census estimates that the number of households has increased by six million (from 112 million prior peak to 118 million today), the implied number of households owning homes has declined by over two million (from 77 million prior peak to 75 million today).

Over the same period, household mortgage debt outstanding has actually declined by $900 billion (from $10.6 trillion to $9.8 trillion), while the labor participation rate has declined from 66.2% to 62.9%. Despite these statistics which would seemingly be negative for housing, the FHFA nationwide home price index is approximately 3% above the prior peak. With a housing market in imbalance pre-crisis (a surplus of supply in excess of demand), combined with now lower labor participation rates, lower home ownership rates and lower aggregate funding levels (less mortgage debt), one should expect home prices to be lower, not higher. Without the Fed's purchase and continual reinvestment of $1.7 trillion in mortgage-backed securities, would this be possible?

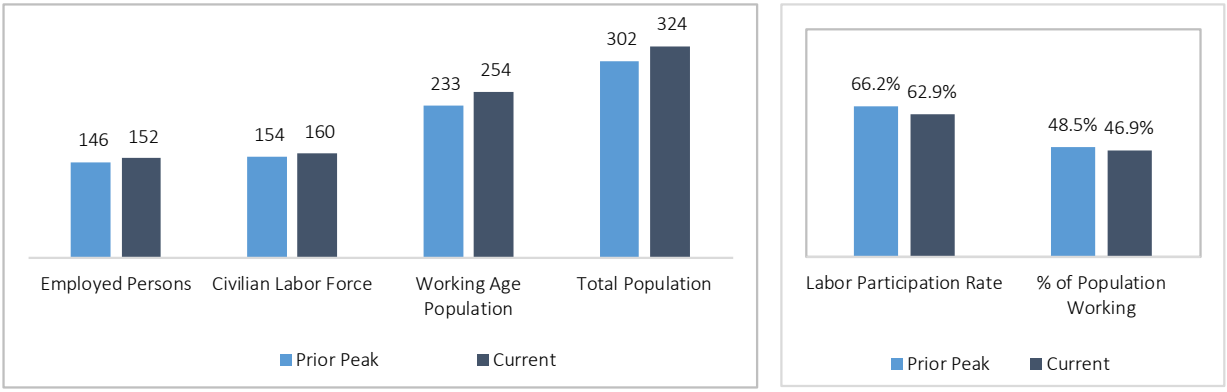
FIGURE 28. *Home Price Index vs. Home Ownership Rate, Labor Participation Rate & Mortgage Debt*
Values Indexed to 2007, Source: Federal Reserve Data.



The imbalances are not only evident in the housing market but also in the labor market. Specifically, there is a considerable imbalance between relative prices and relative wages, partly driven by the decline in the labor participation rate. Note that the labor force participation rate is calculated as the civilian labor force (employed + unemployed actively seeking employment) divided by the working age population which is defined as the population 16 years and over, including those entering and in retirement. Despite the decline in the participation rate, the work force has actually grown from pre-crisis levels by 5.7 million (from 154 million pre-crisis to 159.7 million) and the net number of employed persons has also grown by 5.7 million, i.e. net new jobs created.

However, the working age population in the country has grown by over 21 million during the same period (from 233 million to 254 million). While a 3.3% decline may not seem all that significant, if the current labor force participation rate were equal to the pre-crisis level, there would be approximately 8.4 million more workers in the labor force than there are today (i.e. there would be 168.1 million vs where it currently stands at 159.7 million). The crux is that **for nearly every 4-person increase in the working age population, only 1 is working and in aggregate, nearly 8 million more Americans should be working**.

FIGURE 29. *The Civilian Labor Force: Participation Rate Has Declined by 3.3%*
Eight Million More Americans Would Be Working If the Labor Participation Rate Were at Prior Peak, Source: BLS.



Making the equation worse is that an aging population, the reason often blamed for the declining participation rate, while certainly an issue is far from the only factor at play. The decline in participation rate is broad-based across demographic groups according to the latest data from the Bureau of Labor Statistics which tracked the changes in participation rate from 2004 to 2014. Over this period, Caucasians, African Americans, Asians and Hispanics all experienced 2%+ declines in labor participation rates. Similarly, within each group, both men and women are participating at lower rates, while men generally suffered steeper declines. Most troublesome however is the breakdown by age group as it is actually younger people (16-24) and the middle-age which makes up the core of the workforce (25-54) which are participating at lower rates while older workers (55+) are actually participating at higher rates. As of 2014, there were actually 2.4 million fewer Americans between the ages of 16-54 in the workforce than a decade prior in 2004. The table below shows the breakdown in participation rates from 2004 to 2014 (note that the labor force participation rate in aggregate as of August 2017 is the same as it was in 2014 - approximately 62.9%).

FIGURE 30. *The Lost Decade for the Core Group of Workers: Fewer Workers Aged 16-54*
2004 vs. 2014, Source: Bureau of Labor Statistics.

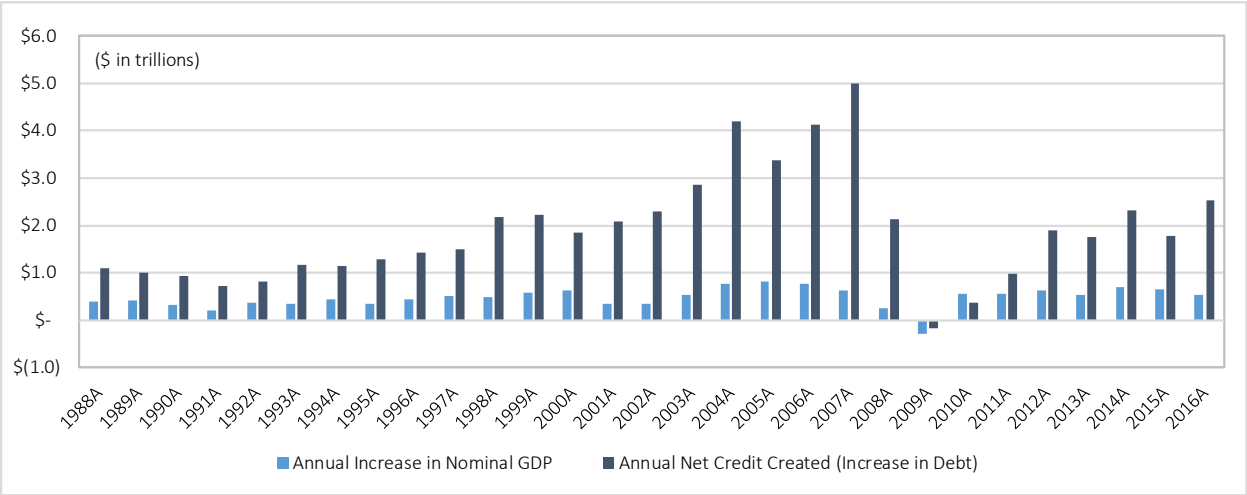
Source: U.S. BLS	Participation Rate			Participating in Labor Force			Working Age Population		
	2004A	2014A	Change	2004A	2014A	Change	2004A	2014A	Change
Age:									
16 to 24	*61.1%*	*55.0%*	*(6.1%)*	*22,268*	*21,295*	*(973)*	*36,419*	*38,712*	*2,293*
25 to 54	*82.8%*	*80.9%*	*(1.9%)*	*102,122*	*100,767*	*(1,355)*	*123,410*	*124,511*	*1,101*
55 and older	36.2%	40.0%	3.8%	23,011	33,860	10,849	63,527	84,724	21,197
Gender:									
Men	73.3%	69.2%	(4.1%)	78,980	82,882	3,902	107,710	119,748	12,038
Women	59.2%	57.0%	(2.2%)	68,421	73,039	4,618	115,647	128,199	12,552
Race:									
White	66.3%	63.1%	(3.2%)	121,086	123,327	2,241	182,643	195,498	12,855
Black	63.8%	61.2%	(2.6%)	16,638	18,873	2,235	26,065	30,843	4,778
Asian	65.9%	63.6%	(2.3%)	6,271	8,760	2,489	9,519	13,785	4,266
All other groups	66.4%	67.6%	1.2%	3,406	4,961	1,555	5,130	7,335	2,205
Total	**66.0%**	**62.9%**	**(3.1%)**	**147,401**	**155,922**	**8,521**	**223,357**	**247,947**	**24,590**

Despite the imbalances evident in the housing market and labor market, the S&P 500 Index and the Dow Jones Industrial Average are both approximately 50% higher than the prior peak in 2007. As is well understood, wealth effects are generally pro-cyclical; higher home values translate to higher household net worth and lower interest rates translate to higher prices for financial assets (stocks and bonds) also driving household net worth higher. Both wealth effects fuel the other, resulting in greater appetite for risk taking. As evidence, household net worth derived from the stock market has risen to $40 trillion, an increase of $15 trillion from the prior peak (or 60% above 2007) at the same time when home prices reach all-time highs. On net, household net worth has increased by over $30 trillion above the prior peak in 2007 according to Fed estimates, all in response to the Fed creating $3.6 trillion through QE despite declining labor participation rates and stagnant real wages.

Ultimately, price levels (and perceived dollar net worth) are a function of the Fed and can only be sustained temporarily as an already over-extended credit system continues to expand. The Fed intended to reflate assets values and it did, in a big way. Unfortunately, **everywhere the market looks, the Fed has created and caused distortion, albeit unintentionally in an effort to stimulate growth.**

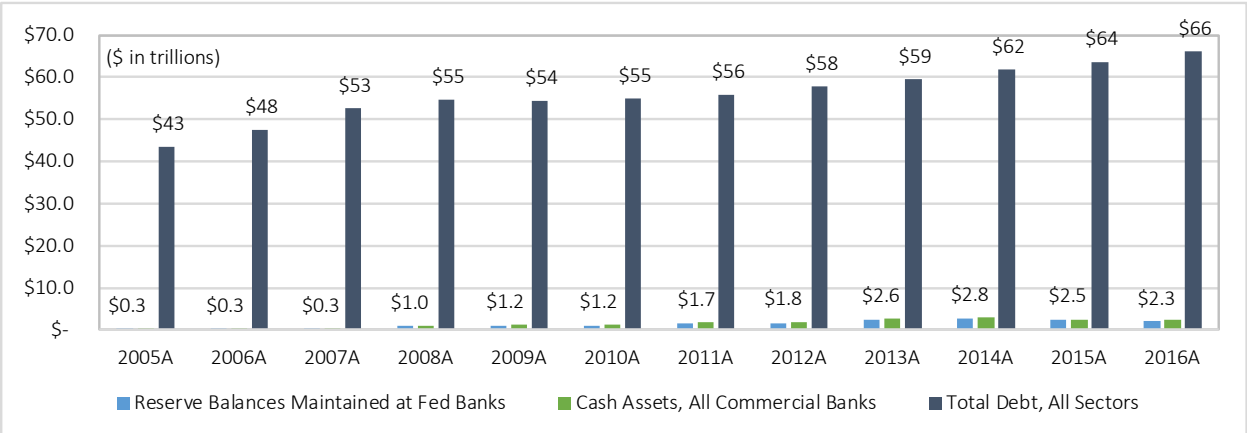
Right or wrong, the Fed has done whatever it takes to fuel credit expansion, without a clear or quantifiable insight into the imbalances created in the housing market, the labor market or financial markets. However, the credit-fueled recovery of the last decade is not fundamentally different than the 20 years leading up to the crisis. The Fed has responded the same way for thirty years. Other than being more material in size and term, the policies of QE are no different than the policies of the Great Moderation. But, **the risks are greater as the Fed has taken us all further out on to the same ledge.**

FIGURE 31. *The Last Thirty Years of Fed Policy: Explosion in Debt Outpacing Rate of GDP Growth*
Annual Increase in System-wide Debt vs. Annual Increase in GDP, Source: Federal Reserve Data.



By 2007, after two decades of the Fed continually making credit cheaper, every dollar that existed within the banking system had been pledged over 150 times ($53 trillion in debt vs. $350 billion in banking system cash), excluding the impact of derivatives. Today, as a function of the Fed increasing the amount of bank reserves through QE by nearly $3 trillion, net system leverage is lower. However, gross leverage is also materially higher for much the same reason, as the Fed's low interest rate policy drove further credit expansion. After multiple QE programs and shifts in the Fed's liabilities (as bank reserves have been converted to physical currency outside the control of the banking system), the $66 trillion in liabilities that exist today are supported by only $2.3 trillion in banking system cash.

FIGURE 32. *An Over-Levered Banking System: $30 Dollars of Debt for every $1 of Bank Liquidity*
Banking System Cash (Green), Bank Reserves (Light Blue) vs. System-Wide Debt (Blue) Source: Federal Reserve Data.



The total cash that is currently in the banking system is approximately $2 trillion higher than it was entering the crisis. However, even after the Fed increased the amount of cash in the banking system by

over 6 times ($350 billion then vs. $2.3 trillion today), every dollar that exists today in the banking system has still been pledged almost 30 times over. Also as a consequence, **even more demand has been pulled forward over the course of the last decade as more credit was created**. The leverage profile of the credit system and the decades of pulled forward demand **restrict the economy and prevent more robust and productive growth resulting in economic fundamentals diverging from the value of financials assets (stocks and bonds),** a status quo that can only exist under easing financial conditions.

The same leverage dynamics also explain why the Fed's fears of inflation have generally always been a false flag. Inflation is principally a function of the balance, or imbalance, between aggregate supply and aggregate demand and the Fed has distorted both supply and demand for an extended period of time. When aggregate demand is in excess of aggregate supply, inflation follows, whether a function of growth in demand outpacing growth in supply (demand-pull inflation) or a function of a supply shock (cost-push inflation). When aggregate demand falls short of aggregate supply, deflation follows.

The Fed's policy created both inflationary and deflationary pressures as it stimulated expenditures on consumer goods (demand-side) and capital projects (supply-side) by lowering interest rates. Low interest rates tend to drive consumption of goods and capital projects that are sensitive to long-term financing (i.e. long-term supply and demand pulled forward which initially has an inflationary impact). In terms of consumer expenditures, this means the likes of housing and autos. In terms of capital investment, it means expansion of supply chains and output capacity. The broader, second order economics effects then follow from increased first order activity (retail, hospitality, restaurants, etc.).

However, as a consequence, the Fed's policy caused long-term demand to be pulled forward and for supply to be expanded. And, the supply side was not only expanded within the U.S. but also globally. Because the dollar is the primary funding currency of the globe, the Fed's policy of ever cheaper dollar funding, combined with the effects of fiscal policy, helped accelerate the globalization of supply chains, further expanding and diversifying supply. More fragmented and more capacity of global supply chains has created an environment in which broad pressures on price levels quickly become evident as global demand predictably slows after years of having been pulled forward. In aggregate, the Fed has created an environment in which current demand is weak and existing capacity on the supply side is more than sufficient. **The net effect, after the initial pull-forward of demand, is a constant deflationary pressure and the only thing the Fed fears more than inflation is deflation**.

When credit systems expand, i.e. when new credit is created, the impact is inflationary as that demand is pulled forward but the opposite is true when credit systems contract. When incentives on both the supply and demand side are distorted through the Fed's low interest-rate policy, it increases the likelihood that supply and demand fall into a more severe imbalance through misallocations of capital. The Fed fails to recognize the extent to which it has created a massive imbalance in the credit system and corresponding supply and demand structures. The effect is cumulative and with limited understanding of the actual size of the imbalance because it is impossible to quantify, the Fed is currently fearful of the inflationary impacts of its policy when it should be focused on the risks of financial stability.

In 2011, as the Fed was completing QE2, there were signs that the economy was slowing yet many members remained concerned about the second order inflationary effects of creating over $1 trillion dollars. In an effort to understand history, Fed Governor Tarullo reviewed the transcripts from 2005 and 2008 to understand how the Fed had weighed inflationary pressures at the time and how those considerations informed policy decisions. In review of 2008, Tarullo found that the Fed was downplaying financial risks and playing up inflationary concerns. While Tarullo did not identify the missing link, he did urge the Fed to question its underlying assumptions and its fundamental understanding of what may be driving countervailing pressures.

FIGURE 33. *History Repeats: False Flag of Inflationary Pressures vs. Downplaying Financial Risks*
Source: Federal Reserve Transcripts, August 2011 Meeting, Governor Tarullo.

> *"MR. TARULLO. Over the weekend, one of the many things I did instead of hunting for Easter eggs was to go through the transcripts of the FOMC from the middle part of 2005 and from all of 2008, periods during which there had been big run-ups in oil prices and, to some degree, other commodity prices, to see how the FOMC was assessing what was going on and to see whether we can learn anything from that experience [...] But I contrast that with just stating things that might happen, and this is what one learns by going back and looking at the transcripts. Concerns about commodity prices, particularly reports of what businesses are saying—**and there was a lot of this in 2005 and 2008—read like this: "Man, we have just shifted. We are now thinking in inflationary terms." And of course, about six months later they weren't. [...]** And I guess, Richard, what I'd say is that **the 2008 transcripts are probably more a lesson in the need to look at what else is going on**. I have to say, I was taken by the **relative downplaying of financial risks** and **the relative playing up of inflationary risks** in the middle part of 2008."*

The same concerns Governor Tarullo highlighted regarding the Fed's thinking in 2008 turned out to be true in 2011. In 2011, through the first quarter and into the summer, there were concerns about inflation. By September, Bernanke was evoking 2008. There is a similar dynamic at play today. The Fed held a meeting on February 1, 2017 and Fed Chair Yellen testified to Congress on February 14, 2017. Yellen signaled to the market that a March hike was possible but not probable. Suddenly, during the last week of February, the Fed rushed several governors out to signal to the market that a March rate hike was coming. The probability of a March 15th rate hike was less than 30% during the week subsequent to Yellen's testimony. By the first week of March, the probability of a March 15th rate hike had increased to 90% and the Fed in fact raised 25 bps.

What changed that caused the Fed to suddenly signal a March hike? The minutes from the meeting downplayed inflationary fears but history says the Fed was afraid of being behind the curve, as market expectations for wage inflation had increased significantly. By accelerating rate increases (1 hike in 2015 and 2016 vs. 3 projected for 2017) and by signaling balance sheet reduction in the near term (incremental tightening), the Fed was clearly concerned about the economy overheating, inflationary pressures rising and its credibility deteriorating after eight years of easy money.

As is often the case with the Fed, there was a dissenting voice but the dissent was overruled by the collective. In this case as the minutes from the Fed's March 2017 show, Minneapolis Fed President Neel Kashkari dissented because "recent data had not pointed to further progress on the Committee's dual objectives and thus had not provided a compelling case to firm monetary policy [.]"

Soon after the Fed's March 2017 meeting, Kashkari took to the internet to further elaborate on his views of the current state of the economy in a blog post specifically aimed at refuting claims made by the CEO of J.P. Morgan, Jamie Dimon, who had argued in a letter to shareholders that bank regulations on capital requirements were excessive and preventing lending that would stimulate economic growth. While not connecting the Fed's role in pulling forward decades of expenditures, Kashkari rightly pointed to the lack of fundamental demand for new loans in order to undress Dimon's claims.

FIGURE 34. *The Fed vs. Wall Street: Regulatory Constraint or Fundamentals Impeding Growth*
Source: Blog Post by Neel Kashkari, Minneapolis Fed President, April 6, 2017.

> *"Mr. Dimon argues that the current capital standards are restraining lending and impairing economic growth, yet he also points out that JPMorgan bought back $26 billion in stock over the past five years. If JPMorgan really had demand for additional loans from creditworthy borrowers, why did it turn those customers away and instead choose to buy back its stock?"*
>
> *"The truth is that borrowing costs for homeowners and businesses are near record lows. If loans were scarce, borrowers would be competing for them, driving up costs. That isn't happening."*

FUNDAMENTALS ARE JUST BEGINNING TO WEAKEN IN RESPONSE TO FED

While there is at least one voice within the Fed that has a directional pulse on underlying fundamental issues, the Fed as a whole has fallen victim yet again to false flags of growth. With rate hikes in December 2016 and March 2017, the Fed has signaled economic strength and remained committed to its tightening course. Over that same period of time and in subsequent months, hard economic data weakened as did market expectations of growth. Q1-2017 GDP growth of 1.2% quarter-over-quarter on a seasonally-adjusted basis, indicated a decelerating pace of expansion from the second half of 2016. Unit auto sales data continues to disappoint with each of the first eight months of 2017 down year-over-year. While jobs data remains positive, bank credit expansion continues to slow as interest rates rise, delinquencies on the consumer side begin to increase, specifically driven by poorer performance of auto loans, credit card loans and student debt, and retail struggles with both structural and cyclical issues.

FIGURE 35. *Unit Auto Sales Struggling: Y-o-Y Declines in First Eight Months of 2017 (and 11 of Last 13)*
U.S. Monthly Unit Auto Sales, Y-o-Y, Source: Ward's Auto Data.

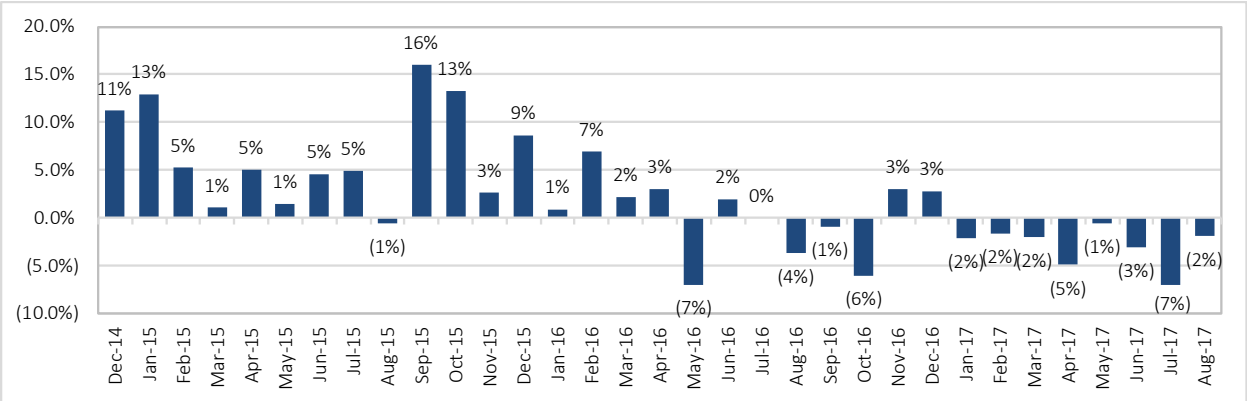


FIGURE 36. *Recent Auto Weakness Related to Increasing Delinquencies & Tightening Auto Credit*
Auto Loans 90 Days+ Past Due, % of Balance, Source: New York Fed Data (through Q2 2017 – June Quarter).

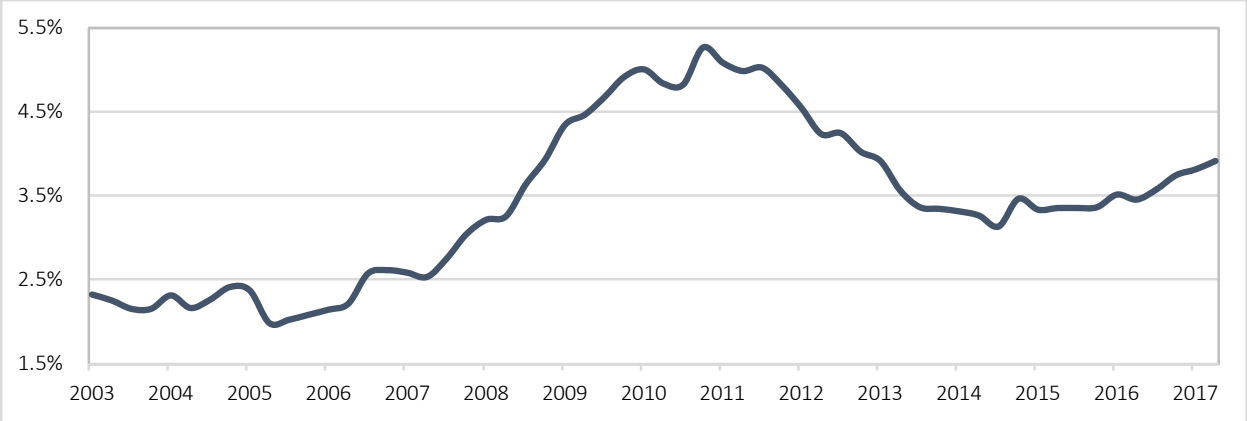


FIGURE 37. *Loans and Leases in Bank Credit: Loan Creation Slowing Broadly Across Banks*
Net Credit Created on a Rolling Last Six-Month Basis, $ in Billions, Source: Federal Reserve Data.

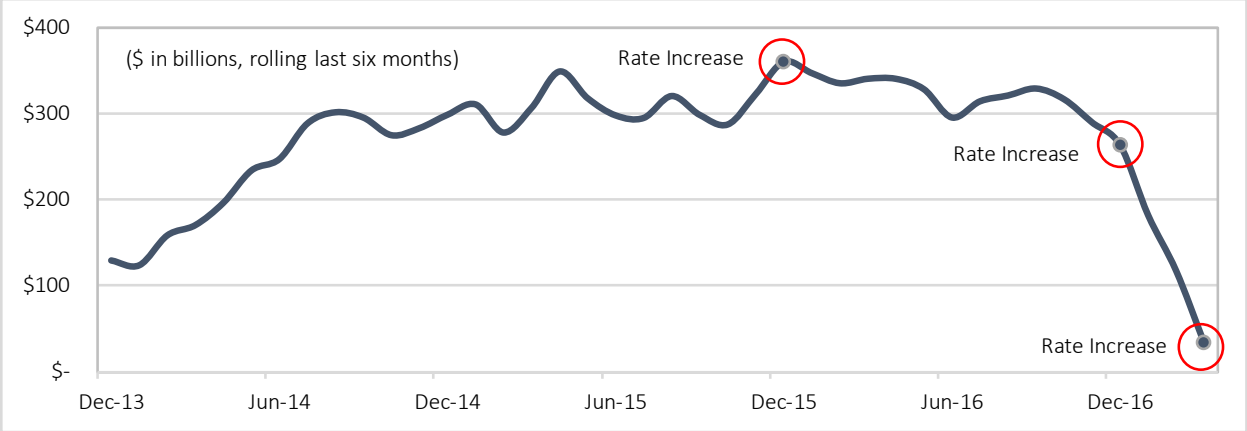
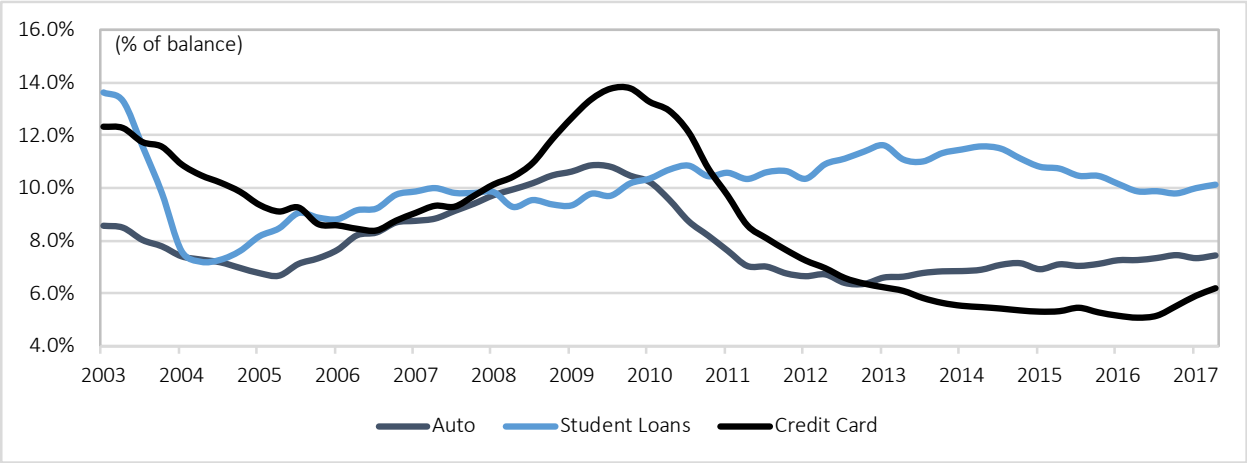


FIGURE 38. *Consumer Credit: Fundamentals Just Beginning to Deteriorate as Delinquencies Start to Rise*
Transition into Delinquency: New Delinquencies 30+ Days Past Due (% of Balance), Source: NY Fed Data.



In the 10 weeks subsequent to the March rate hike, the yield on the 10-yr U.S. treasury declined by 40bps from (2.6% to 2.2%) and the spread between 10-yr treasuries and 2-yr treasuries collapsed by 33 bps (from 125 bps to 92 bps), **signaling market fears of broad economic weakness**. Generally, when economic conditions weaken, the treasury yield curve flattens as it has (spreads between long duration bonds and short duration bonds tighten). Historically, during recessions, it is not uncommon for the yield curve to invert (long duration bonds trading at a premium to shorter duration bonds on a yield basis). For example, during a recession, it is not uncommon for the 10-yr treasury to trade at a lower yield than a 2-yr treasury, primarily due to deflationary concerns and more negative longer-term outlooks.

FIGURE 39. *Signs the Market is Not Confident: 10 Yr. Treasury Yields Decline Over 40 bps Post Rate Hike*
Daily Yield on 10-Yr U.S. Treasury, Source: Federal Reserve Data.

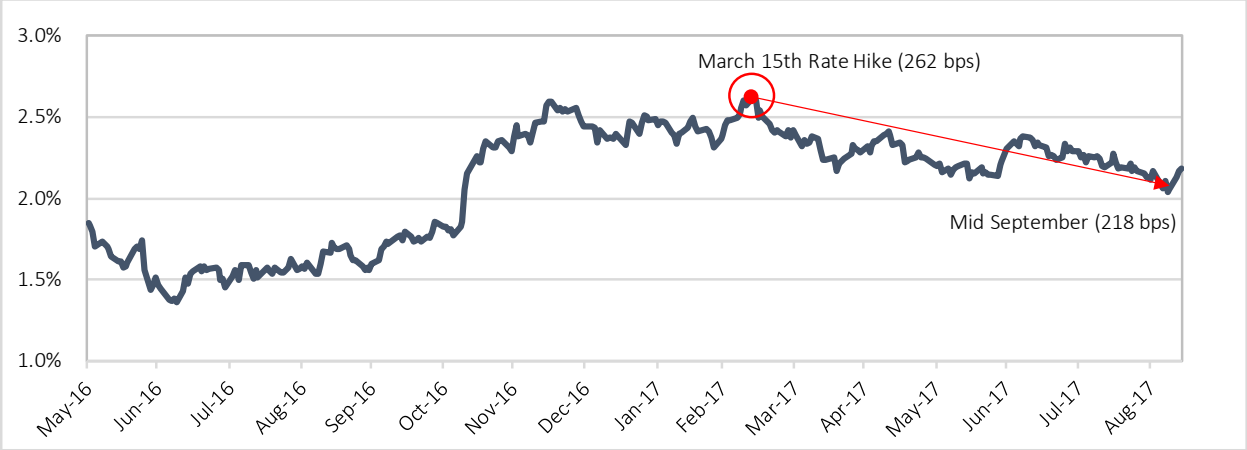
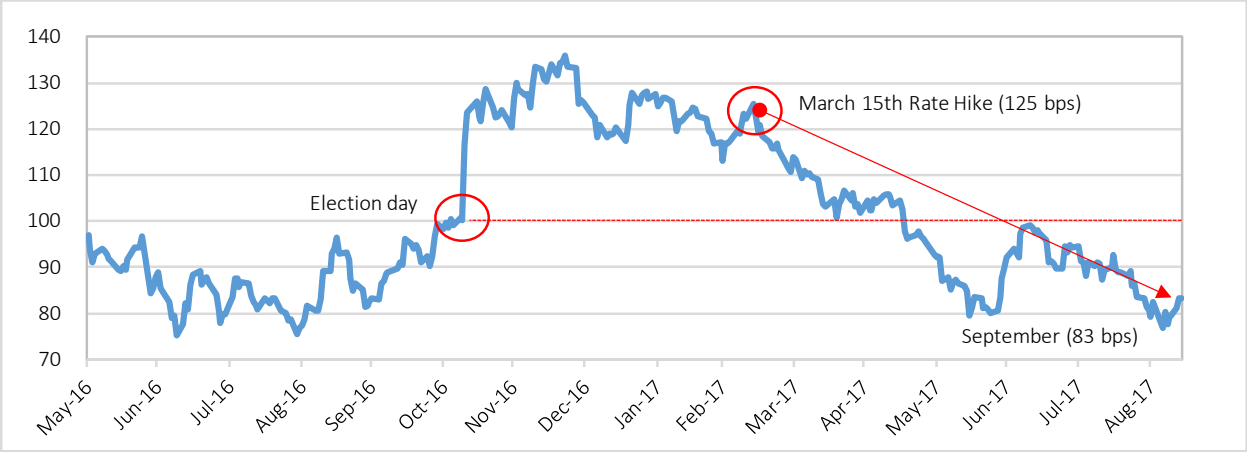


FIGURE 40. *Signs the Market is Not Confident (Continued): Spread Between 10yr & 2yr Treasury Collapse*
Spread Between Daily Yield on 10-Yr U.S. Treasury and 2-Yr U.S. Treasury, Source: Federal Reserve Data.



Following the election of Donald Trump, the market began to focus on fiscal reform as an economic stimulant rather than monetary policy for the first time in nearly a decade. Confidence soared and bond

yields rose as investors sold bonds to rotate into the stock market. Distracted by the promise of tax reform, the rolling back of regulation including Dodd-Frank and environmental protections, and the repeal of Obamacare, the market lost focus on the Fed. Unfortunately for the market and the Fed, fiscal reform cannot suddenly make the mountain of debt created by sins of many decades suddenly disappear. Deficit financed tax cuts that do not address entitlements and long-term spending levels would only serve to provide a temporary and muted increase in demand in exchange for even more government debt. Rolling back regulation would be fundamentally positive on the margin going forward but it would not solve for the imbalances that currently exist between relative price levels and relative wage levels. Because of 30 years' worth of flawed policy and the Fed's current stance to tighten monetary conditions, the future economic and market outlook remains all about the Fed.

WHAT COMES NEXT – REVESE QE aka FED BALANCE SHEET REDUCTIONS

The Fed unwittingly created a problem and the problem is made worse by continually moving the figurative goal posts closer and then further away. If the Fed fully understood how sensitive economic conditions truly are to interest rates, it would not be signaling incremental rate increases and it certainly would not be discussing shrinking its balance sheet. The shadow banking system (~$66 trillion assets/liabilities) is levered to the commercial banking system ($16.2 trillion assets/liabilities) which is levered to the Fed's balance sheet ($4.5 trillion assets/liabilities). **If the Fed's balance sheet contracts, it will cause all balance sheets levered to it to contract.**

The linkage will not be direct but it will be causal. Should the Fed shrink its balance sheet, bank reserves (i.e. liquidity) will be drained from the system. As a result, there will be fewer dollars that exist within the banking system and each remaining dollar will become more expense (longer-term rates rise). As more dollars were created, supply increased and the funding costs for dollars (interest rate) declined. If the Fed shrinks its balance sheet, the reverse will be true: supply will decrease and dollar funding costs will rise.

Rising interest rates slow down the propensity to borrow and spend. By raising short term rates, the Fed is effectively incentivizing banks not to create credit on the margin which will have the impact of slowing the velocity of money. Similarly, but differently, as the Fed stops reinvesting its balance sheet, longer term interest rates will rise which will cause corporations, individuals and governments to demand less incremental longer-term credit. Not only will there be less demand for incremental credit as credit becomes more expensive but there will also be fewer dollars to repay existing loans; as a consequence, delinquencies and defaults on existing credit will increase which will cause velocity to slow and GDP to decline more precipitously. As business and consumer confidence turns, savings rates will increase and spending, investment and GDP will decline further. It will be a precipitous negative feedback loop.

Expanding the money supply through QE allowed for a system that was too levered to add trillions of debt and the type of growth it generated was dismal. **Shrinking the money supply will make the original problems all the more evident as it forces the beginning stages of a system-wide**

deleveraging event. As discussed previously, a system-wide deleveraging event will almost assuredly lead to a liquidity problem because there are not nearly enough dollars to fund all the liabilities that exist. As the Fed's balance sheet contracts, perceived liquidity in short-term and funding markets will evaporate.

Why does the Fed not see the buzz-saw coming? Mainly because of how it views market liquidity and thus financial stability but also because the Fed views the current state of the economy as stronger than the weakening data would suggest. From a liquidity standpoint, the Fed thinks about the size and composition of its balance sheet largely as if its two main type of liabilities, bank reserves and currency in circulation, are more or less interchangeable when in reality the two are very different. Bank reserves provide the liquidity needed to fund liabilities in the banking system (the $66 trillion in debt among other obligations). Currency in circulation represents physical cash which is almost entirely outside the control of the banking system. Think cash in your wallet, cash under your mattress, in a safety deposit box, in the black market or sent outside the country. Accordingly, currency in circulation does not provide liquidity to the banking system to fund liabilities. As a consequence, in terms of the stability of the banking system, the amount of bank reserves is far more important than the overall size of the Fed's balance sheet.

When most experts (including current Fed officials, ex-Fed officials and expert macro economists with PhD) evaluate the impact of pending balance sheet reduction, this distinction is not made because the focus is on the expected impact to interest rates and financial markets rather than liquidity and the real economy. Recall that QE2 and QE3 were about interest rate targeting to spur demand, not to solve a liquidity problem. In the Fed's mind, the liquidity crisis had passed. Consequently, when the Fed considers unwinding QE, its goal is to increase interest rates to slow growth in the economy and control inflation. It is not focused on draining liquidity. To the Fed, liquidity is excessive if anything. This is the macro reason why the Fed does not expect the balance sheet reduction to have a material impact on the economy; it will simply slow demand.

From a more technical perspective, the standard argument presented for why balance sheet reduction will not have a large impact is two-fold: 1) it will happen gradually, over time and 2) the balance sheet will not be reduced to pre-crisis levels. First, after the Fed always maintained as it pursued QE that it was the stock of debt that it purchased (size of balance sheet) which mattered rather than the flow (actual purchases), now the argument goes that it will not have a significant impact because the rate of reduction (the flow) will be gradual. Second, regarding the future size of the balance sheet, experts (including current Fed officials) have suggested that the Fed balance sheet will only be reduced to ~$2.5 trillion (a reduction of $2.0 trillion from its current size at $4.5 trillion) when it is fully normalized, this compared to the pre-crisis size of $900 billion.

The primary reason why most experts argue that the balance sheet will not be reduced to its original size: currency in circulation will continue to grow. The following is how Ben Bernanke recently explained it in an op-ed penned in January 2017.

FIGURE 41. *Ben Bernanke Explains How Money Grows on Trees: The Public Just Demands It*
Source: Brookings Op-Ed, January 2017

> *"That's a pretty good description of the Fed's balance sheet before the crisis: liabilities were about $800 billion in currency in circulation, and assets (almost all in Treasuries) were only slightly greater than that. However, today currency in circulation has grown to $1.5 trillion.* ***Because of rising nominal GDP, low interest rates, increased foreign demand for dollars and other factors****, Fed staff estimates that, the amount of currency in circulation will grow to $2.5 trillion or more over the next decade.[7] In short,* ***growth in the public's demand for currency alone implies that the Fed will need a much larger balance sheet*** *(in nominal terms) than it did before the crisis."*
>
> *"Taking currency demand into account as well, it's not unreasonable to argue that the optimal size of the Fed's balance is currently greater than $2.5 trillion and may reach $4 trillion or more over the next decade.* ***In a sense, the U.S. economy is "growing into" the Fed's $4.5 trillion balance sheet, reducing the need for rapid shrinkage*** *over the next few years."*

And, this is where Bernanke's comment to 60 Minutes in 2010 about QE not increasing the currency in circulation breaks down. Since 2007, over $715 billion of cash (currency in circulation) has been withdrawn from the banks, on a net basis – withdrawals net of deposits. At the end of 2007, the banks only had $325 billion of cash in total including reserves held at the Fed. Since the crisis, customers have withdrawn more than twice as much cash that existed pre-crisis; **effectively, there have been over two entire bank runs on the banking system since the crisis**. **This could not have happened without QE**. How those in Fed circles describe the growth in currency in circulation – "the economy is growing so there is growth in the public's demand for currency so the Fed balance sheet will be larger in the future" – is intellectually dishonest and glosses over the insolvency of the banking system. How could $715 billion have been withdrawn from banks if banks only had $325 billion to both finance lending and satisfy withdrawals, rhetorically, emphasis added.

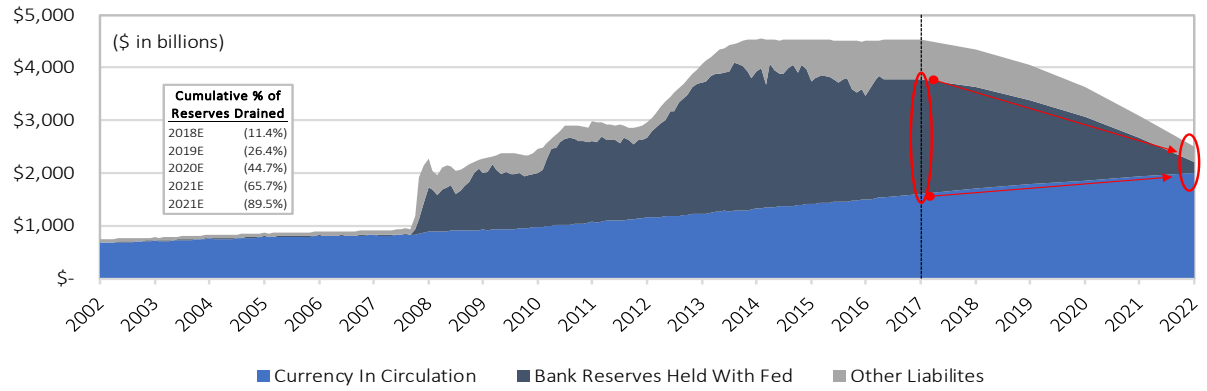
The Treasury may print dollars but the Fed creates them. It does so by first creating a bank reserve. When the public goes to the bank to withdraw cash, that bank reserve is converted to currency in circulation. The Treasury then prints a dollar to supply to the Fed which then can supply it the bank which then supplies it to the public. As a net effect, the conversion of bank reserves into currency in circulation drains liquidity from the banking system; it just does so gradually. However, the current annual average over the past four years is approximately $90 billion per year, representing 4% of current bank liquidity, whereas before the crisis the average annual rate was less than $30 billion (so much for the war on cash).

Soon to be added to the reserves already being drained is the full amount by which the Fed plans to reduce its balance sheet. This is because the Fed cannot directly control the public's tendency to demand currency; it can only control the amount of reserves. The consequence is that, if the experts suggest that the Fed's balance sheet will be reduced by $2 trillion (a reduction of ~45% to the overall balance sheet), this would cause bank reserves to be reduced by approximately 90% and cash liquidity in the banking system to be reduced by over 80%, from $2.4 trillion to $400 billion, albeit over a period time. In a recent interview on CNBC, Fed Governor Jerome Powell suggested just that as if it will not present a problem.

FIGURE 42. *Fed Governor Indicates Bank Reserves Will Return to Fairly Small Number*
Source: Fed Governor Jerome Powell, CNBC Interview with Steve Liesman, June 2017

> *"It's hard for me to see the balance sheet getting below $2.5 trillion, $2.5 trillion to $3.0 trillion and that assumes that we normalize the balance sheet over the course of the next 5 years and go back to a fairly small number of reserves."*

FIGURE 43. *Reverse QE: Based on Initial Fed Indications Bank Reserves Will Be Drained by ~90%*
Fed Balance Sheet Liabilities, Source: Federal Reserve Data (Historical Data), Projections Based on Fed Statements.



The problem with this scenario is that the $66 trillion in debt that exists in the shadow banking system would be supported by only $400 billion in liquidity. Essentially, each dollar would be levered at approximately 165:1, a leverage ratio even higher than existed pre-crisis. Despite this, the Fed does not forecast there being a problem because the Fed thinks about liquidity in terms of how depositors (mainly corporations and households) demand liquidity on a short-term basis in a status quo environment in which credit is expanding and debts are easily refinanced. In reality, the credit system as a whole will begin to contract once the Fed begins to shrink its balance sheet, not when the balance sheet is fully normalized. It just will not be immediately apparent that the contraction will lead to a system-wide deleveraging event.

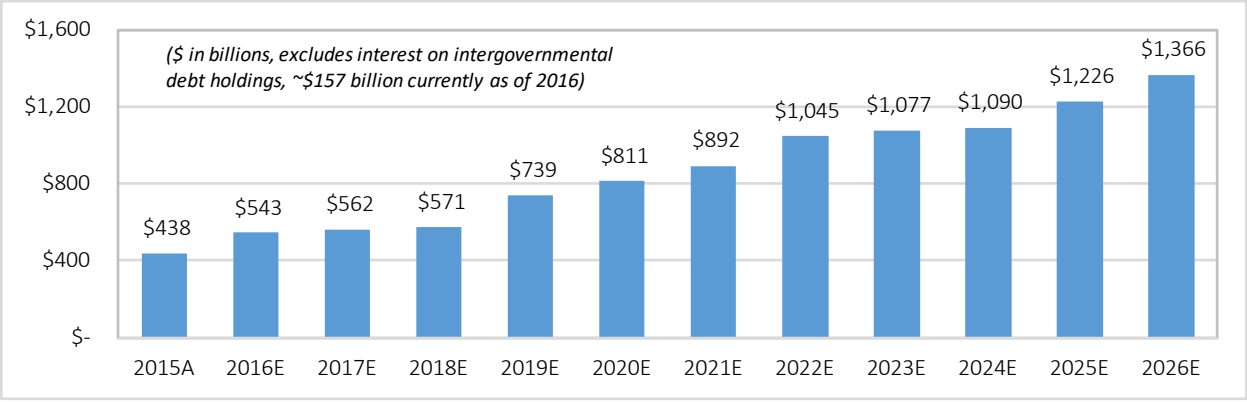
In an over-simplified explanation, everyone agrees that QE caused financial assets to go up (significantly) but no one is willing to admit that when QE is unwound, the reverse will be true. **When dollars were created through QE, the dollar value of financial assets increased** because there were more dollars; **when dollars are removed through reverse QE, the dollar value of financial assets will go down** because there will be fewer dollars. Again, an over-simplification of the transmission mechanism. From a practical perspective, most market participants believe that if the Fed were to tighten financial conditions, it would only happen after the Fed was sure the economy had recovered sufficiently; guided by trust in the efficacy of the Fed's policy, most view QE like an antibiotic rather than an addictive drug. Once the economy is healthy, the antibiotic can be removed; if conditions deteriorate, take more of the antibiotic until it works. Unfortunately, because QE induced the creation of trillions more in fixed liability and fixed maturity debts, QE is more like crack than an antibiotic; the more applied to a financial system, the more dependent that system becomes on it and the worse off when it is removed.

The actual function by which the value of financial assets will be forced lower is through the funding gap that the Fed leaves behind when it stops reinvesting a portion of its securities that mature in the normal course, notably treasuries. Through this transmission mechanism, real interest rates will finally be forced higher; because of the unsustainable leverage in the credit system, the already weakening fundamentals will further deteriorate as interest rates rise and as less market liquidity is available to fund maturing liabilities. There will be a waterfall-like effect as bond investors are compensated in incremental yield for higher quality credit and at each point in the value chain, credit spreads will widen. As investment grade (IG) corporate bondholders and emerging market (EM) sovereign bondholders shift to treasuries, spreads between IG/EM and treasuries will widen. As high yield bondholders shift to IG, spreads between IG and high yield will widen. The ultimate result will be that lower quality credit will continually find a more challenged environment to secure liquidity needed to refinancing maturing obligations.

Because it is a certainty that the Federal Government's deficit will only grow over the next several years, the combined funding gap created by the Fed's gradual balance sheet reduction and the increase in the deficit will need to be funded by resources that are currently devoted elsewhere in the market, notably to finance higher risk sovereigns (EM) and the private sector (IG and high yield).

FIGURE 44. *Maturity Schedule of Treasuries Held by Fed: Currently Reinvesting 100% of Maturities*
When the Fed Begins to Shrink Balance Sheet, It Will Taper Reinvestments, Not Halt Completely. Source: Fed Data.

FIGURE 45. *Federal Deficit: $550 Billion Per Year and Growing Due to Increasing Mandatory Spending*
Source: Congressional Budget Office. Assumes Average Nominal GDP Growth of 4.1%.



The conventional wisdom is that foreign buyers will step in to satisfy a majority of the funding gap. The reality is that foreign buyers have reduced purchases of treasuries materially over the past three years and were actually net sellers of treasuries to the tune of over $200 billion in 2016. Even if foreign buyers increased purchases, that demand will have to come at the expense of some other financial asset because dollar liquidity as a whole will have been reduced (as a function of the Fed). The impact will be widening spreads between risk assets and risk-free assets and higher nominal interest rates of risk assets (corporate bonds and the discount rate applied to equities).

As yields are pushed higher and as less market liquidity is available to fund maturing liabilities, corporate refinancings will become more difficult, less credit will be extended to consumers, and delinquencies and defaults will rise. Savings will increase as consumers and businesses need to source dollars in order to fund liabilities maturing in the future. Spending will decrease, investment will decrease and corporate profits will suffer. The Fed will reverse course but only after it becomes evident that financial markets and economic activity are deteriorating.

While it is unclear at what point critical mass will set in as the Fed shrinks its balance sheet, the force pulling risk assets down in aggregate will be like gravity, no matter how gradual at first. Because the market is focused on fiscal reform rather than monetary policy and because the markets misunderstand the impact of balance sheet reduction on liquidity and the real economy, risk is broadly mispriced. The Fed will surely step in and reverse course in order to avoid a 2008-like crisis with the highest probability scenario being that the Fed responds with more QE, in an aggressive way and sooner than most think. Similarly, and with a high degree of confidence, it should be expected that the Fed is successful in stabilizing markets before the market reaches a true liquidity crisis (90%+ probability of Fed success). However, the Fed will have to be reactionary to market declines rather than proactively altering course in response to deteriorating fundamentals; if the Fed stops shrinking its balance sheet and returns to easy monetary policy while markets remain at all-time highs, it risks losing credibility when it is most needed.

As a consequence, it will not be sufficient for fundamentals to deteriorate in order for the Fed to reverse course; it will have to have become evident in financial markets (lower equities and higher credit spreads). In a scenario in which the Fed's action forces market deterioration but not to the extent that a full crisis ensues, the equity markets will likely have corrected 10-20% (and the high-yield credit markets 20-30%) before the Fed becomes concerned (depending on how orderly or disorderly the early moves).

There is a saying that markets can remain irrational for longer than you can stay solvent. Because of this, execution is the key to neutralizing the unpredictability of timing and the market. Rather than short equities which may suffer greater losses in the end, shorting credit on a relative value basis is the most effective way to manage risk (both timing and mark-to-market) while also providing asymmetric return; in early 2008, credit spreads widened significantly while equities remained neutral as credit instruments fundamentally remain more closely and sensitively linked to initial moves in interest rates. Furthermore, there is naturally less downside risk and volatility to shorting a bond index that is trading in aggregate above par than there is to shorting the equity market which could easily see prices gains that incrementally diverge from fundamentals for extended periods of time.