Monochrome
Research

Bitcoin
Foundational
Series

Monochrome Asset Management

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Contents

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Bitcoin Foundational Series

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The Origins and Evolution of Bitcoin

Research & Insights

MONOCHROME ASSET MANAGEMENT

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Learning Outcomes

In this piece, you will learn about the history of Bitcoin, including:

1   Its early origins and creation.

2   The basics of the underlying technology and functionality.

3   The monetary problems it aims to solve.

4   The evolution of Bitcoin narratives over time.

Note: This activity meets the guidelines for qualifying CPD, and has been accredited for continuing professional development by the Financial Planning Association of Australia (FPA). This does not constitute FPA's endorsement of the activity.

Foreword

As Bitcoin enters its second decade, it is opportune to reflect on its transformation from a monetary thought experiment, the first recorded transactional use being to buy pizza, into a fully-fledged financial ecosystem that has garnered significant interest, both from retail and institutional investors.

Digital assets constitute a market cap of US$2.1 trillion,[1] with market leader Bitcoin boasting over 110 million users[2] and around US$5 billion[3] in daily settlement volume as of early September. Companies such as PayPal,[4] Visa,[5] and Square[6] are integrating digital asset payment processing to preempt disruption; financial institutions such as Fidelity[7] and Goldman Sachs[8] are expanding their trading services to meet the surge in client demand; and, central banks from the Federal Reserve[9] to the People's Bank of China[10] are developing Central Bank Digital Currencies (CBDC) of their own.

Despite this increase in adoption, various challenges remain for institutional investors to procure digital assets, whether as an investment or as a hedge against the broader macroeconomic environment. This document explores Bitcoin from the perspective of an institutional investor to strategize for what lies ahead in the digital asset market.

Bitcoin History

Origins

Bitcoin is an open-source monetary system created by Satoshi Nakamoto, a pseudonymous individual or group, who first detailed the underlying architecture in the 2008 whitepaper "Bitcoin: A Peer-to-Peer Electronic Cash System".[11] Through its proposed digital timestamping technology, Satoshi envisioned a world in which digital settlements were executed without a trusted third party such as

[1] CoinMarketCap, 'Total Cryptocurrency Market Cap (mnchr.me/3uFLO3a/)', CoinMarketCap, n.d., accessed 30 June, 2021.

[2] Crypto.com, 'Global Cryptocurrency Adoption Doubled Since January (mnchr.me/39xaGQK)', Crypto.com website, 29 July 2021, accessed 10 September 2021

[3] Blockchain.com, 'Estimated Transaction Value (USD)(mnchr.me/3ivqLva)', Blockchain.com, n.d., accessed 10 September 2021.

[4] Paypal Newsroom, "PayPal Launches "Checkout with Crypto" (mnchr.me/3lamBLe)', Paypal, 30 March 2021, accessed 10 September 2021

[5] The Visa Blog Newsletter, 'Digital currency comes to Visa's settlement platform (mnchr.me/2WFJQmO)', Visa, 29 March 2021, accessed 5 October 2021.

[6] J Dorsey, 'Cash App - Bitcoin (mnchr.me/3oCyrzJ)', [tweet], Twitter, 1 February 2018, accessed 5 October 2021.

[7] Fidelity Investments, 'Fidelity Launches New Company, Fidelity Digital Assets (mnchr.me/3Aa4edE)', Fidelity Investments, 15 October 2018, accessed 5 October 2021.

[8] S Nagarajan, 'Goldman Sachs announces a new crypto trading team in an internal memo (mnchr.me/3moDcKx)', Markets Business Insider, 7 May 2021, accessed 5 October 2021.

[9] J Cox, 'The Fed this summer will take another step in developing a digital currency (mnchr.me/3izqI1v)', CNBC, 20 May 2021, accessed 5 October 2021.

[10] J Areddy, 'China Creates Its Own Digital Currency, a First for Major Economy (mnchr.me/3AbFEJp)', Wall Street Journal, 5 April 2021, accessed 5 October 2021.

[11] S Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System (bitcoin.org/bitcoin.pdf)', Bitcoin.org, 31 October 2008, accessed 10 September 2021

a bank or payment processor. Instead, these settlements would be verified and recorded in a public global ledger called the blockchain[12] and supported by stakeholders of the Bitcoin protocol.

Solving a Database Problem

To fully appreciate blockchain as a solution, consider the monetary problem it endeavours to solve. Today, people can either transact with cash, or through "the banking system" via Point-of-Sale and online card payments, cheques, and bank transfers. Paying someone in cash is instant and final, but possible only when both parties are in proximity to each other. Bank transfers are usually only fast or instant when both sender and recipient are customers of the same bank (and accordingly, have balance records from the same database), otherwise transactions take longer as banks need to de-risk themselves from overdrawn accounts or double spending. Recent changes have seen groups of banks creating shared databases, allowing for fast or instant interbank transfers.[13] Modern fintech start-ups also offer a partial solution by leveraging network effects to get some users on the same database, but users outside of these second-degree networks still face the same problem.

Blockchain solves this database problem, which has so far been mitigated using trusted third parties. It does so by distributing the database across many nodes, and where the security and accuracy of the database is not controlled by any entity or authority, but via encryption and code. Anyone with an internet connection can view all historical transactions made on Bitcoin from the moment of its inception. If you have copies of the same database and no one is in charge, however, how would you ascertain which copy of the database is accurate and most up-to-date?[14]

Bitcoin Basics

In lieu of trust placed with a third party, Bitcoin leverages public key cryptography to facilitate communications between network participants without divulging sensitive information. Each network participant has addresses associated with a pair of public and private keys that are stored in a wallet.[15] Only senders with a private key can 'sign' and authorize a transaction of Bitcoin to be sent from that address, but all users within the network can easily verify the signature using the sender's public key.

Once new transactions are initiated, the blockchain is appended through a process called 'mining'. Mining incorporates the following stages:
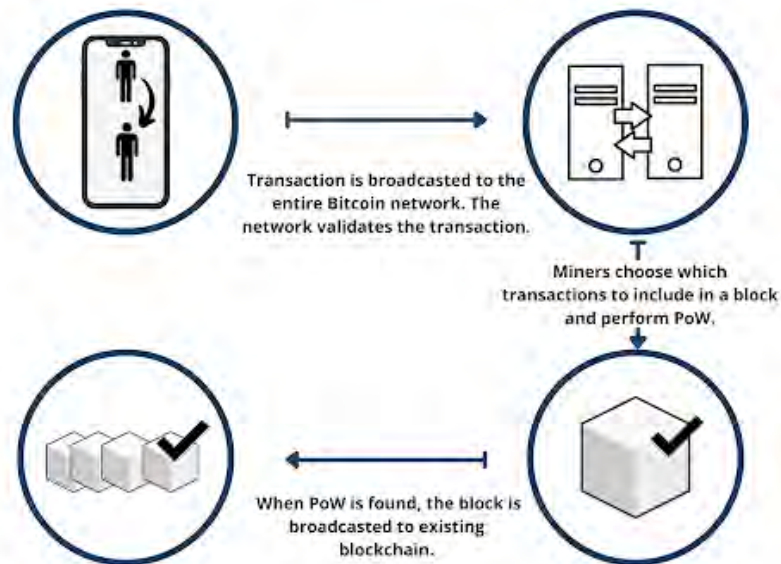
1. New transactions are broadcasted to the entire Bitcoin network via nodes.
2. Miners choose which transactions to include in the next block, often based on transaction fees.
3. Miners then expend computational power to perform Proof-of-Work (PoW).
4. When PoW is found, the miner broadcasts the new block throughout the network.
5. Nodes validate the new block, and the process repeats.

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[12] FUN FACT: The term "blockchain" doesn't feature in the white paper! In fact, the earliest Bitcoin source code refers to it as the "Timechain." Had the "Timechain" name stuck, the "blockchain" industry would probably not exist today (Bitcoin Talk, 'Bitcoin source from November 2008 (mnchr.me/3uJiTvg)', Bitcoin Talk, 23 December 2013, accessed 5 October 2021)

[13] NPP Australia is a national infrastructure for fast, flexible, data-rich payments in Australia. SEPA is a comparable infrastructure in Europe. See nppa.com.au/the-company/ for more.

[14] This question has been explored by scientists dating back to 1982, where parties reach consensus without having to trust one another (Lamport et al., 'The Byzantine Generals Problem (lamport.azurewebsites.net/pubs/byz.pdf)', ACM Transactions on Programming Languages and Systems, July 1982, accessed 10 September 2021).

[15] HWallets can take the form of hardware, software, paper, or custodied by a third party.

Transaction is broadcasted to the entire Bitcoin network. The network validates the transaction.

Miners choose which transactions to include in a block and perform PoW.

When PoW is found, the block is broadcasted to existing blockchain.

The Bitcoin ecosystem's growth over the past decade has been enabled by stakeholders with different roles. Specifically, they are:

1. Users who transact with one another on the network and pay to have transactions finalized.
2. Miners who incur costs to process transactions, in exchange for newly minted bitcoin.
3. Nodes that run Bitcoin software to maintain a copy of the global ledger.
4. Developers who maintain Bitcoin software that is executed by miners through 'mining'.

The PoW exercise in mining maintains the security of the network. It is a consensus mechanism that requires miners to expend electrical energy[16] (called 'hash power') in solving an arbitrary mathematical problem.[17] By design, each problem takes about 10 minutes to solve, with the difficulty of the problem adjusting to maintain this solving rate as miners enter and exit the ecosystem.

After mining a new block, the successful miner is rewarded with newly issued bitcoin and fees from transactions known as 'mining rewards'. Newly issued bitcoins follow a schedule that halves every 210,000 blocks mined, approximately every 4 years. Blocks mined in 2009 rewarded miners with 50 Bitcoin, while each block mined today is rewarded with 6.25 Bitcoin.[18] Only 21 million Bitcoin will ever be mined, after which miners will only be compensated by transaction fees.

Because blocks are added sequentially to the blockchain[19] and copies of the blockchain are distributed amongst nodes, it is incredibly difficult to attack the network. To do so, malicious actors would have to perform a "51% attack" in which they take control of more than half of the network's hash rate to alter transactions on the blockchain.[20] So far, there have been no successful 51% attacks on Bitcoin in its history.

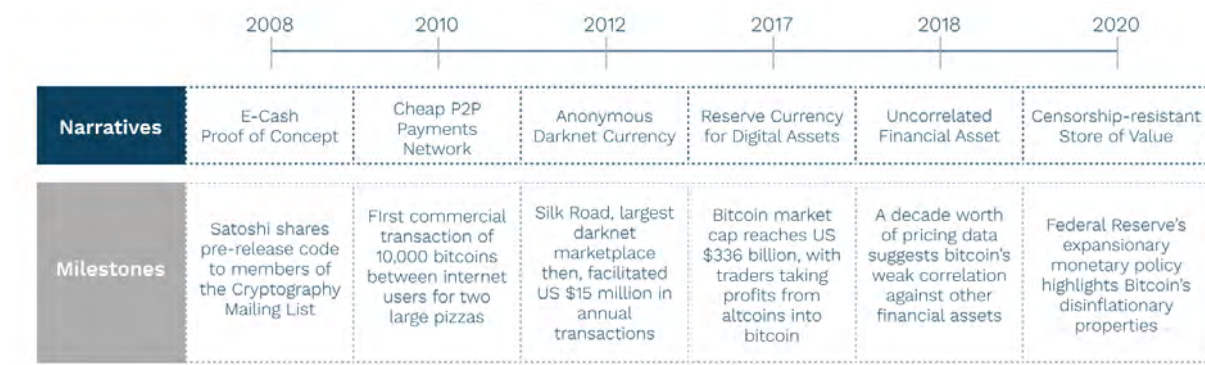[16] Miners use specialized equipment called ASICs to mine bitcoin, expending energy in the process.

[17] DThe mathematical problem can be described as a low probability game played by many participants. The game is played with a 1000-sided dice, with the goal to roll a number less than 10. Once a player rolls a number less than 10, other players easily verify the results, and the next round begins. See mnchr.me/3a7FQyE for more.

[18] Last halving event occurred May 11, 2020.

[19] Total size of the bitcoin blockchain is 352GB as of Jun 30, 2021 (mnchr.me/3ixlIuo).

[19] As of Jan 11, 2021, a 51% attack on Bitcoin would require $5.5 billion in setup costs alone (Braiins, mnchr.me/3otUHMd).

What was Bitcoin created for?

	2008	2010	2012	2017	2018	2020
Narratives	E-Cash Proof of Concept	Cheap P2P Payments Network	Anonymous Darknet Currency	Reserve Currency for Digital Assets	Uncorrelated Financial Asset	Censorship-resistant Store of Value
Milestones	Satoshi shares pre-release code to members of the Cryptography Mailing List	First commercial transaction of 10,000 bitcoins between internet users for two large pizzas	Silk Road, largest darknet marketplace then, facilitated US $15 million in annual transactions	Bitcoin market cap reaches US $336 billion, with traders taking profits from altcoins into bitcoin	A decade worth of pricing data suggests bitcoin's weak correlation against other financial assets	Federal Reserve's expansionary monetary policy highlights Bitcoin's disinflationary properties

Like any nascent asset, the Bitcoin narrative has undergone an evolution since its inception in 2008.[21] It was first recognized as another e-cash proof of concept when Satoshi circulated pre-release code amongst other revered members in the cryptography community.[22] Initial reactions were lukewarm at best, as the community had seen b-money, Hashcash, and bit gold fail before Bitcoin.[23] Skeptics fell silent in early 2009, when Satoshi successfully bootstrapped the network and mined the first few blocks. He initiated the first transaction of 10 Bitcoins to a fellow enthusiast Hal Finney, and kicked off momentum in the network.

Before long, the experimental internet money gained popularity amongst early adopters as a cheap P2P payments network, the most notable transaction being 10,000 Bitcoins for two large pizzas in 2010. This narrative both made sense and was necessary early on as usage in the network experienced exponential growth. Transaction fees were fractions of a cent at the time,[24] contrasting the 6.38% global average charged by remittance companies.[25] Due to block size constraints and growing demand, however, this narrative weakened as average transactions cost as high as US$55 during the peak of the 2017 bull market.[26] Instead, other projects such as Bitcoin Cash and "layer two" solutions like Lightning Network have since attempted to gain market share in remittance, either through increasing block sizes[27] or bidirectional payment channels.[28]

Many critics of Bitcoin have also challenged its legitimacy, citing the use of cryptocurrencies as a medium of exchange in darknet marketplaces. This narrative was most prevalent in 2012-3 when it was revealed that the Silk Road had facilitated sales worth 9,519,664 BTC, equivalent to US$183m at time of sales, between February 2011 and its closure in July 2013.[29] It is enticing to follow this line of thinking, since Bitcoin wallets are not registered to specific identities and early KYC requirements

[21] This part of the document builds on the previous arguments of Nic Carter, Murad Mahmudov, and Adam Tache (mnchr. me/3FaKiea).

[22] RM Kapilkov, 'Previously Unpublished Emails of Satoshi Nakamoto Present a New Puzzle (mnchr.me/3FgI7pu)', Coindesk, 27 November 2020, accessed 5 October 2021.

[23] A Costello, 'The history of first cryptocurrencies before Bitcoin (mnchr.me/2YrZkf9)', Medium.com, 22 February 2020, accessed 5 October 2021.

[25] Transactionfee.info, op. cet.

[26] World Bank, 'Remittance Prices Worldwide Quarterly (mnchr.me/2YhMznr)', World Bank, March 2021, accessed 5 October 2021.

[27] Hackernoon.com, 'Cryptocurrencies with the Largest Blocks in Their Blockchains (mnchr.me/3FaKiea)', 13 June 2021, accessed 5 October 2021.

[28] A Van Wirdum, 'Understanding the Lightning Network, Part 1: Building A Bidirectional Bitcoin Payment Channel (mnchr. me/2YdFhk6)', Bitcoin Magazine, 31 May 2016, accessed 5 October 2021.

[29] United States of America v. Ross William Ulbricht, 'Sealed Criminal Complaint (mnchr.me/3oxPrHf)',p 15, 27 September 2013, accessed 4 October 2021.

for crypto exchanges were loose at best. A closer look at the data, however, suggests that criminal activity represented only 0.34% of all cryptocurrency transaction volume in 2020,[30] while 2 - 5% of global annual GDP is associated with illicit activity.[31] This means that criminal transactions using cryptocurrency are much more uncommon than fiat currency, both on a fractional and dollar value basis. Today, 99% of cryptocurrency transactions are performed through centralised exchanges, which are subject to Anti-Money Laundering and Counter-terrorism Financing regulation, similar to traditional financial institutions.[32] Despite overwhelming data to suggest otherwise, this 'criminal activity' narrative is still unfortunately proffered by many respectable figures, including U.S. Secretary of the Treasury, Janet Yellen.[33]

When Bitcoin peaked in 2017, it was also viewed as a reserve currency for the entire digital market landscape. At the time, Initial Coin Offerings (ICOs) were commonplace, and week-old startup projects that offered little to no differentiation to one another were raising millions in capital. Retail traders wanted to partake in the upside of these alternatives to Bitcoin, but eventually were reminded of these projects' outsized risks relative to Bitcoin. They quoted the prices of these alternative projects in satoshis,[34] trading against Bitcoin with the aim of increasing their Bitcoin stack over time. The practice of having Bitcoin as the numeraire for the rest of the digital asset industry is still prevalent today amongst traders, businesses, and distributed networks that hold reserves in Bitcoin.

As one decade's length of Bitcoin price data became available, it became apparent that its price was largely uncorrelated to other financial assets in the market. This asset became attractive to asset managers - Modern Portfolio Theory states that adding assets to a diversified portfolio with low correlations can decrease portfolio risk without sacrificing return. To illustrate in the table below, Bitcoin's correlation with other global asset classes has proven to be low. Many proponents of this narrative are not overly preoccupied with owning Bitcoin per se - they simply want Bitcoin-flavored risk.[35]

Calendar Year Correlation to Bitcoin	2020	2019	2018	2017	2016	2015	2014	2013
S&P 500	0.22	-0.09	0.04	-0.01	-0.01	0.01	-0.03	-0.12
U.S. Bonds	0.07	0.00	-0.03	0.04	0.04	-0.06	0.04	0.10
Gold	0.34	0.14	-0.02	0.01	0.07	0.04	-0.08	-0.04
U.S. Real Estate	0.17	-0.09	-0.03	0.04	-0.03	0.01	0.01	-0.10
Oil	0.23	0.02	0.00	0.06	0.03	0.00	0.00	-0.03
Emerging Market Currencies	0.25	-0.02	0.07	-0.04	-0.07	-0.04	-0.03	-0.07

Correlation of Bitcoin to traditional asset classes.[36]

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[30] Chainanalysis, 'The 2021 Crypto Crime Report (mnchr.me/3A58Ph6)', Chainalysis, 16 February 2021, accessed 5 October 2021.

[31] United Nations Office on Drugs and Crime, 'Money Laundering (mnchr.me/2YnjZAQ)', United Nations, n.d., accessed 5 October 2021.

[32] E Silfversten et al, 'Exploring the use of Zcash cryptocurrency for illicit or criminal purposes (mnchr.me/2YkiDGV)', Rand Corporation, 2020, accessed 5 October 2021.
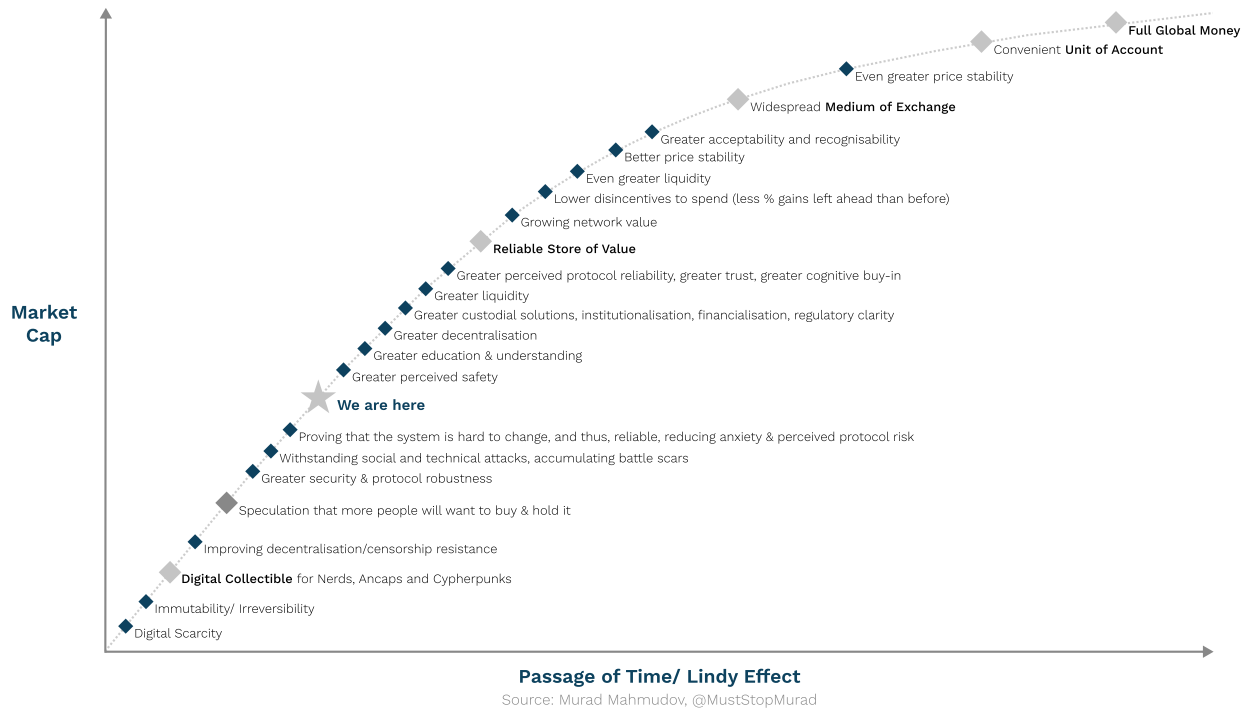
[33] I Lee, 'Janet Yellen says using bitcoin is an 'extremely inefficient' way to transact (mnchr.me/3uEw4gK)', Business Insider, 22 February 2021, accessed 5 October 2021.

[34] Satoshi is the smallest unit of a bitcoin, equivalent to 100 millionth or 10-8 of a bitcoin.

[35] Monochrome Research, 'Volatility of Bitcoin', Monochrome Asset Management, n.d., accessed October 5, 2021.

[35] VanEck, 'Bitcoin's Correlation to Markets Hits Record in 2020 (mnchr.me/3A8BVfm)', VanEck, 8 February 2021, accessed 28 September 2021.

It is worthwhile noting that none of these narratives are necessarily incorrect - they simply form part of the story of Bitcoin to date. The below framework developed by Bitcoin analyst Murad Mahmudov provides another view on Bitcoin narrative evolution over time, and offers a glimpse into the future.[37] Whilst this framework was first published in mid-2018, we are realistically just under half way between the 2018 "We are here" marker and the "Reliable Store of Value" marker, perhaps at "Greater Decentralisation", and closely approaching "Greater regulatory clarity". Volatility, and hence upside and downside risk, will likely stay high until after Bitcoin has evolved into a widespread medium of exchange, which could be well over a decade or more away, if ever at all.

Full Global Money
Convenient **Unit of Account**
Even greater price stability
Widespread **Medium of Exchange**
Greater acceptability and recognisability
Better price stability
Even greater liquidity
Lower disincentives to spend (less % gains left ahead than before)
Growing network value
Reliable Store of Value
Greater perceived protocol reliability, greater trust, greater cognitive buy-in
Greater liquidity
Greater custodial solutions, institutionalisation, financialisation, regulatory clarity
Greater decentralisation
Greater education & understanding
Greater perceived safety
We are here
Proving that the system is hard to change, and thus, reliable, reducing anxiety & perceived protocol risk
Withstanding social and technical attacks, accumulating battle scars
Greater security & protocol robustness
Speculation that more people will want to buy & hold it
Improving decentralisation/censorship resistance
Digital Collectible for Nerds, Ancaps and Cypherpunks
Immutability/ Irreversibility
Digital Scarcity

Market Cap

Passage of Time/ Lindy Effect

Source: Murad Mahmudov, @MustStopMurad

[37] M Mahmudov, 'The Monetary Evolution of Bitcoin (mnchr.me/3mbC5xE)',[tweet], Twitter, 26 July 2018, accessed 29 September 2021.

Monochrome
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How to Value Bitcoin

Research & Insights

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MONOCHROME ASSET MANAGEMENT

0.50 CPD Hours **|** FPA Accredited

Learning Outcomes

Bitcoin is many things to different people. In this session, you will learn about the different Bitcoin valuation models and frameworks used by professionals and academics of different perspectives, as well as critiques of these frameworks. They include:

1   Traditional network valuation frameworks, such as Metcalfe's Law.

2   Cost-of-Production Modelling.

3   Regression models, like Stock-to-Flow.

4   Market Size / Total Addressable Market Valuation.

5   Valuing Bitcoin as a tech startup.

Note: This activity meets the guidelines for qualifying CPD, and has been accredited for continuing professional development by the Financial Planning Association of Australia (FPA). This does not constitute FPA's endorsement of the activity.

1.1 Foreword

In a canonical July 2010 Bitcointalk.org forum post by Satoshi Nakamoto, Bitcoin's creator, they said "*Sorry for being a wet blanket. Writing a description for this thing for general audiences is bloody hard. There's nothing to relate it to.*"[1] Because Bitcoin is so hard to describe, define or contextualise, people can barely agree on what Bitcoin is, let alone how to value it. By default, all frameworks we attempt to apply to Bitcoin will fall short, simply because Bitcoin isn't "just" a network, software, commodity, or financial asset; it is all of the above, and potentially more. In short, the following valuation methods in isolation are unsuitable for valuing Bitcoin, but when taken together, can be quite useful.

1.2 Network Effects (Metcalfe's Law)

Proponents often view Bitcoin as a network, and look to value it as such. Metcalfe's law is a concept used in telecommunications in which a network's inherent value is equal to the square of the number of nodes in its network.[2] Using the example of fax machines, there is no value in owning a fax machine unless there is another to communicate with. The connections between cryptocurrencies and people can hence be quantified by the increase in their adoption.[3]

According to Timothy Peterson's work in Metcalfe's Law as a Model for Bitcoin's Value, the model re-quires three datasets: wallets, number of bitcoins created, and Bitcoin price.[4] As Metcalfe's law was seen to be too optimistic a figure, Peterson incorporated a method used to measure mobile phone usage.[5] Peterson's data can be found below, including Metcalfe value against Bitcoin price.[6]
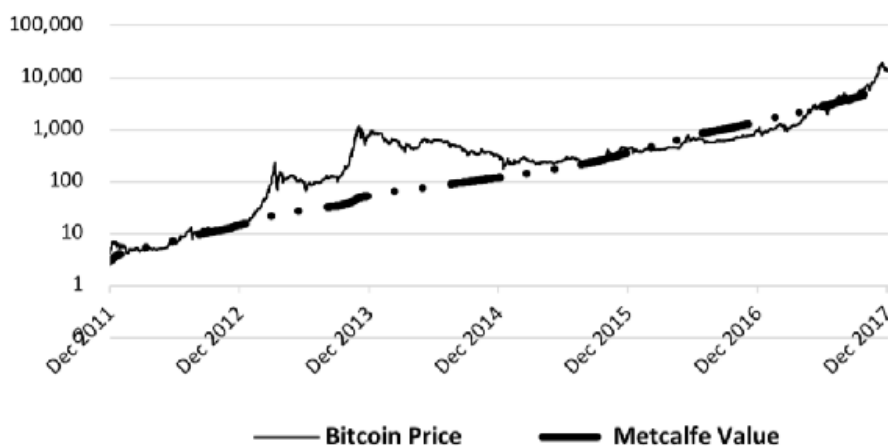
[1] S Nakamoto, 'Re: Slashdot Submission for 1.0 (mnchr.me/2ZgMH6z)', [online forum post], Bitcoin Forum, 5 July 2010, accessed 20 September 2021.

[2] B Metcalfe, 'Metcalfe's Law after 40 Years of Ethernet', IEEE, 2013, 46(12):26-31, doi:10.1109/MC.2013.374.

[3] Wheatley et al., 'Are Bitcoin Bubbles Predictable? Combining a Generalized Metcalfe's Law and the LPPLS Model'.

[4] Chartered Alternative Investment Analyst Association (CAIA), 'Metcalfe's Law as a Model for Bitcoin's Value (https://caia.org/sites/default/files/metcalfeslaw_websiteupload_7-5-18.pdf)', CAIA, 2018, accessed 14 September 2021.

[5] Islam et al., 'Modelling multinational telecommunications demand with limited data'.

[6] CAIA, op. cet.

Peterson found the model's price to be approximately 85% correlated with the market price of Bitcoin. It is important to note, however, that it isn't a "comprehensive valuation model in the strictest sense".[7]

1.2.1 Criticism

No Agreed Upon Exact Figure for Users

This model refers to users as the number of wallets, which is not necessarily an indicator of the number of users. The latest industry data from Crypto.com currently estimates 114 million users, dwarfing Peterson's estimate.[8] This model also fails to consider which type of users are successfully contributing to a network effect - as there are inactive users, users with no balance, and users who do not trade with another that are included. Most importantly, Bitcoin is not "just" a network, and therefore, is difficult to measure solely on that basis.

1.3 Cost of Production Model by DataDater

Since the creation of new bitcoins requires electricity consumption via computational power, Hayes (2016) suggests Bitcoin can derive intrinsic value from its cost of production. The nature of competition in the Bitcoin Mining space is near-perfect due to, among other things, its commodity-like nature, low barriers to entry and exit, large number of buyers and sellers, and high mobility.[10] Due to this level of competition, we can expect marginal revenue of mining firms to eventually equal marginal cost in long-term equilibrium. The cost of production of Bitcoin is fundamentally a strong benchmark for its absolute floor price, as a rational miner will choose to simply buy Bitcoin instead of mine if mining is unprofitable. It also illustrates how market price gravitates towards its cost as commodities tend to do, outlined in Satoshi Nakamoto's work.[11]

Do Other Commodities Derive Intrinsic Value from Mining?

The demand for gold and desire to hold gold as a hedge drive its price. It is not gold mining that gives it value, but the factors forming why people want gold. Bitcoin is the same. People mine Bitcoin because other people want it, with market price being indicative of how many and how much people want it.

Mining Efficiency Increase Does Not Decrease Price

Hayes states that as mining efficiency increases due to technological progress, it is expected to negatively influence the price as it decreases the cost of production.[12] Whilst it may indeed decrease

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[7] CAIA, op. cet.

[8] Crypto.com, 'Global Cryptocurrency Adoption Doubled Since January (https://mnchr.me/39xaGQK)', Crypto.com website, 29 July 2021, accessed 10 September 2021.

[9] A Hayes, 'Bitcoin price and its marginal cost of production: support for a fundamental value (https://mnchr.me/3i33WPs)', Applied Economics Letters, June 2018, accessed 14 September 2021.

[10] H McCook, 'Projecting Bitcoin's Future Energy Use (mnchr.me/2XYTlxY)', Bitcoin Magazine, 28 June 2021, accessed 23 September 2021.

[11] S Nakamoto, 'Re: Current Bitcoin economic model is unsustainable (mnchr.me/3CK6j1h)', [online forum post], Bitcoin Forum, 21 February 2010, accessed 20 September 2021.

[12] A Hayes, 'A Cost of Production Model for Bitcoin (https://mnchr.me/2XYRRno)', The New School for Social Research, February 2015, accessed 12 September 2021.

cost of production, Bitcoin supply is highly inelastic, and decreased cost of production simply leads to more competition. Further, this hasn't been illustrated in the real world as of yet. Despite improvements in processing power, it cannot have an effect on price, only react to it. If the cost to mine is lower than price, hash rate - the collective processing power of the network - will increase.[13]

1.4 Stock-to-Flow (S2F)

Another way to value Bitcoin can be as a Store of Value (SoV) commodity. This value store is attributed to scarcity created by its underlying code; a maximum issuance of 21 million coins, with a predetermined diminishing supply. This allows Bitcoin to be valued using stock-to-flow (S2F) ratios primarily used for SoV commodities.[14] It should be noted that this is one of the most contentious valuation models, even within the Bitcoin community, with critics and supporters.

	Stock (tn)	Flow (tn)	SF	Supply Growth	Prize $/Oz	Market Value
Gold	185,000	3,000	62	1.6%	$1300	$8,417,500,000,000
Silver	550,000	25,000	22	4.5%	$16	$308,000,000,000
Palladium	244	215	1.1	88.1%	$1400	$11,956,000,000
Platinum	86	229	0.4	266.7%	$800	$2,400,000,000

The S2F ratio is the stock of the resource divided by the amount of new production, or flow. Referring to the table above, gold currently has the highest ratio of 62 - meaning 62 years of production to amass the current amount available.[15] Due to the nature of Bitcoin's fixed supply schedule, "flow" is trivial to determine, and most interestingly, Bitcoin's "flow" is programmed to cut in half roughly every 4 years, until eventually flow becomes zero when the 21 million coin limit is achieved. Each of these events is known as a "halving", with the most recent one occurring in May 2020. Bitcoin's S2F ratio has been around ~57 since the last halving, and will double to ~120, far higher than gold, after the next halving in 2024.[16] This ratio is useful for commodities like gold as they show the amount of supply that enters the market relative to its total supply. Proponents of this theory claim a higher S2F ratio indicates superior store of value properties in the long-run, and apply this rationale to Bitcoin.[17]

[13] H McCook, 'Bitcoin Mining Competitive Economics 101 - The Oversimplified Version (https://mnchr.me/2XGTZQj)', Medium website, 16 January 2019, accessed 23 September 2021.

[14] Differs to fiat currencies as governments preset an amount of inflation while bitcoin has a changing issuance rate.

[15] PlanB, 'Modeling Bitcoin Value with Scarcity (https://medium.com/@100trillionUSD/modeling-bitcoins-value-with-scarcity-91fa0fc03e25)', Medium website, 13 March 2019, accessed 10 September 2021.

[16] Look Into Bitcoin, Stock-to-Flow Model (https://mnchr.me/3EKJPiB), Look Into Bitcoin website, 2019, accessed 12 September 2021.
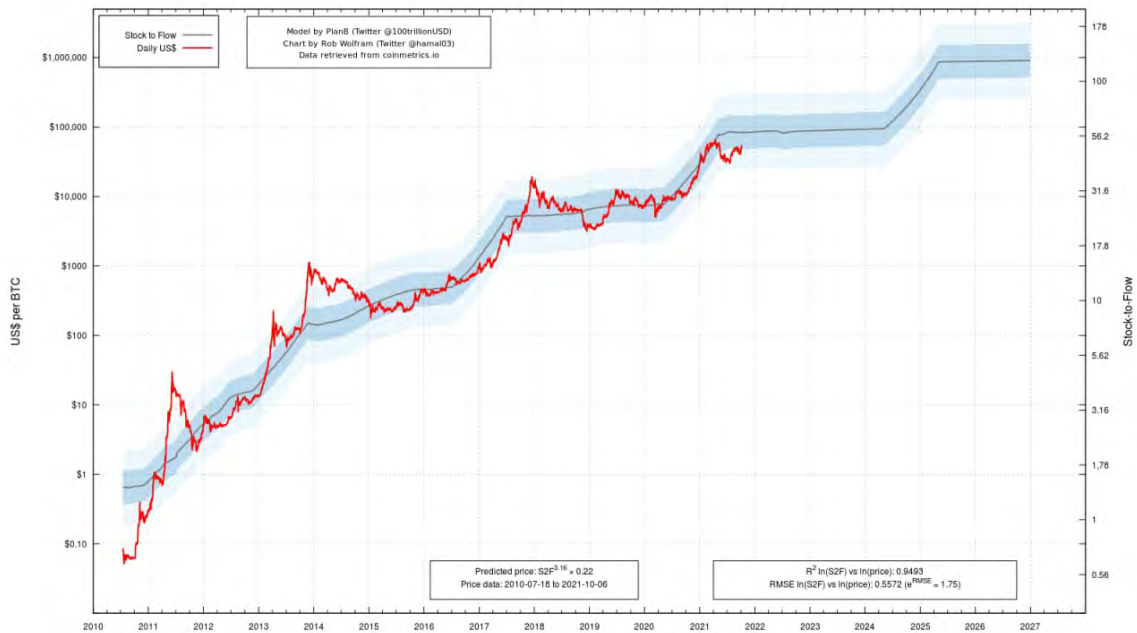
This value can be written as a power law function, plotted in the graph above.[18] The modeled price on the 29th of September 2021 was approximately US$84,650.91, exhibiting a difference of about 104% more than the closing price of US$41,454. The market and S2F price of Bitcoin reveals a statistically significant relationship of approximately 94% correlation.[19] Factors that are said to inhibit this correlation include regulation, cyber attacks, and other news. This reinforces the idea that a predominant factor influencing value is captured with S2F.

1.4.1 Criticism

Efficient Market Hypothesis (EMH)

EMH is an economic theory which outlines that markets are information processing systems that deliver the best price discovery. There are three forms of EMH. Weak EMH states historical price data has been priced in. Semi-strong EMH refers to prices factoring in public news, while strong EMH is where all information, public or private, is priced in.[20]

S2F is based on publicly available information; the supply trajectory and stock to flow, and therefore must be already priced in. Some argue that few capital controls and dwindling opportunities for arbitrage suggest that Bitcoin has a reasonably efficient market. However, by definition, there is a lack of a universally agreed upon definition of and valuation model of Bitcoin that pricing entities agree upon, so efficiency is difficult, if not impossible, to achieve.

The EMH is viewed as an equally contentious model as S2F amongst the Bitcoin community.

[17] Genesis Block, 'What is Stock to Flow Ratio (S2F)? (https://genesisblockhk.com/what-is-stock-to-flow-ratio-s2f/)', Genesis Block website, 8 March 2021, accessed 24 September 2021.

[18] R Wolfram, Daily updated charts of Bitcoin's stock-to-flow vs price (https://s2f.hamal.nl/s2fcharts.html), Hamal website, 2021, accessed 24 September 2021.

[19] D Okorafor, Stock to Flow Analysis Shows Bitcoin Could Reach $288K This Year (https://finance.yahoo.com/news/stock-flow-analysis-shows-bitcoin-102500022.html), Yahoo Finance, 2021, accessed 20 September 2021.

[20] EF Fama, 'Efficient Capital Markets: A Review of Theory and Empirical Work', The Journal of Finance, 1970, 25(2):383-417, doi:10.2307/MC.2325.486.

Infinite Value

The S2F model assumes that mining bitcoins will continue until 2136. When the final block is mined, the value will theoretically be infinite, as there will be no denominator in the S2F ratio to base the model on.[21] In reality, the price will likely continue to be subjected to supply and demand factors while miners continue to compete in validating transactions.[22] In line with this criticism, technical infinity can be also achieved in the event of a collapse or devaluation of the US Dollar, since the price of Bitcoin is expressed in USD.

Demand

This model indicates demand but does not directly include it in its predictions. Although supply is consistent, it cannot be changed to meet demand. In the event of a sharp increase in demand, new supply cannot rise to meet it.[23] Regulations and laws surrounding cryptocurrencies or other factors can also influence demand in ways that the S2F cannot account for.[24]

Broad Range

The S2F model is not useful for horizons of a quarter or less. During extreme bull market phases such as the 2013 and 2017 peaks, the market price of Bitcoin traded at over 4 times the predicted price. Similarly, during the depths of the 2014-2016 and 2018-2020 bear cycles, the price can be observed to be as much as half the predicted value. The range of error is too wide.

1.5 Market Size Approach

The Market Sizing method can be used by valuing the Bitcoin market against comparable markets, including global remittances and gold. This approach is well suited for gold given the similarities.[25] The implied Bitcoin price can hence be calculated as the level of penetration multiplied by the value of the target market divided by the fully-diluted circulating supply (how much will exist). A penetration rate is a proportion of what Bitcoin captures and changes depending on its usage. Lanre Ige and Michael Gotimer from Amun have forecasted paths required for the Bitcoin price to reach gold penetration levels until mid 2025.[26] At 10% penetration, Bitcoin will generate a target price of $38,600. This figure increases to $115,700 at 30% penetration. This timeframe is selected to represent an adequate advancement made in Bitcoin's underlying technology and infrastructure. As Bitcoin grows in value

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[21] S2F Ratio = units of asset in reserve divided by units produced per year.

[22] A Hayes, 'What Happens to Bitcoin After All 21 Million Are Mined? (https://mnchr.me/2W8a9BP)', Investopedia website, 28 February 2021, accessed 14 September 2021.

[23] River Financial, Bitcoin and the Stock to Flow (S2F) Model (https://mnchr.me/3i2ZfoK), River Financial website, n.d., accessed 24 September 2021.

[24] S Flynn, The Stock-to-Flow Model: What Cryptocurrency Investors Should Know (https://mnchr.me/3o4cqcH), Coin Central website, 28 July 2021, accessed 22 September 2021.

[25] Reliable monetary supply, store of value, (quasi-)fungibility.

[24] L Ige and M Gotimer, 'Valuing Bitcoin: An Analysis of Methodologies for Valuing Bitcoin (https://mnchr.me/3CEkHIA)', Amun Research, n.d., accessed 14 September 2021.

and daily transactions, it becomes more useful. An increase in usability will increase market size, thus increasing in accordance with the buying power that matches the natural growth of civilisation.

1.5.1 Criticism

Bitcoin's most ideal comparable market can change over time due to microeconomic factors. This includes a change in technology or creation/development of competitors within the cryptocurrency space. Macroeconomic factors such as legality or government control that impose adverse actions against cryptocurrencies also pose threats. Given the shifting narratives within Bitcoin, the future perception of the market may render the SoV lens unfavourable or obsolete. In such cases, alternative markets can be more suitable for comparison.

1.6 Bitcoin As a Startup

There is no shortage of venture capitalists in the digital asset space, and it is irresistible for them to not think of digital assets as startup companies. Indeed, according to US Securities and Exchange Commission (SEC) Chairman Gary Gensler, the gross majority of "digital assets", Bitcoin excluded, can likely be defined as securities or startup companies.[27] Fundraising rounds can be compared to Bitcoin's reward eras, as shown in the below framework chart.[28]
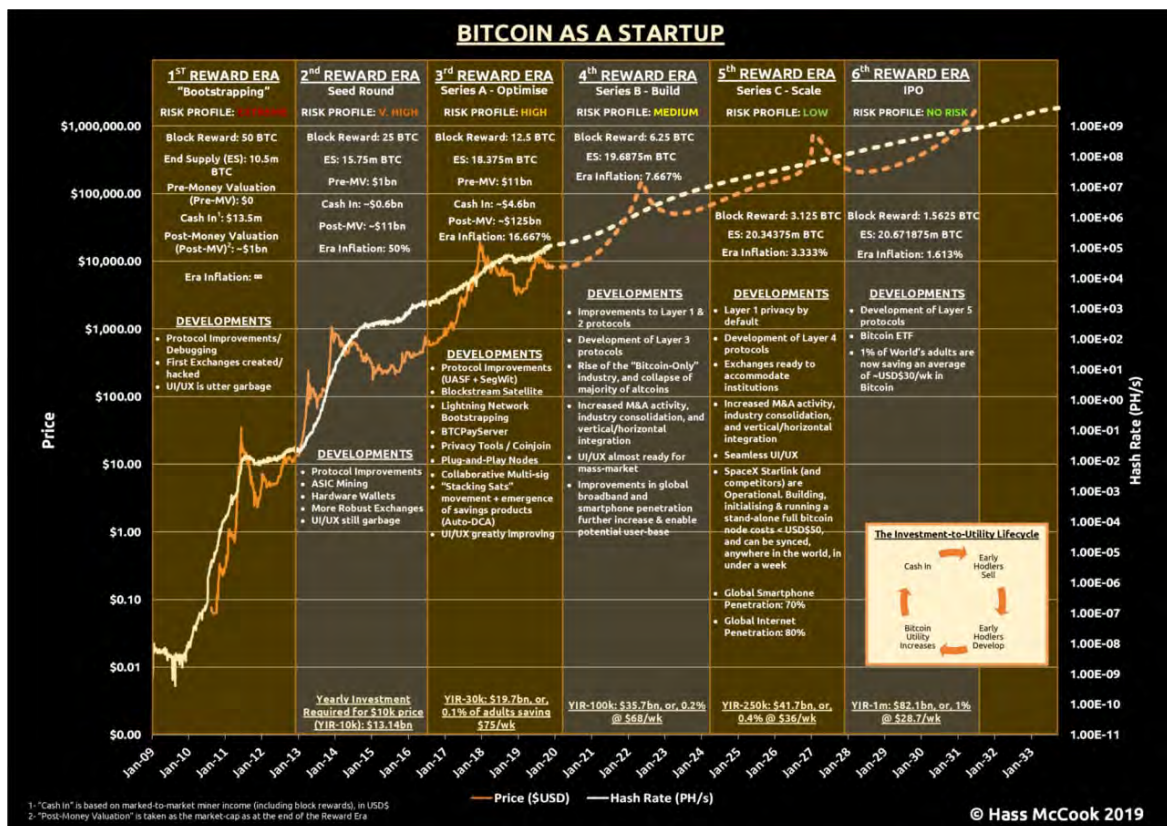
[27] Washington Post, 'Transcript: The Path Forward: Cryptocurrency with Gary Gensler (mnchr.me/39AtW02)', Washington Post Live, 21 September 2021, accessed 24 September 2021.
[28] H McCook, 'Bitcoin as a Startup (mnchr.me/3ACFEmJ)', Medium website, 29 December 2019, accessed 23 September 2021.

The earliest stage was the pre-seed round, or 1st reward era (2009-2012). This period saw an extreme risk of failure where the earliest developers used both sweat equity and funds from the market to bootstrap the startup. The earliest developers can be very easily compared to the early equity employees of Google. The next round (seed round) saw the first VCs entering, investing in Bitcoin companies or Bitcoin itself.

For a typical "Series A" round, companies opt for funding to improve their user base and product offerings.[29] Bitcoin was improved through protocol optimisations like SegWit, which allowed for the possibilities of the Lightning Network.[30] A startup then uses funding in the Series B round to meet new and increased levels of demand. (Remember there isn't any actual formal fund-raising or allocation done as Bitcoin is not a company.) The investment-to-utility lifecycle presented in the figure above suggests that it is simply a distributed network of Bitcoiners, who started off by building sweat-equity in a project they were passionate about, increasing the utility of the platform, thereby drawing in more participation, investment, and ultimately, additional utility over time. In Bitcoin's case, after a "raise", as people are busy at work and out of the limelight, price has tended to settle down to a natural floor over a protracted bear market. In the world of startups, this would be referred to as "burn rate".[31]

In startup terms, scarcity will then become a prominent element in its 5th reward era (Series C) until 2028. This Series' funding allows people to use their influence to promote Bitcoin and increase the amount of people who buy Bitcoin. Finally, running into the 6th Reward Era (2028 - 2032), Bitcoin can be compared to an IPO. Beyond this, it can be expected to resemble a blue chip, with a relatively stable price and inflation nearing zero.

1.6.1 Criticism

Bitcoin is most certainly not a start-up company, and should not be valued as one. However, taking the multi-round approach shows how much of a part increasing utility and growth narratives play in raising money for and valuing startup companies and digital assets.

1.7 Conclusion

Valuing Bitcoin can be a challenge as, due to its abstract nature, there is "nothing to relate it to."[32] However, by shifting the lens through which we view Bitcoin, we can arrive at compelling theories through S2F, cost of production, Metcalfe's law and relating it to a start-up. Each model also hosts criticisms, accommodating for improvements and adaptations. Ultimately, Bitcoin's speculative nature calls to attention the need for more understanding of its various methods of valuation.

[29] N Reiff, 'Series A, B, C Funding: How it Works (mnchr.me/3ENEMOj)', Investopedia website, 31 May 2021, accessed 24 September 2021.

[30] J Frankenfield, 'SegWit (Segregated Witness) (https://www.investopedia.com/terms/s/segwit-segregated-witness.asp)', Investopedia website, 22 March 2021, accessed 20 September 2021.

[31] Corporate Finance Institute (CFI), 'Burn Rate - The rate of depletion of a company's cash pool (mnchr.me/3o3tKyM)', CFI website, n.d., accessed 24 September 2021.

[32] S Nakamoto, 'Re: Slashdot Submission for 1.0 (mnchr.me/2ZgMH6z)', [online forum post], Bitcoin Forum, 5 July 2010, accessed 20 September 2021.

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Volatility of Bitcoin

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Learning Outcomes

In this piece, you will learn about the volatility of Bitcoin, namely:

1   Historic volatility data.

2   Why Bitcoin is currently volatile.

3   The nature of Bitcoin and its likely volatility in the future.

4   How to manage Bitcoin's volatility.

Foreword

Bitcoin has been garnering significant attention as it begins to be adopted by a wider range of investors. The investor base is starting to shift from retail investors to large institutions. Naturally, questions regarding its volatility and legitimacy as an investment opportunity will arise. This paper will address such questions and provide solutions to including and managing Bitcoin in a well structured portfolio.

1.0 Bitcoin as an Asset

Bitcoin launched in 2009 as the first cryptocurrency to introduce and use a distributed ledger ("Blockchain") to guarantee the scarcity of its native monetary unit, and has a current market capitalization of ~AUD $1,500BN.[1] Since its launch, Bitcoin has generally demonstrated three performance characteristics: High returns, high volatility and low correlation to traditional assets.

Whilst Bitcoin can be compared to a raft of other assets based on particular criteria, it stands alone when viewed as a total package. Bitcoin is a software protocol first and foremost, however, it is obviously not "just software". Bitcoin shows many traits of different financial assets, but it is not strictly confined to cash, bonds or equities. Bitcoin is software, finance, and ultimately, a socioeconomic phenomenon all put together, that has found value in the marketplace.

2.0 Volatility

2.1 How Volatile is Bitcoin?

One of the main concerns people might have about Bitcoin is volatility. Intraday, daily, annual, or peak to trough measures all illustrate the high volatility that accompanies the historically high returns.[2] Graph 1 below shows the volatility of Bitcoin against a traditional 60/40 portfolio.

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[1] Glassnode Studios, 'Bitcoin Market Cap (mnchr.me/2WCP16X)', Glassnode Studios, n.d., accessed 27 October 2021.
[2] CFA Institute, 'Cryptoassets (mnchr.me/3C43YhL)', CFA Institute, 2021, accessed 25 September 2021.

Exhibit 1 Rolling One-Year Volatility

Source: Morningstar Direct. Data as of May 31, 2021.

Graph 1: Volatility of Bitcoin against a traditional 60/40 portfolio.[3]

2.2 Why is Bitcoin so Volatile?

Bitcoin's volatility boils down to its design and position in the market as a nascent asset class. There is no central bank to govern the supply of Bitcoin, meaning that its price can't be supported when it falls, unlike traditional currency and bond markets. As a result, the price of Bitcoin is determined entirely by the market, governed by the laws of supply and demand. However, Bitcoin has a perfectly inelastic supply curve - where supply cannot keep up with demand, this leads to spikes in price. Its supply is finite much like gold or coal, but the differences are in the way it is mined. The framework is coded such that there is a maximum of 21 million Bitcoins available, with 18.7 million currently in circulation.[4] Mining becomes progressively harder as more people join the mining network and the size of the rewards halve every 210,000 blocks, or roughly 4 years (referred to as a "halving").

With the digital asset industry in its early stages, and Bitcoin at the forefront of it, speculation and market sentiment plays a large factor in its pricing.[5] This allows recent events such as China's cryptocurrency crackdown, El Salvador's Bitcoin legal tender law or even comments from public figures to move its price significantly.

The Bitcoin market isn't viewed as one that requires expertise like the real estate or stock markets. This, combined with the low barriers to entry, attract "fragile investors" who invest hoping to make quick gains but withdraw soon after losing patience. This frequent entry and withdrawal contributes

[3] Millson, 'How a LIttle Bitcoin Can Change Your 60/40 Portfolio a Lot (mnchr.me/3nehEAN)', Morningstar, 2021, accessed 22 September 2021.

[4] Glassnode Studios, 'Bitcoin Supply (mnchr.me/2YfMe4F)', Glassnode Studios, n.d., accessed 21 September 2021.

[5] NDTV, 'Why Is The Cryptocurrency Market So Volatile? (mnchr.me/3FfdUHg)', NDTV, 14 August 2021, accessed 19 September 2021.

Graph 2: The Monetary Evolution of Bitcoin

3.0 Correlation of Bitcoin

3.1 Low Correlation to Traditional Assets

Bitcoin's correlation structure compared to traditional asset classes can make it a useful tool in portfolio construction. Typically, investing in an asset with low or negative correlation helps enhance diversification and reduce portfolio volatility.[11] Bitcoin has relatively low correlation to traditional assets, being near-zero or negative across the board, with the exception of 2020, as shown in Table 1 and Graph 3. JPMorgan has discussed Bitcoin as an "attractive option for multi-asset portfolios for diversification" and being "less vulnerable to any further appreciation in the dollar."[12]

Calendar Year Correlation to Bitcoin	2020	2019	2018	2017	2016	2015	2014	2013
S&P 500	0.22	0.09	0.04	−0.01	−0.01	0.01	−0.03	−0.12
U.S. Bonds	0.07	0.00	−0.03	0.04	0.04	−0.06	0.04	0.10
Gold	0.34	0.14	−0.02	0.01	0.07	0.04	−0.08	−0.04
U.S. Real Estate	0.17	−0.09	−0.03	0.04	−0.03	0.01	0.01	−0.10

Table 1: Correlation of Bitcoin to traditional asset classes.[13]

[11] Guggenheim, 'Asset Class Correlation Map (mnchr.me/3BaVXr9)', Guggenheim, 2021, Accessed 14 September 2021.
[12] Hajric, op. cet.
[13] VanEck, 'Bitcoin's Correlation to Markets Hits a Record in 2020 (mnchr.me/3A8BVfm)', VanEck, 8 February 2021, Accessed 14 September 2021.

3.2 Correlation or Coincidence?

Most Australian and global asset classes entered a bull market following the Covid-19 market crash in March 2020. Over the same period, Bitcoin has seen a 525% increase in price.[14] But is this real correlation or a coincidence? Indeed, many might look at the below chart and see a near 100% correlation between Central Bank balance sheets and asset prices.[15]

Figure 6.

S&P 500 & ASSETS OF MAJOR CENTRAL BANKS

Note: QE1 (11/25/08-3/31/10) = $1.24tn in mortgage securities; expanded (3/16/09-3/31/10) = $300bn in Treasuries. QE2 (11/3/10-6/30/11) = $600bn in Treasuries. QE3 (9/13/12-10/29/14) = $40bn/month in mortgage securities (open ended); expanded (12/12/12-10/1/14) = $45bn/month in Treasuries. QT (10/1/17-7/31/19) = balance sheet pared by $675bn. RM (11/1/19-3/15/20) = reserve management, $60bn/month in Treasury bills. QE4 (3/16/20-infinity). Source: Federal Reserve Board, Standard & Poor's and Haver Analytics.

Page 3 / *March 10, 2021* / **Monthly Balance Sheets**

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Some commentators report that this short term increase in correlation will not continue because the underlying return drivers of Bitcoin are inherently different from other asset classes. Bitcoin is driven by widespread adoption whereas equities and bonds follow more traditional metrics such as interest rates and economic growth. Many predict these fundamental differences will continue to keep Bitcoin's correlation low relative to other asset classes.[16]

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[14] Glassnode Studios, 'Bitcoin Market Cap (mnchr.me/2WCP16X)', Glassnode Studios, n.d., accessed 21 September 2021.

[15] E Yardeni, 'Central Banks: Monthly Balance Sheets (mnchr.me/3jZXWYP)', 22 October 2021, Yardeni Research Inc., accessed 25 October 2021.

[16] CFA Institute, op. cet.
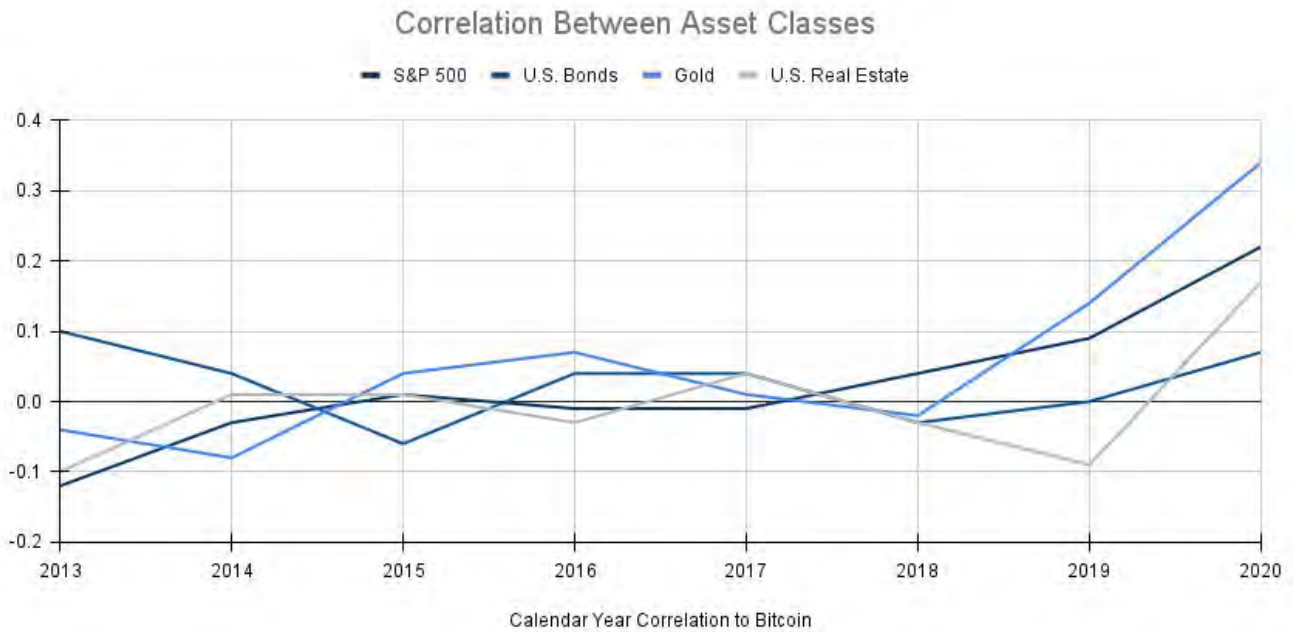
Graph 3: Correlation of Bitcoin to traditional asset classes.[17]

4.0 Managing Bitcoin's Volatility

When looking at allocating Bitcoin in an investment portfolio, the strategy must be carefully considered. Bitcoin can be treated like any normal investment, where one allocates a certain amount and rebalances accordingly. Commonly asked questions are "how much do we allocate" and "how often do we rebalance it".

Bitcoin's high volatility might be a deterrent to some investors but positive contributions can be harnessed through a disciplined rebalancing strategy. Due to its highly volatile nature, rebalancing may be done to manage risk. A certain weight is established and will be rebalanced either through time or target based strategies. Time based rebalances include rebalancing on a set time basis, ranging from monthly to annually. Not rebalancing can significantly alter the risk/return characteristics of a portfolio, while rebalancing too frequently can lead to potentially missed returns.[18] Target based allocation includes establishing a tolerance and allowing the allocation to fluctuate within this range. For example, a portfolio may set a 5% allocation to Bitcoin with a 2.5% tolerance - the allocation can range from 2.5% to 7.5% before rebalancing is performed.

Dollar Cost Average (DCA) investing is another traditional strategy that can be applied to Bitcoin investing, where a fixed amount is invested over recurring periods of time. The intended effect of this is to lower the average price paid for the investment and ultimately maximise returns.[19]

[17] VanEck, op. cet.

[18] Bitwise, 'The Case for Crypto in an Institutional Portfolio (mnchr.me/3joFlFr)', Bitwise, August 2021, accessed 2 October 2021

[19] BT Financial Group, 'The Benefits of Dollar Cost Averaging (mnchr.me/3B9ChE1)', BTFG, May 2009, accessed 6 October 2021

The strategies discussed above are analysed further in the Monochrome Research report Bitcoin in a Portfolio, delving deeper into the effects of rebalancing frequency and allocation size.

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