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FACTORS SHAPING BITCOIN'S VALUATION AND PRICE FORMATION

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Abstract

Our research examines the factors shaping Bitcoin's valuation and price formation. It highlights the role of scarcity, which, combined with demand, influences prices over the long term. Models such as the Stock-to-Flow (S2F), Network Value-to-Transaction (NVT), and Metcalf's Law provide valuable insights into Bitcoin's valuation dynamics. Bitcoin's predetermined monetary policy, including halving events, contributes to its scarcity and deflationary nature, affecting miner profitability and price dynamics. Network effects, evidenced by growing user base and adoption, also drive demand and valuation. While scarcity and network effects are primary drivers, other factors like technological advancements and regulatory developments also play a role. Understanding these dynamics is crucial for assessing Bitcoin's long-term value in the digital asset landscape.

Kľúčové slová: Bitcoin, valuation, prices

JEL Classification: D46, E31, E50, G10

1. INTRODUCTION AND LITERATURE REVIEW

Bitcoin (BTC) had surpassed many milestones since its inception in late 2000's. For some investors, BTC is considered as highly speculative asset, but others consider it as building block of new digital assets class. As Bitcoin does not generate cash flows, its valuation and price formation recall fiat currency in circulation (M0). In short term, it is likely to be affected either by general market determinants or Bitcoin specific factors. Among the latter, we can include extension of potential demand in the form of retail ETFs or the FOMO during the halving event. General market determinants might include investors sentiment or liquidity changes in the financial markets. There are numerous studies that analyze and

identify short term drivers of price action. But for the long-term investors, understanding of the long-term drivers are more important. This study aims to identify and evaluate Bitcoin supply and demand factors that drive its price in long term.

1.1 On scarcity, value and prices

Some of the Bitcoin academic maximalists adopted popular claim that scarcity of BTC is the factor that drives its value and prices up in the long term. Of course, this contradicts many theories, including Menger's (1976) value theory, who claimed that scarcity itself does not create value and there needs to be more factors combined.

According to Robbins (2007), scarcity dictates the availability of resources relative to the demand for them. It arises from the limited nature of resources against unlimited human wants. Scarcity inherently inputs resources with value, as individuals must allocate these scarce resources efficiently to satisfy myriad needs and desires. Consequently, prices emerge as signals of this scarcity and value relationship, serving as the mechanism through which resources are allocated within an economy.

Also Mankiw (2018) points out that scarcity forces individuals, businesses, and societies to allocate resources efficiently to maximize utility or satisfaction. This allocation leads to the determination of value, where goods and services become valuable precisely because they are scarce. The interplay of scarcity and value then influences prices, as articulated by Friedman (1953), who suggests that prices emerge as a result of the interaction between demand and supply in a market economy. Thus, prices serve as signals, reflecting both the scarcity of a good or service and its perceived value within the market.

As Hayek (1945) noted, prices provide crucial information about relative scarcities, guiding individuals and businesses in their consumption and production decisions. Thus, scarcity, value, and prices are closely connected components of economic systems, shaping resource allocation and economic behavior in significant way.

There is a special case for scarcity in the currencies, as it is intensified by central banks' monetary policies, which regulate the supply of money in circulation. According to Friedman (1953), the scarcity of money, coupled with its role as a medium of exchange, store of value, and unit of account, shapes its value relative to goods and services. Therefore, scarcity acts as a fundamental driver in establishing the value of currencies, influencing their purchasing power and exchange rates in domestic and international markets.

1.2 Bitcoin valuation

Bitcoin, the pioneering cryptocurrency, was originally conceived as internet money. "A purely peer-to-peer version of electronic cash", as Nakamoto (2008) described it in the first sentence of his white paper. Scarcity stands as a foundational principle underpinning the value of Bitcoin, as the pseudonymous creator of Bitcoin, embedded scarcity into its protocol by establishing a finite supply of 21 million units.

Original idea of BTC as internet money (Egorova et al., 2019) was never empirically adopted due to enormous volatility of the asset. The Bitcoin narrative pivoted away from being a medium of exchange and directed towards being a store of value with easily achieved aspect of the monetary premium that gives money value. BTC rebranded as "digital gold" and its entire market cap was attributed to its monetary premium.

In academic literature and economic practice, there are different approaches and views on the value of BTC (Wingreen et al., 2020). In current analytical studies and scientific works, we can find traditional methods of value determination through fundamental, technical or behavioral analysis. On top of traditional methods, various new models have been proposed to

analyze and predict the valuation of Bitcoin, reflecting the cryptocurrency's complexity and evolving market dynamics.

One of the popular models is the stock-to-flow (S2F) model, introduced by pseudonymous analyst „PlanB" (2019). The S2F model evaluates Bitcoin's value by comparing its stock (existing supply) to its flow (rate of new issuance), drawing parallels to the valuation mechanisms of scarce commodities like gold. PlanB's model suggests a positive correlation between Bitcoin's scarcity, as measured by its S2F ratio, and its market value, proposing a bullish outlook for Bitcoin's future price trajectory. While subject to debate and critique, the S2F model has gained traction among investors and analysts as a tool for understanding Bitcoin's valuation dynamics in the context of its fixed supply and halving events.

Another prominent model for Bitcoin valuation is the network value-to-transaction (NVT) ratio introduced by Woo and Kalichkin (2018). They propose the NVT ratio as a metric for assessing Bitcoin's market valuation relative to its on-chain transaction volume. By dividing Bitcoin's market capitalization by its daily transaction volume, the NVT ratio aims to identify periods of overvaluation or undervaluation in the cryptocurrency market. Changes in the NVT ratio may signal shifts in investor sentiment, network adoption, or speculative activity, offering insights into Bitcoin's price movements. Despite its utility, the NVT ratio is not without limitations, including potential distortions from off-chain transactions and the need for supplementary analysis to account for network developments. Nonetheless, the NVT ratio remains a valuable tool for investors and researchers seeking to measure Bitcoin's valuation fundamentals in a rapidly evolving digital asset landscape.

Value determination through the network effect is explained by Metcalf's Law (Bakhtiar et al., 2023). It has been applied to Bitcoin valuation, leveraging the network effect to assess the cryptocurrency's worth. Originating from telecommunications, Metcalf's Law suggests that the value of a network is proportional to the square of the number of its users. In the context of Bitcoin, this principle suggests that as the network of users grows, the utility and value of Bitcoin increase exponentially. Moore and Christin (2013) examined the relationship between Bitcoin's market capitalization and the number of unique Bitcoin addresses, providing empirical evidence supporting the application of Metcalf's Law to the cryptocurrency market. By quantifying the network effect, Metcalf's Law offers insights into Bitcoin's valuation dynamics, highlighting the importance of network growth and adoption in determining its long-term value.

Furthermore, Metcalf's Law has implications for understanding Bitcoin's resilience and potential for mainstream adoption. As articulated by Rosenfeld and O'Brien (2014), the network effect driven by Metcalf's Law contributes to Bitcoin's robustness against security threats and regulatory challenges. The expanding network of users strengthens Bitcoin's decentralization and censorship resistance, enhancing its value proposition as a borderless and permissionless digital currency. However, critics caution that Metcalf's Law alone may oversimplify Bitcoin's valuation, overlooking other factors such as technological developments, market sentiment, and regulatory scrutiny. Nonetheless, the application of Metcalf's Law underscores the significance of network effects in shaping the value and resilience of Bitcoin within the broader landscape of digital assets.

2. AIM AND METHODOLOGY

The aim of this article is to identify and evaluate selected drivers that determine the value and price formation of Bitcoin in long term. We will look both at supply and demand factors.

The subject of the research is Bitcoin price and value. The object of the research is selected drivers on supply and demand side. In our qualitative research, we applied the praxeological approach of the Austrian school of economics (Degutis, 2011). Additionally, we used a

different set of complementary methods, such as induction, deduction, analysis, synthesis, comparison, or abstraction. Emphasis is placed on the literary, historical-logical, content-critical and content-causal method. In assessing the correctness or incorrectness of the economic theorem, we proceed from a priori approach (reason without the help of experience), axiom and deductive logic. In this approach, empirical knowledge is used only as an illustrative supplement to the praxeological analysis and therefore it is not necessary to evaluate data using mathematical-statistical methods and verify or falsify the conclusions based on experience. The work is mostly of a qualitative research nature.

The structure of this paper starts with the introduction of the topic, then it is followed by literature review, methodology, results and discussion, and ends with conclusions.

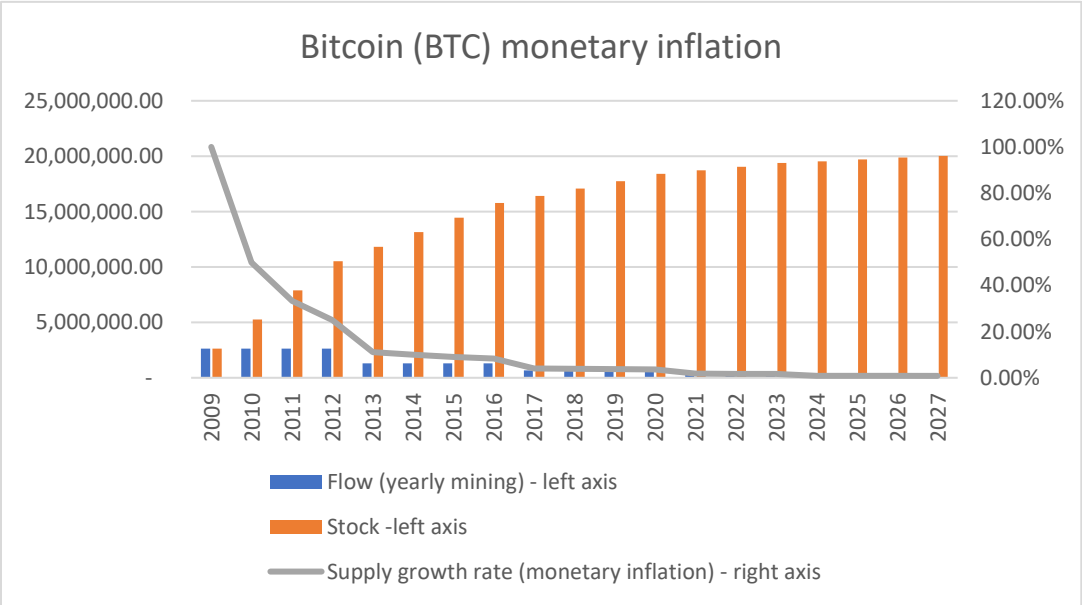
3. RESULTS AND DISCUSSION

There are numerous factors determining BTC valuation and price action that can be analyzed. Our research is focused on two aspects, Bitcoin monetary policy on the supply side and network effect on demand side.

3.1 Bitcoin monetary policy

The monetary policy of Bitcoin is predetermined and relatively restrictive compared to conventional central bank policies that affect fiat currencies (EUR, USD, CZK). This process is built into the Bitcoin protocol to control its supply and ensure that only a limited number of Bitcoins (21 million) are ever created. The game theory behind Bitcoin assures transactions integrity by providing miners incentive in form of newly created tokens. Incentive reduces to half during an event called “halving“. Empirical evidence shows to have a significant impact on the Bitcoin market. This can affect the profitability of miners, the rate of creation of new Bitcoins, and potentially affect the price of Bitcoin due to changes in supply and demand dynamics. Overall, halving is a key aspect of Bitcoin's monetary policy and its path to becoming a deflationary digital asset.

Fig. 1: Bitcoin (BTC) monetary inflation 2009-2027



Source: Own elaboration based on data retrieved from internet, 15.11.2023, https:// blockchain.com (data for 2024-2027 is an estimate)

Bitcoin halving occurs approximately every four years. After every 210,000 blocks mined, the reward miners receive for verifying transactions and adding them to the blockchain is halved. The creators of BTC initially set the reward at 50 BTC per block (2009), which was reduced to 25 BTC in "halving 1" (2012), then to 12.5 BTC (2016), and so far the last halving occurred in May 2020 reducing the reward from 12.5 BTC to the current 6.25 BTC per block. Next halving is expected to happen in April 2024.

When we analyze data (Figure 1), Bitcoin supply growth rate was robust at earliest stages of Bitcoin adoption. Around midyear 2010, when BTC received attribute of monetary value through exchange of tokens for goods (BTC Pizza Day of 22th May, 2010), annualized monetary inflation was dropping from level of „hundreds" percent to level of "tens" of percents (Table 1). This disinflationary trend continues and BTC inflation reached similar values as EUR currency around year 2016. There is certain paradox, that massive BTC "monetary" inflation was not transformed into BTC "goods" inflation. On contrary, price action of Bitcoin proved to be strong and BTC gained significant value. We attribute this to stronger demand, represented by BTC users growth rate at higher values than supply growth rate.

Table 1 Bitcoin (BTC) supply growth rate and S2F during 2010-2024

ASSET	CAGR	S2F	STOCK		PERIODS			NOTE
			start	end	no.	start	end	
Bitcoin (BTC)	12.36 %	8	3,846,586	19,653,325	14	2010	2024	Long term*
	51.23 %	2	3,846,586	10,819,400	2.5	2010	2012	Pre HALVING 1*
	9.77 %	10	10,819,400	15,711,150	4	2012	2016	Pre HALVING 2
	3.93 %	25	15,711,150	18,329,675	4	2016	2020	Pre HALVING 3
	1.76 %	57	18,329,675	19,653,325	4	2020	2024	Pre HALVING 4

Source: Own elaboration based on data retrieved from internet, 15.11.2023, https:// blockchain.com (data for 2024 is an estimate)

Stock to flow (S2F) indicator suggests number of years needed to double stock of asset given the flows remain at the same pace. According to Morillon and Chacon (2022), gold has SF2 at around 62 and silver at 22. This represents supply growth of 1,6 % (gold) and 4,5 % (silver). Bitcoin S2F has overall a downward trajectory. At earliest stages, it took Bitcoin to double stock at around time of 2 years and this represented significant monetary inflation of 51,23 % p.a. At the time of Halving #4, SF2 will reach value of 57 and supply growth will be roughly equal to gold. As monetary policy of Bitcoin is predetermined and encoded in protocol, there will be further declines in supply growth and rise of S2F.

Table 2 Euro currency M3 aggregate (EUR) supply growth rate and S2F during 1999-2024

ASSET	CAGR	S2F	STOCK		PERIODS			NOTE
			start	end	no.	start	end	
EUR (M3 in bil.)	5.24 %	19	4,464	16,021	25	1999	2023	Long term
	7.73 %	13	4,464	9,400	10	1999	2009	Pre BTC era
	1.07 %	94	9,400	9,808	4	2009	2012	Pre HALVING 1
	3.42 %	29	9,808	11,221	4	2012	2016	Pre HALVING 2
	5.39 %	19	11,221	13,842	4	2016	2020	Pre HALVING 3
	3.72 %	27	13,842	16,021	4	2020	2023	Pre HALVING 4

Source: Own elaboration based on data from ECB

Valuation of any asset is always relative to monetary unit valuations. For this reason, we examined monetary inflation and S2F indicator for EUR currency (Table 2). Monetary policy of Eurozone countries tends to be more flexible than Bitcoin. It is affected mainly by 3 factors: interest rates, risk assessment of lenders and sentiment of borrowers. Currency EUR compared to BTC tends to fluctuate more, which is proven empirically (Table 2). Stock-to-flow indicator varies in values from 13 to 94, which results in unpredictable supply growth rate. As EUR users base is rather stable in short and medium terms, we estimate that price/value action is mostly driven by change in overall productivity of EUR economies combined with fiscal and monetary policies, which have effect on supply growth. Given lower values S2F for EUR compared to BTC and other valuation determinants not changed, Bitcoin will tend to gain value in EUR terms.

3.2 Network effect

Bitcoin's network effects, including its growing user base, merchant acceptance, and developer community contributes to increasing demand as the network becomes more robust and widely adopted. Increased adoption of Bitcoin as a mean of payment or investment by individuals, businesses, and institutions drives demand and subsequently affect the price. Demand for Bitcoin can be enhanced also by secondary or substitute markets. Some examples include “wrapping Bitcoin” into Ethereum network (wbtc on ERC 20 token), wrapping Bitcoin in corporate treasury (MicroStrategy, Inc.), wrapping Bitcoin into ETFs or various derivatives products.

According Bitinfocharts.com (2023), Bitcoin dominates crypto ecosystem in almost all „network metrics”: inception date, all addresses, active addresses or Reddit subscribers. Its users base comprises of almost 49 mil.(Table 3) compared to its fork Bitcoin cash (BCH), which has only 26 mil. users. Comparison of valuation and price action of BTC and BCH is important, as BCH shares identical monetary policy (past and future) with BTC in terms of supply growth rate, halvings, number of coins in circulation, limited supply of 21 mil. coins, etc. We assume that differentiating factor for price and valuation is network effect.

Table 3 Bitcoin (BTC) users base with distribution of addresses

Balance, BTC	Addresses	% Addresses (Total)	Coins	% Coins (Total)
(0 - 0.00001)	3,649,458	7.47% (100%)	18.55 BTC	0% (100%)
[0.00001 - 0.0001)	9,693,191	19.84% (92.53%)	418.64 BTC	0% (100%)
[0.0001 - 0.001)	12,005,942	24.57% (72.7%)	4,608 BTC	0.02% (100%)
[0.001 - 0.01)	11,192,712	22.9% (48.13%)	41,548 BTC	0.21% (99.97%)
[0.01 - 0.1)	7,832,748	16.03% (25.22%)	264,531 BTC	1.36% (99.76%)
[0.1 - 1)	3,475,256	7.11% (9.2%)	1,079,165 BTC	5.53% (98.41%)
[1 - 10)	861,982	1.76% (2.08%)	2,144,709 BTC	10.99% (92.88%)
[10 - 100)	140,164	0.29% (0.32%)	4,449,302 BTC	22.8% (81.89%)
[100 - 1,000)	13,963	0.03% (0.03%)	3,896,645 BTC	19.97% (59.09%)
[1,000 - 10,000)	1,908	0% (0%)	4,714,029 BTC	24.15% (39.12%)
[10,000 - 100,000)	103	0% (0%)	2,260,741 BTC	11.58% (14.97%)
[100,000 - 1,000,000)	4	0% (0%)	660,085 BTC	3.38% (3.38%)
Total BTC addresses:	**48,867,431**			

Source: Retrieved from internet, 15.11.2023, https://bitinfocharts.com/bitcoin-distribution-history.html

Value of Bitcoin might be determined by other factors as well. Though, these factors are difficult to measure and thus determine its contribution to valuation. Among those we consider *technological maturity*, as aadvancements in Bitcoin's technology, such as improvements in scalability, security, and usability, can attract more users and investors, driving demand. Furthermore, *geopolitical events*, such as government crackdowns, geopolitical tensions, or economic crises, can drive demand for Bitcoin as a store of value or safe-haven asset. *Economic conditions*, such as inflation rates, interest rates, and overall market stability, can influence demand for Bitcoin as a hedge against inflation or economic uncertainty. And finally *regulatory environment and developments*, such as government regulations or legal recognition of Bitcoin, can affect demand. Positive regulatory developments may boost confidence and increase demand, while negative regulatory news can have the opposite effect. These factors deserve further research focus and investigation.

4. CONCLUSION

The article's aim was to identify and evaluate selected drivers that determine the value and price formation of Bitcoin in long term. Based on the results, several conclusions can be drawn regarding the factors influencing the valuation and price formation of Bitcoin. The scarcity of Bitcoin, defined by its fixed supply of 21 million units, plays a significant role in determining its value and prices over the long term. Contrary to some traditional economic theories, scarcity alone does not dictate value, but when combined with demand, it influences

prices. Bitcoin's scarcity is similar to that of traditional currencies, with its value being shaped by the interplay of scarcity, demand, and market dynamics.

Various models have been proposed to understand and predict Bitcoin's valuation. The Stock-to-Flow (S2F) model, Network Value-to-Transaction (NVT) ratio, and Metcalf's Law are among the prominent ones. These models assess Bitcoin's value based on factors such as scarcity, transaction volume, and network effects. While each model has its strengths and limitations, they provide valuable insights into Bitcoin's valuation dynamics and long-term trajectory.

Bitcoin's predetermined monetary policy, characterized by halving events that reduce block rewards approximately every four years, contributes to its scarcity and deflationary nature. These halving events have a significant impact on the Bitcoin market, affecting miner profitability, supply dynamics, and price. The decreasing supply growth rate and rising Stock-to-Flow ratio underscore Bitcoin's evolution towards becoming a store of value akin to gold.

Bitcoin's network effects, including its growing user base, merchant acceptance, and developer community, drive demand and contribute to its valuation. Increased adoption of Bitcoin as a means of payment or investment by individuals, businesses, and institutions enhances its utility and value. The comparison between Bitcoin and its fork, Bitcoin Cash (BCH), highlights the importance of network effects in determining valuation.

While scarcity and network effects are key drivers of Bitcoin's valuation, other factors also play a role. Technological advancements, geopolitical events, economic conditions, and regulatory developments can influence demand for Bitcoin as a store of value or safe-haven asset. Further research is needed to understand the contribution of these factors to Bitcoin's valuation.

Our conclusions are that Bitcoin's valuation and price formation are influenced by a combination of factors, including scarcity, network effects, monetary policy, and broader economic and regulatory dynamics. Understanding these factors is crucial for investors and analysts seeking to assess Bitcoin's long-term value and trajectory in the evolving digital asset landscape.

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REFERENCES

1. Bakhtiar, T., Luo, X., & Adelopo, I. (2023). Network effects and store-of-value features in the cryptocurrency market. Technology in Society, 74, 102320.
2. Degutis, A. (2011). Economics as Praxeology: Philosophical Foundations of the 'Austrian School of Economics'. Logos-Vilnius, 69, 6-20.
3. Egorova, E. N., Mukhomorova, I. V., & Mosalev, A. I. (2019). Digital currency in the development of payment systems on the bitcoin platform. In The Future of the Global Financial System: Downfall or Harmony 6 (pp. 167-175). Springer International Publishing.
4. Friedman, M. (1953). Essays in Positive Economics. University of Chicago Press.
5. Hayek, Friedrich A. "The Use of Knowledge in Society." American Economic Review, vol. 35, no. 4, 1945, pp. 519-530.
6. Mankiw, N. G. (2018). Principles of economics. Cengage Learning.
7. Menger, C. (1976) [1871]. Principles of Economics. New York: New York University Press.

8. Moore, T., & Christin, N. (2013). Beware the Middleman: Empirical Analysis of Bitcoin-Exchange Risk. In: Financial Cryptography and Data Security. Springer. Available: https://link.springer.com/chapter/10.1007/978-3-642-39884-1_3.
9. Morillon, T. G., & Chacon, R. G. (2022). Dissecting the stock to flow model for Bitcoin. Studies in Economics and Finance, 39(3), 506-523.
10. Nakamoto, S. (2008, October 31). Bitcoin: A Peer-to-Peer Electronic Cash System. Retrieved from https://bitcoin.org/bitcoin.pdf
11. PlanB. (2019). Modeling Bitcoin's Value with Scarcity. Available: https://medium.com/@100trillionUSD/modeling-bitcoins-value-with-scarcity-91fa0fc03e25.
12. Robbins, L. (2007). An essay on the nature and significance of economic science. Ludwig von Mises Institute.
13. Rosenfeld, M., & O'Brien, M. (2014). Bitcoin and Beyond: A Technical Survey on Decentralized Digital Currencies. Available: https://arxiv.org/abs/1405.4498.
14. Wingreen, S. C., Kavanagh, D., Dylan-Ennis, P., & Miscione, G. (2020). Sources of cryptocurrency value systems: The case of Bitcoin. International Journal of Electronic Commerce, 24(4), 474-496.
15. Woo, W., & Kalichkin, D. (2018). Introducing the Bitcoin NVT Ratio. Available: https://woobull.com/introducing-the-bitcoin-nvt-ratio-90-day-moving-average.