The Economics of Bitcoin and Digital Assets

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March 21, 2021

Just recently, Bitcoin was able to surpass a market capitalization of 1 Trillion US-Dollars, at an individual price of over $60'000. Analysts attribute this sudden price surge to multiple factors – from widespread adoption by large companies such as Tesla and Mastercard to the announcement of the $1.9 Trillion COVID-19 stimulus package by the Biden Administration. Bitcoin's year-to-date return for 2021 already stands at an impressive 112% (as of March 13). For comparison, the market capitalization of gold stands at roughly $10 Trillion US-Dollars. Optimists believe that Bitcoin might attain similar levels, due to its properties of being a "safe haven asset" – assets that perform well in volatile market environments and periods of actual or expected economic downturn.[1] But what are the fundamental economic mechanisms driving digital assets? And why do opinions on it differ so drastically, even among renowned economists and hedge fund managers?

[1]Note that the classification of Bitcoin as a true safe haven asset has also been disputed. But since there is no consensus on most of Bitcoin's properties, I will treat it as one in this article. See: *Smales, L. (2019). Bitcoin as a safe haven: Is it even worth considering?. Finance Research Letters, 30, 385-393. doi: 10.1016/j.frl.2018.11.002.*

Figure 1: Bitcoin's price development since 2016. Source: tradingview.com

First, it is useful to take a quick look at the fundamental workings of Bitcoin. In more general terms, Bitcoin can be seen as a digital file, that lists accounts and money like a ledger. A copy of the ledger is stored on each computer within the Bitcoin network. Hence, a Bitcoin isn't a simple string of data with the possibility of being duplicated, but it's an entry in this ledger, i.e. the blockchain. The blockchain consists of chronologically arranged blocks. A block is a permanent record, consisting of several of the most recent Bitcoin transactions, before providing a pathway for the next blocks in the chain. Thinking in these terms, a Bitcoin transaction is not a transfer of data from person A to person B, it's merely the creation of a note explaining which coins belong to whom within the blockchain. In addition, in a Bitcoin transaction, you need to send out your digital signature which shows proof of ownership. Of course, a big part of the security also relies upon cryptography. Bitcoins are earned through the process known as *mining*. A miner is someone who decides that they would like to process transactions for which they are rewarded with new Bitcoins. This approach can be compared with some sort of lottery or game. The entry fee for a miner is the costly computer equipment – specifically the ASIC (application-specific integrated circuit). If you are not interested in becoming a miner, then you can just buy Bitcoins on the market. The price of these cryptocurrencies is solely defined by supply and demand and more specifically contingent on whether miners are willing to provide their computing power for transaction processing. The miners are rewarded with Bitcoins for their labor and confirm transactions. Faster miners will always win this competition and earn more Bitcoins. You can also join a pool to share your hash power to accelerate the generation of Bitcoins but you have to agree to share your earnings with the pool in the same way as when you join. Mining can be modelled as follows:[2]

$$p(i) = \frac{q(i)}{\sum_{m=1}^{M} q(m)}$$

This expression, which is rooted in the microeconomics of mining, reveals that the probability $p(i)$ of "winning" is proportional to the fraction of computational power $q(i)$ owned my M miners who compete to update the blockchain. As $M \to \infty$, the expected value is zero, and the aggregate computing power of miners dissolves all rewards from mining. This analysis could be continued by including discounted rewards βR, and optimizing those rewards over computing power $q(i)$, but will be omitted due to the complexity of the derivation of the first order conditions and the resulting equilibrium. For interested readers I recommend exploring the source below.

[2]Chiu, J., & Koeppl, T. (2017). The Economics of Cryptocurrencies Bitcoin and Beyond. *SSRN Electronic Journal.* doi: 10.2139/ssrn.3048124

The Economic Properties of Bitcoin

One of the key characteristics of the blockchain for its economic assessment is the fact that it is completely decentralized. There is no central authority, as it is the case with fiat currency, that controls the creation and hence the supply of the currency. This is linked to another property that distinguishes Bitcoin; its supply is capped at 21 million coins.[3] Once all 21 million Bitcoins are mined, the supply will be exhausted. This means that Bitcoin is a valuable hedge against inflation or expectations of future inflation. Does this mean that I'm talking about digital gold? Not really. Bitcoin, just as fiat currency, is backed by nothing. The bank account value of a Bitcoin is purely fictitious – it only looks like it has value because people use it as money and *believe* that it has value.

So far we have compared Bitcoin to gold, i.e. we treated it as an asset class. But what about Bitcoin as a currency? As we will see, this is not very simple. The main question here would be: Why use Bitcoins instead of dollars? There are various reasons for doing so. The most obvious one would be anonymity. One of the main features of a digital ledger is that it can be shared and copied around the world, without hindrance from national borders. There are also various ways in which an individual can increase anonymity, such as encrypting his wallet with a Bitcoin mixing service's private key (e.g. Blockchain Analysis) or using multiple wallets with different addresses (e.g. Ethereum). Currently, one can't buy bitcoin anonymously, but there are some services that allow users to store their Bitcoin without having their identities attached. However, the fact that you can spend bitcoins anonymously is not enough to make it a viable currency. What we are looking for is a mechanism by which Bitcoin can be used as a medium of exchange. To be able to do this you need something that people trust and want to participate in – this is where the price stability and the technological shortcomings of Bitcoin come into play. In an ideal world there would be no transaction costs. These would be the price you pay for the convenience of banks, or in this case, an electronic ledger. Yet, in reality, these costs do exist. And while many people might be willing to ignore them because they are such a small percentage of the overall value of a transaction (about 0.1 percent), it is not certain whether it will stay this low. Especially since mining is currently a big source of reward, transaction fees will likely increase in the future, to incentivize miners enough to keep the system secure (when all or almost all Bitcoins have been mined). It is also worth considering how governments and regulators will respond to digital currencies over time. The European Central Bank's former chief, Mario Draghi, has said that *"Bitcoins or anything like that are not really currencies, they are assets. A euro is a euro – today, tomorrow, in a month, it's always a euro."*, implying that using digital assets as currencies is not a viable option. There is no doubt that Bitcoin has one thing going for it: popularity. But popularity alone does not make it a practicable candidate for money. There are many more currencies and payment systems coming onto the market in the near future, and a lot of them attempt to eliminate the problems posed by Bitcoin. Hence, other digital currencies may or may not be a viable option as a means of exchange, but it nevertheless remains an unlikely scenario. Still, cryptocurrencies and other digital assets are and probably will remain a useful payment system for many people around the world, especially as worldwide adoption is increasing rapidly.

The Supply Side

Let's analyze some of the aggregate macroeconomic phenomena surrounding Bitcoin a bit closer. As already mentioned, Bitcoin is highly volatile. The reason for this is a strong inelasticity of supply:

$$E^s \equiv \lim_{\Delta p \to 0} \frac{\Delta q}{\Delta p} \frac{p_0}{q_0} \equiv \frac{\partial q}{\partial p} \frac{p_0}{q_0} = \frac{\partial q / \partial p}{p_0 / q_0}$$

This expression perfectly illustrates that given a price p of Bitcoin and a decreasing change in quantity supplied Δq, the elasticity will decrease. At some point, when all Bitcoins are mined, it will become perfectly inelastic (the expression above clearly converges to 0 as $\Delta q \to 0$). Given this inelasticity of supply, an upward shift in demand for Bitcoin leads to a large change in price, as compared to the price change resulting from the same shift at a time when supply is elastic:

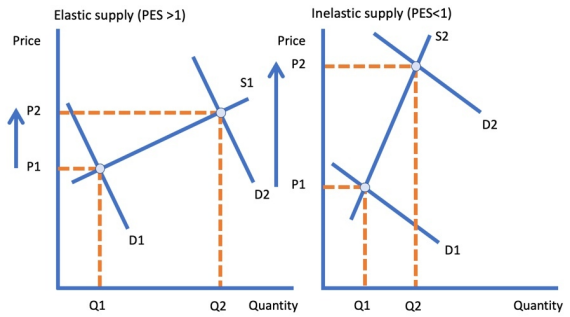

Figure 2: Demand changes with elastic vs. inelastic supply. Source: tutor2u/economics

[3] Since many people have lost their private keys or have died without leaving instructions to anyone, it is estimated that about 4 million Bitcoins are lost forever. This puts the expected effective supply at around 17 million

This is exactly what we are seeing with Bitcoin. Although demand for Bitcoin has increased dramatically over the past year, there has been very little increase in its naturally constrained supply. In other words, supply inelasticity creates volatility, as increases in demand have much stronger effects on price. Consequently, it is precisely this inelasticity that causes the dramatic price appreciations as we have seen them in 2017 or now in early 2021. In this respect it is also important to note that the supply of Bitcoin, as long as we don't reach the limit of 21 million, is directly connected to its mining difficulty. The harder it gets to mine a Bitcoin, the slower the increase in overall supply. For example, from the cryptocurrency's inception in 2009 up to 2013, the Bitcoin supply increased by roughly 10.5 million coins. From 2017 to 2020 it only increased by about 2.5 million coins. Hence, as the number of calculations required to unlock the next Bitcoin increases – the mining-supply difficulty – its price follows:

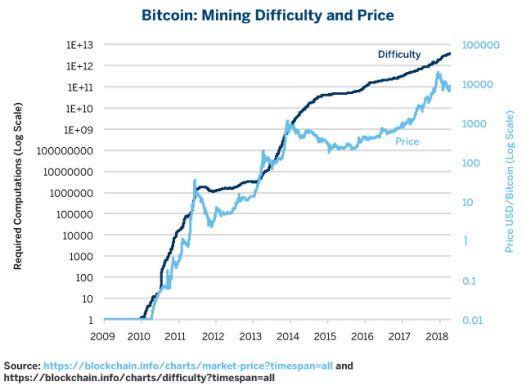

Figure 3: Bitcoin Mining Difficulty and Price Development. Source: bloomberg.com

The Demand Side

While the supply side is fairly straightforward to analyze, the demand side is a lot more difficult. While the demand for Bitcoin is primarily driven by its value as a medium of exchange, it is hard to quantify this value, as it is purely subjective. As already described in the introduction, Bitcoin does not possess any intrinsic value. Therefore, it is merely a matter of how many people or institutions actually believe in its value, that fundamentally drives its demand. Several factors have historically influenced demand. One of them, which has largely been responsible for the recent surge, is institutional adoption. As more companies accept Bitcoin as a method of payment or buy large amounts as a hedge against other types of investments they made, the larger the confidence of the public. And the more assured people become about the value of Bitcoin, the larger the demand. Recently, the institutional support from corporate treasuries has been rising dramatically – Tesla purchased $1.5 billion, MicroStrategy $1 billion, and Square $170 million worth of Bitcoin in February 2021 alone. Another driver has been the pandemic. As central banks are printing trillions of dollars of fiat money and relax inflation targets, people become increasingly scared about potential future inflation. Therefore, we have seen a large increase in safe haven asset prices in general, and since Bitcoin is viewed as such too, large amounts of money have been flowing into digital currencies. A third factor is purely psychological. As people see the price of Bitcoin skyrocket, many feel a so-called "fear of missing out" on the move, and buy into it as well. This bubble-like mechanism is often pointed out when talking about the large risks associated with the digital currency. Due to a lack of long-term outlook and unrealistic expectations, many get trapped into the cyclical dynamics of the price development of Bitcoin. Yet, this herd effect is rather constrained to the short run – exponential demand surges solely based on this mechanism are undoubtedly unsustainable in the long run. Hence, when looking at those long run equilibria, it makes more sense to leave this out of the equation.

Conclusion

While there have always been a lot of sceptics surrounding the digital asset space, the widespread adoption we see now indicates that cryptocurrencies are here to stay. Bitcoin has created a new asset class that cannot be ignored and presents many interesting opportunities for investment, development, and regulatory oversight. Notwithstanding, nobody can presume to know what will happen to it, as it is connected to so much uncertainty. Predictions of a total collapse as well as expectations of Bitcoin reaching the market cap of gold seem both implausible. The truth probably lies somewhere in between. It is noteworthy that decentralized architectures do have some unique benefits. In contrast to traditional financial infrastructure that requires exchange of information between many parties and central entities, this need is absent in the cryptocurrency space. One thing is for certain; Bitcoin will continue to be volatile, and price fluctuations will likely surpass its all-time highs in the foreseeable future. As more and more people enter the space and the price continues to inflate and retrace, this volatility is likely to ensue for years to come.