

Bitstamp

BITCOIN'S VALUE DRIVERS

OCTOBER 2020

An in-depth report by ByteTree
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ByteTree

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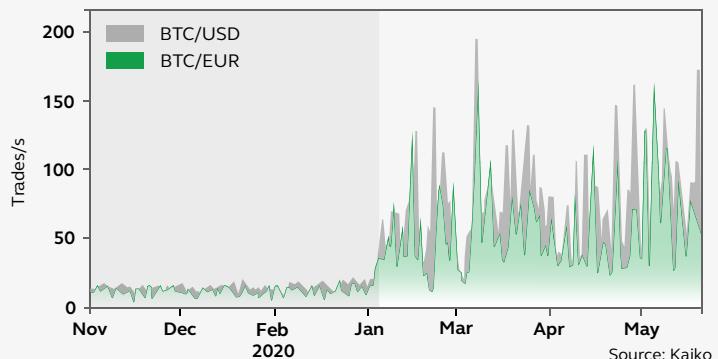
Bitstamp's new matching engine makes it the first regulated crypto exchange with tech that can reach levels of performance found in FX markets

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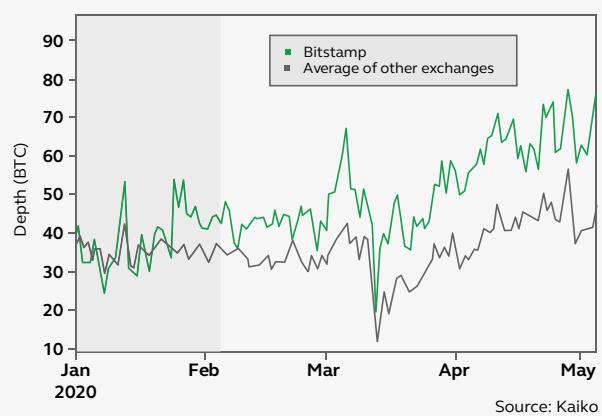
But the road to long-term success requires a long-term solution. That's why Bitstamp joined forces with Nasdaq to implement a matching engine capable of increasing order matching speeds by 1250X and throughput by 400X. While it will still take a while for the crypto pioneer exchange to reach the full potential of its new tech backbone, implementing Nasdaq's engine already resulted in:

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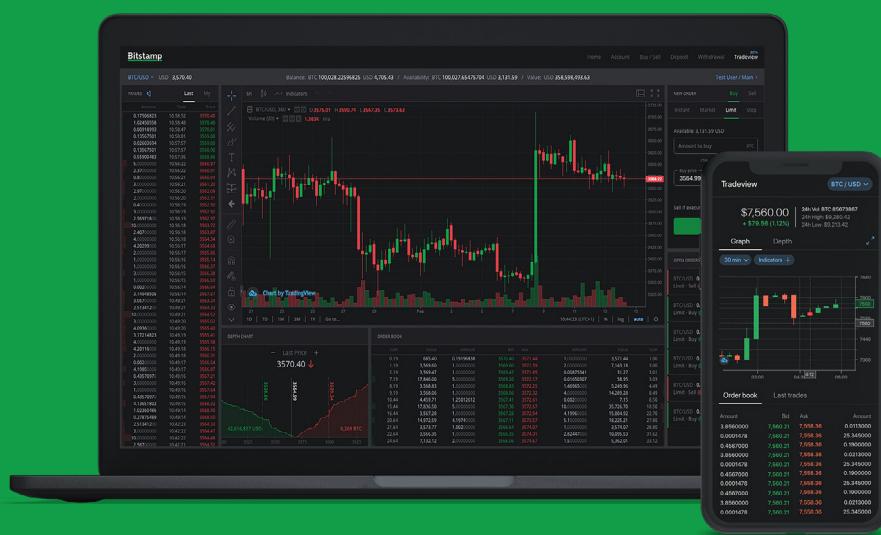
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ByteTree is a leading provider of institutional-grade crypto-asset data. The ByteTree investor terminal tracks over **80 metrics for Bitcoin in real-time**. ByteTree's on-chain data platform was conceived in 2013 as a tool to assist a multi-asset fund manager with managing risk in his portfolio. After yielding great success, the tool launched as a publicly accessible investor terminal in 2018. ByteTree brings rigorous practices in data quality and delivery to crypto-asset investing. **The Terminal is currently the leading source of real-time data for UTXO-based blockchain networks.**

<https://terminal.bytetree.com/>



About the Authors

Charlie Morris, Co-Founder and CIO



Charlie is a lead portfolio manager and develops both crypto and traditional investment strategies for ByteTree and ByteTree Asset Management. He has 23 years' experience in fund management, where he has built a reputation for managing actively managed, multi-asset portfolios, with an emphasis on efficient diversification and risk management. Although well versed in traditional asset classes, Charlie is best known for his expertise in alternative assets, notably gold and Bitcoin.

James Bennett, CEO



James is the Chief Executive Officer of Crypto Composite Ltd (CC), the parent company of ByteTree, and a Director of ByteTree Asset Management. He leads the development and expansion of the CC group, engaging across the organisation on a strategic level. Prior to ByteTree, James worked for global infra-tech company General Electric (GE), where he was responsible for planning and executing strategic projects in FP&A, Supply Chain and Risk Finance, across all levels of the organisation. James is an active member of the London blockchain scene, a regular speaker at events, invited expert to the world's largest blockchain hackathon and co-host of the London Blockchain Meetup.

Tom Salter, Digital Asset Analyst



Tom is a digital asset analyst at ByteTree where he focuses on on-chain data analytics. He started in the digital asset space in 2016 when he started DigUp Ltd, a cryptocurrency mining operation which used anaerobic renewable energy to power Bitcoin miners across the UK. Tom now specialises in Decentralised Finance (DeFi) and believes that institutional adoption is key to the growth of the digital asset space. Tom is awaiting results from Nottingham Trent where he studied Law with Business LLB.

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Chapter 1

Key Macro Drivers for Bitcoin in 2020

Charlie Morris, Co-Founder and Chief Investment Officer

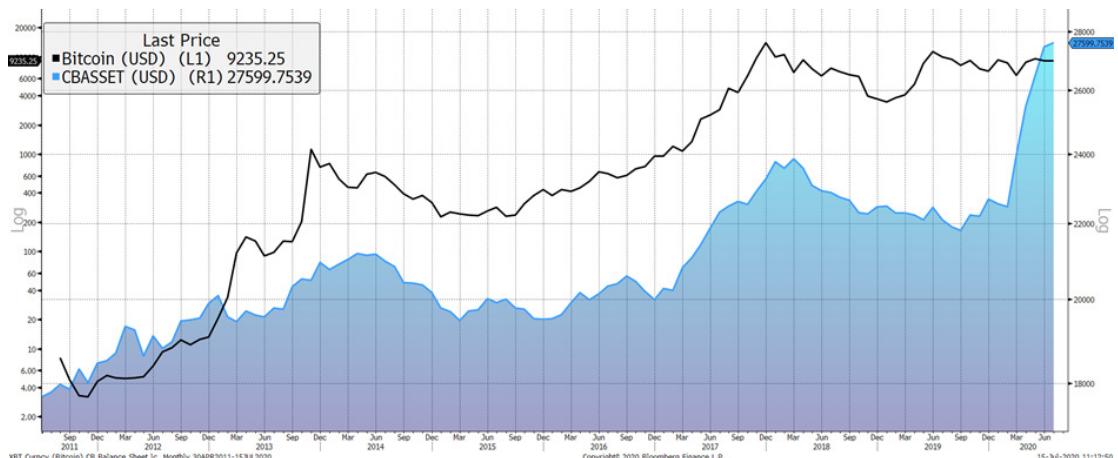
As a multi-asset class investor, I have learnt from over two decades of experience that asset prices are not only merely driven by their own fundamentals but by external factors as well. There can be no doubt that in the long-term, the stock market is driven by corporate profits, yet it can fall when profits are rising just as it can rise when profits are falling. Similarly, gold is a natural inflation hedge that can rise or fall for reasons unrelated to inflation. In this chapter, I shall focus on the external macroeconomic factors that influence the price of Bitcoin.

In the early days, Bitcoin's vast price appreciation was driven by rapid adoption. That continues to grow but at a more measured pace than in the pre-2012 era. As Bitcoin matures into an institutional grade asset class, macroeconomic factors will become more important, and I highlight those likely to stand the test of time.

Central Banks

Bitcoin was inspired by the need for sound money. The major central bank balance sheets (Fed, ECB, BOJ, PBOC) have grown at a rate of 11.6% per year since 2002, which amounts to a seven-fold increase. That has been supportive of asset prices in general, of which we consider Bitcoin to be one, yet has done surprisingly little for consumer price inflation; something that may yet change. I have combined the four major central bank balance sheets below and plotted them against the price of Bitcoin.

Bitcoin Likes Easy Money



Source: Bloomberg. Combined central bank balance sheets (\$ trillion) and Bitcoin since 2011

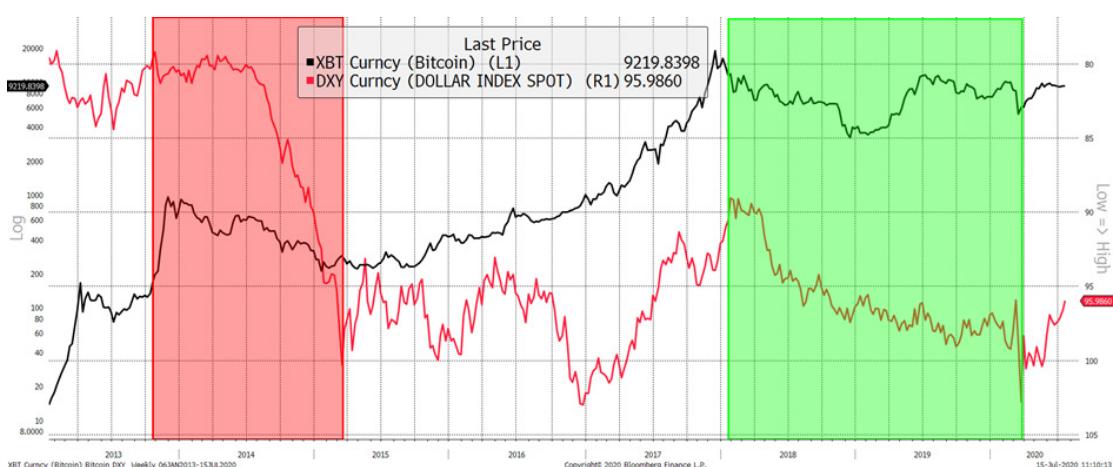
Bitcoin has performed best during periods of balance sheet expansion and worst during periods of contraction, as evidenced by the chart. In 2014 and 2018, the system saw monetary contraction, which coincided with Bitcoin's worst years on record. In contrast, 2013 and 2017 were years of significant balance sheet expansion that coincided with Bitcoin's best years post-2012 (the early adoption surge).

It is most unlikely that the central banks bought Bitcoin, but they don't need to. Their balance sheet sits at the top of the monetary food chain, and as it expands, money flows around the system, like water at floodtide. The central banks typically buy bonds, the seller receives cash, and reinvests it elsewhere. This is repeated, and the money soon finds its way around the financial system and lifts asset prices. A rising tide floats all boats, and the price of Bitcoin rises.

You would be forgiven for thinking that Bitcoin is owed a bounce in 2020, given the recent surge in central bank balance sheets. I would agree, but other factors must also be considered. One recent influence may have come from the halving premium. That is, some investors bought in anticipation of a post halving rally. There are many reasons for Bitcoin to appreciate, but halving is not among them.

One casualty of easy monetary conditions is the US dollar. As markets turn bullish, money flows out of the dollar to the rest of the world. In the chart, the dollar index (DXY) is inverted. The shaded areas show periods of dollar strength which incidentally fall into 2014 and 2018, the Bitcoin bear years. And Bitcoin saw its best performance during periods of dollar weakness, or at least stability.

Bitcoin Likes a Weak Dollar



Source: Bloomberg. The US Dollar Index (inverted RHS) and Bitcoin (\$ LHS) since 2013

When the dollar rises, the global economy is starved of liquidity. There are huge amounts of outstanding US dollar debt issued by countries and corporates. A dollar fall makes it easier to repay debt and boosts credit worthiness. In contrast, a strong dollar puts the economy under pressure, which equates to a global liquidity squeeze. There can be little doubt that, like gold, Bitcoin likes easy money, which is why it is correctly seen as

a hedge against money printing.

Furthermore, when you measure an asset price in dollars, then if the dollar falls, the asset must rise and vice versa; all things being equal. But this obvious point has little impact, because the FX moves are small compared to the moves in Bitcoin. According to Bloomberg data, the DXY volatility has averaged 6% since 2015 in contrast to Bitcoin at 60%. This inverse relationship holds true, but the impact is relatively minor.

Bitcoin and Risk Conditions; Bitcoin is a Risk-On Asset

Given Bitcoin is responsive to monetary conditions, it is naturally correlated with risk-on assets, including equities and credit. In this next chart, I define “risk conditions” as the relationship between equities and bonds, with the red line rising when equities outperform. At the time of writing, risk is turning down.

Bitcoin is Correlated with Risky Assets

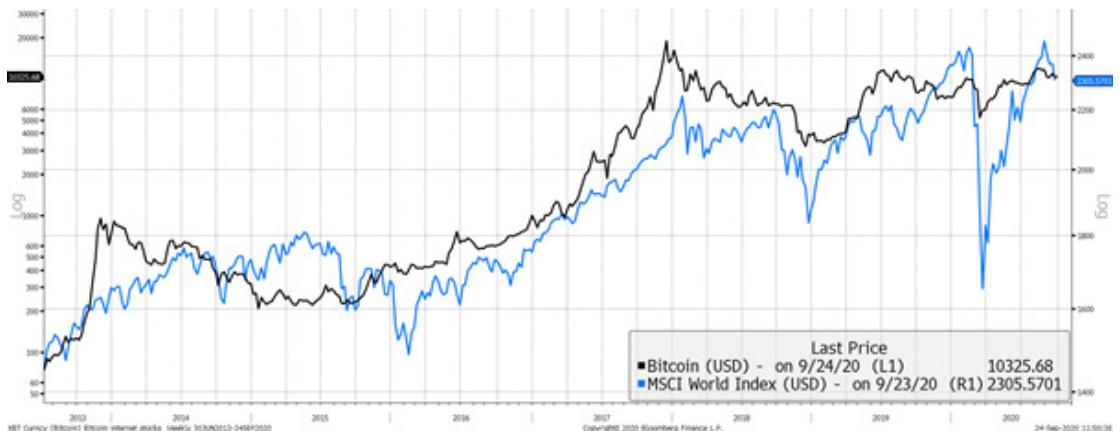


Source: Bloomberg. Bitcoin \$ and Equities versus bonds since 2013.

The relationship is imperfect but has seen increasing correlation over time. What stands out is the rally in 2016/7, the drop in Q4 2018 and the move over the COVID crash. I have not shown correlation tables because the results are misleading. Bitcoin trades in a different environment to traditional assets, meaning the day to day moves have little in common. However, it is indisputable that the longer-term relationships are more visible, at least with the help from log scales.

Looking at Bitcoin and global equities, the relationship has been strengthening. Of interest is the 2017 Bitcoin peak, which led the equity peak by 40 days. Thereafter, the match in Q4 2018 is evident, as is the COVID fall. However, there have been periods of mismatch. Bitcoin drifted lower in H2 2019; perhaps it got ahead of itself following the H1 surge. And today. Once again, Bitcoin is lagging risk assets in general. More on that in chapter 4.

Bitcoin and Global Equities



Source: Bloomberg. Bitcoin \$ and MSCI Global Equities Index since 2015.

Perhaps slightly more convincing than global equities is social media stocks, as represented by the Solactive Social Media Index (SOCL). SOCL includes companies such as Facebook, NAVER, Tencent and Yandex; a global mix. Although the general trend is similar to global equities, the short-term correlations are slightly higher. This should not surprise because Bitcoin is an evolution of the internet, that follows the laws of the Network Effect. Social media stocks exchange photos and messages with activity being correlated to value. In Bitcoin, the exchange of value is the most important driver of price. You can read more about that in chapter 3.

Bitcoin and Social Media



Source: Bloomberg. Bitcoin \$ and Social Media Index since 2013.

Bitcoin and Gold Are Opposites

They say opposites attract. The supply side of Bitcoin was designed around the idea of gold, such as: limited supply, fungibility, reliability, and so on. That ought to mean gold and Bitcoin have something in common, but it turns out to be much less than you might think. As previously mentioned, Bitcoin enjoys easy monetary conditions, but in a different way to gold. The key difference is that gold is a risk-off asset, by which I mean,

it outperforms equities (and Bitcoin) when the economic tide is going out. When there has been a deflationary shock, asset prices have fallen, but gold has fallen to a much lesser degree than risk assets.

Generally speaking, asset prices like easy monetary conditions, but gold is unique as it thrives on falling real interest rates, rather than central bank stimulus, because it has a strong link to inflation. Hypothetically, when interest rates are falling, and inflation is rising, that is the perfect storm for gold. Conversely, tight money occurs when rates rise faster than inflation; a condition that is devastating for gold.

The “taper tantrum” of Q2 2013, when the Federal Reserve signalled they would raise rates in the future, saw gold collapse and Bitcoin surge. In fact, 2013 was Bitcoin’s best ever year (5400%) and gold’s worst year (-28%) since 1981. How much can gold and Bitcoin possibly have in common when they show diametrically opposite behaviour in response to a macroeconomic change? Incidentally, 2013 was a specular year for social media stocks (62%) as well, which supports my view that Bitcoin is a growth asset.

Growth stocks like rising real rates (defined here as the 10-year yield less the 10-year expected rate of inflation) whereas gold likes falling real rates. That is an opposite condition, and a clear distinction between the two assets. It means that a portfolio that embraces both gold and Bitcoin will have superior risk adjusted returns than either asset alone. The last peak in real rates was seen in October 2018, when they touched 1%. Is it a coincidence that the Bitcoin price collapsed days later while gold began a new bull run? I very much doubt it, because notwithstanding the shared love of stimulus and an inverse reaction to the dollar, gold and Bitcoin are more opposite than alike.

Gold and Bitcoin Versus Real Rates



Source: Bloomberg. Bitcoin, gold and US 10 years forward real interest rates since March 2018 rebased.

The chart was rebased to 100 at the peak in real rates on 31st October 2018. Coincidentally, gold and Bitcoin have returned more or less the same return since, but via very different paths. If you had invested in gold, you would have made 52% and 64% from investing in Bitcoin. However, if you had invested in both of them on a 50/50 basis, and rebalanced

each month, you'd now have 93% (to end August 2020 ByteTree data). Magical, isn't it? That benefit only comes when you combine negatively correlated assets. I will elaborate more on this in the next chapter.

Summary

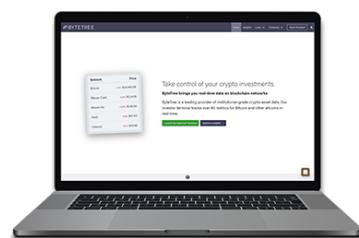
Bitcoin has its own fundamental relationships which we'll explore in chapter 3. That looks into the network value and what a Bitcoin might be worth. However, while we like to believe asset prices have a mind of their own, it is inescapable that they have close links to external factors, that are outside of their control.

In this chapter, we have looked at central banks, the US dollar, global equities, social media stocks, real interest rates and gold. There's an old saying that if it quacks like a duck, it's a duck. Bitcoin quacks like a growth stock. Sure, it likes central bank printing and a weak dollar, but what doesn't? It is risk-on and broadly follows the path of equities, especially social media stocks. Finally, it prefers real rates to be rising and has shown its highest returns during such times. When real rates have fallen, Bitcoin has on occasion collapsed, just as gold has taken off. Finally, I showed how a blend of gold and Bitcoin is a remarkably effective strategy.

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Chapter 2

Gold Versus Bitcoin

Charlie Morris, Co-Founder and Chief Investment Officer

In chapter 1, I showed the impact of central bank stimulus, also referred to as liquidity. An increase in liquidity is supportive of asset prices in general, whereas a contraction is detrimental; Bitcoin is no exception. In this exercise, I go a stage further and see how different asset classes behave in different ways. Some are more responsive to liquidity than others, and furthermore, there are different types of conditions to consider.

At the heart of global macro considerations are interest rates and inflation, as they estimate the future value of money and the discount rate by which assets are valued. This is central to the gold versus Bitcoin discussion because it helps us to better understand their differences and similarities from a macroeconomic perspective.

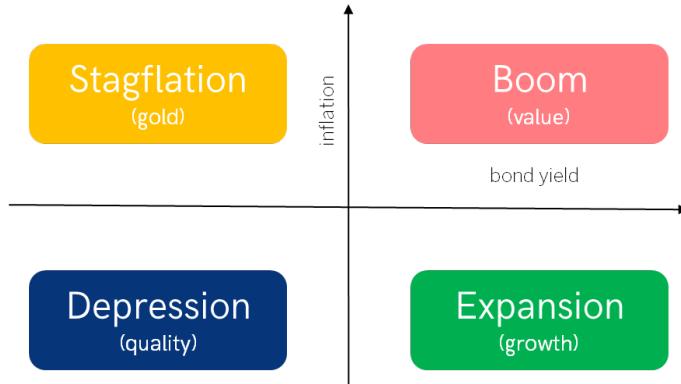
In this exercise, I use the 10-year US Treasury bond yield and the 10-year breakeven rate (future inflation expectation derived from TIPS prices). US data is used because we are pricing Bitcoin in US dollars, and because US monetary conditions dominate global conditions. I use 10-year data as it gives us a glimpse of what the market sees into the future. If you use overnight rates and reported inflation, the information is backward looking and much less effective for macroeconomic analysis.

I have split the market cycle into four different distinct regimes, which broadly fit with different rates and inflation scenarios:

1. Depression - flight to quality into defensive assets, such as consumer staples and utilities, as bond yields and inflation fall.
2. Expansion - growth assets, such as brands, consumer discretionary and technology lead as real rates rise (the bond yield rises faster than inflation).
3. Boom – economically sensitive real assets, such as commodities and heavy industry, lead as bond yields and inflation rise.
4. Stagflation - gold soars as real rates fall (inflation rises faster than the bond yield).

With reference to the diagram, consider that in a boom, you would expect to see stagflation and expansion assets (neighbours to the boom) hold up while depression assets (opposite) lags. Similarly, in a stagflation regime, boom and depression assets (neighbours to stagflation) should hold up while expansion assets (opposite to stagflation) lags, and vice versa. As interest rates and inflation shift, so does asset class behaviour.

The ByteTree QUAD Model



Source: ByteTree.com.

Changes in inflation expectations and bond yields represent the future value of money. When inflation is rising, hard assets (upper two quadrants) will outperform financial assets (lower two quadrants), as money will have less value in the future and hard assets preserve real value. In contrast, when inflation is low and stable, the future value of money is underpinned, and assets that can generate more money (growing profits) in the future, are rewarded with higher valuations today.

"Rising inflation favours hard assets over financial assets"

That can be confusing but consider that quality and growth companies literally “make money” and are expected to make even more of it in the future. If inflation is low and stable, then those future profits are desirable. Strange though it may seem, future profits are less attractive when inflation is rising. Put simply, money is losing its value, so why chase it? Still in doubt, then ask why the market does not rate domestic growth stocks in high inflation countries, yet we happily rate their natural resources. Their natural resources are real, and always will be, whereas their money will be worthless.

This is a multi-asset class thesis that applies equally to equities, bonds, property, and commodities. The aim is to better understand how crypto or digital assets sit within a macroeconomic framework.

| | Asset class | | | | | |
|---------------------------|-------------|-------------------------------------------|-------------------------------------|---------------------|-----------------------------|--------------------------------|
| | Equity | Bond | Property | Commodity | FX | Crypto |
| Rate and inflation regime | Quality | Consumer staples, healthcare | US long bond | Hospital | | USD, JPY Tether \$ |
| | Growth | Tech, consumer discretionary, industrials | Corporate bonds | Office | Palladium | EUR, GBP, SGD Bitcoin? |
| | Value | Energy, materials, financials | Emerging market local currency debt | Industrial and farm | Energy, metals, agriculture | AUD, RUB, CNH, BRL Bitcoin? |
| | Gold | | TIPS | | Gold | CHF Gold token |

Source: ByteTree.com.

In recent years, we have seen deflationary busts in 2008, 2015, 2018 and 2020. Under these scenarios, quality outperformed because these high-quality assets are resilient and offer certainty. Companies such as Johnson and Johnson or Nestle still fell during periods of crisis, but much less than the market, and therefore outperformed. Similarly, US treasuries are highly desirable when the market collapses, whereas emerging market and corporate debt come under pressure. In property, healthcare REITs outperformed retail, industrial or office REITs. There was a flight to the US dollar and to the Japanese yen. During these periods, value performed poorly.

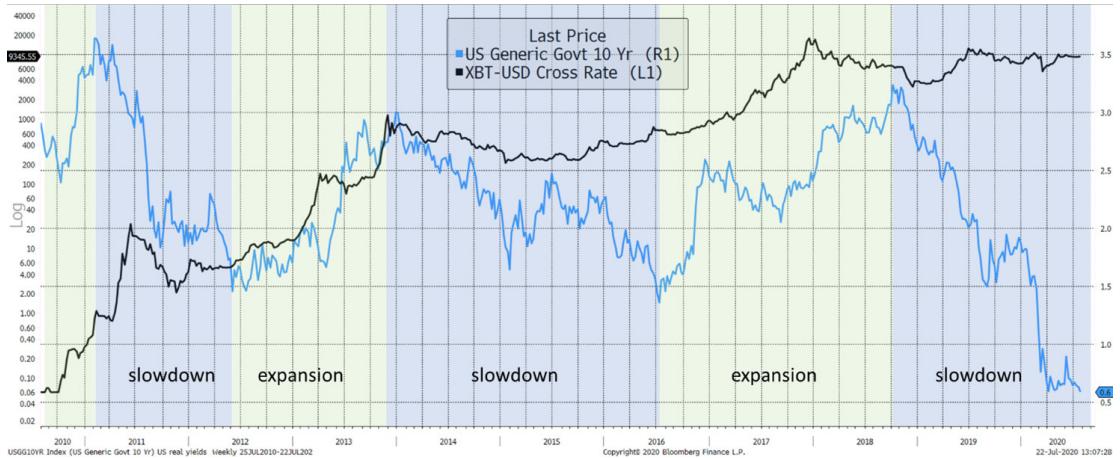
During the inflationary boom in 2011, gold surged along with the Swiss Franc, while corporate credit came under pressure. Although palladium is a precious metal, it fell by 18%, and tech stocks struggled. I could keep going, but the focus is on Bitcoin, to see how it responds to rates and inflation.

Bitcoin and the Macro Regime

Leaving aside the early years, where it is unlikely that macro factors had much impact, Bitcoin has tended to do best alongside growth assets in 2013 and 2017. Then again, Bitcoin has done worst alongside growth assets in 2014 and 2018. With 2013 being a terrible year for gold, the evidence so far is that Bitcoin is a growth asset. But this evidence is only circumstantial, and we need to dig deeper.

In the first instance, I examine how Bitcoin has fared under rising and falling bond yields, which is an approximation for economic growth. The economy has done best when yields have risen and contracted when they have fallen. The bond yield isn't the perfect Bitcoin trader, but it's not bad at all. You can see from the naked eye, that owning Bitcoin during periods of economic expansion (rising yield) has been better than when the economy was contracting.

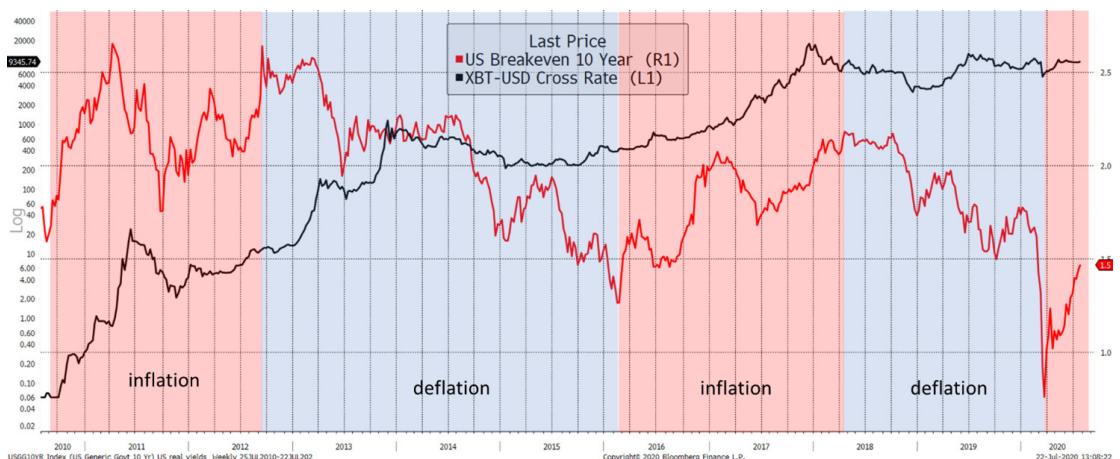
Bitcoin and the 10-Year Treasury Yield



Source: Bloomberg. Bitcoin and 10-year treasury yield since 2010.

The same holds true for inflation. Rising inflation, which reflects higher demand, has also coincided with some of Bitcoin's best years. That said, it did miss the critical 2013 bull market, but has been reasonably effective since.

Bitcoin and the 10-Year Breakeven Rate



Source: Bloomberg. Bitcoin and 10-year breakeven rate since 2010.

To finish off this point, I have run a simple test when you own Bitcoin under the stated conditions. I have used the gradient of the 40-week moving average to define whether rates or inflation are rising or falling. It is imperfect but objective. Since the bond yield is always either rising or falling, one side will always be invested, and so the combined outcome of both conditions will equal buy and hold. The same is true for the inflation test. I have added the real yield (the bond yield less inflation), and the curve (the bond yield plus inflation).

Testing Bitcoin Against the Treasury Market

| Test | Invest when | Return | Contribution to return |
|--------------|-----------------------|-------------|------------------------|
| Quality | Bond yield is rising | \$122,092 | 97.9% |
| | Bond yield is falling | \$2,538 | 2.1% |
| Value | Inflation is rising | \$77,513 | 95.0% |
| | Inflation is falling | \$3,881 | 5.0% |
| Gold | Real yield is rising | \$80,701 | 95.0% |
| | Real yield is falling | \$4,070 | 5.0% |
| Growth | The curve is rising | \$75,410 | 94.5% |
| | The curve is falling | \$4,126 | 5.5% |
| Buy and hold | | | |
| Bitcoin | | \$3,116,773 | 100.0% |

Source: ByteTree.com. \$100 invested 31st December 2010 to 27th July 2020.

We should be cautious when interpreting these results because there is only one Bitcoin over just one decade. We are still learning how Bitcoin behaves and responds to external events, and we will need more time to draw solid conclusions. Furthermore, despite the usual market volatility, this past decade has been overwhelmingly deflationary. Bond yields have reached record lows and have been heavily influenced by central bank stimulus.

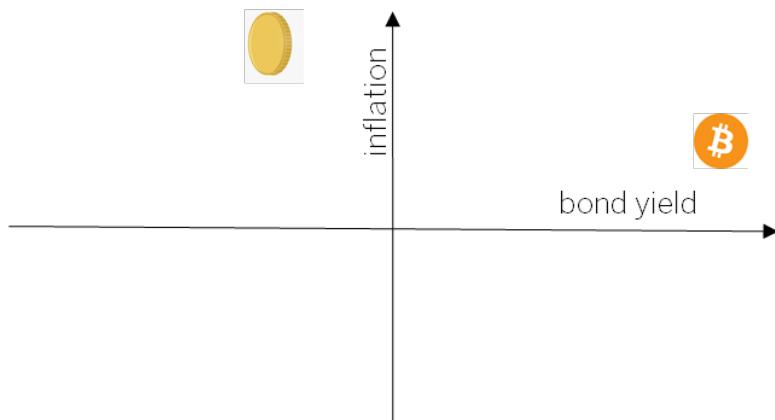
That said, it is striking how Bitcoin has performed materially better when both the bond yield and inflation have been rising. That implies that Bitcoin has value credentials. Yet it also seems to prefer rising real rates which puts it into the growth camp as well. The implication is that Bitcoin is a risk-on asset.

"Bitcoin responds to a strong economy and higher risk"

Gold likes real rates to fall, so we can be fairly sure that Bitcoin isn't a challenge to gold. Yet it much prefers real rates to be driven by rising inflation than falling yields, and so not all real yield calculations are equal. A similar situation is probably true for Bitcoin. It likes the real yield to rise but seems to be more sensitive to economic strength than the deteriorating value of money. In any event, it likes both.

Pin the Donkey

The evidence from this exercise suggests that Bitcoin is economically sensitive and so it must sit on the right. It is also inflation sensitive, so it sits above the line. But because it prefers risk to inflation, I have placed it lower down and far to the right. Strange but true, but that is also where the banks live. Bitcoin is not just a tech stock, but a fintech stock.



Source: ByteTree.com. Bitcoin's place within a macro framework.

In comparison to gold, it is inflation sensitive. But is risk-on and the other risk-off. That means they work well together as a team.

Summary

In this chapter, I have shown how gold and Bitcoin are highly complementary assets, because a portfolio that rebalances between them on a regular basis seems to generate excess return. Of course, when Bitcoin is doing what it did in 2013 or 2017, any diversification will reduce returns. While Bitcoin will have a bright future, it seems unlikely that we will see years like those repeated.

In the next chapter, I will focus on the internal drivers. That is what makes the Bitcoin Network valuable and how to measure it.

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Chapter 3

An Alternative Model for Understanding the Value of Bitcoin: Network Demand Indicators and Historic Performance

Charlie Morris, Co-Founder and Chief Investment Officer

James Bennett, Chief Executive Officer

The Bitcoin Network is a peer-to-peer distributed network. This means that there is no central server responsible for reading and writing new information into a database. Instead, Bitcoin's database is distributed across many thousands of local servers known as "nodes". Nodes are access points onto Bitcoin's ledger and are essential to the addition and preservation of information on the ledger.

While the Bitcoin Network is the infrastructure layer, supported by nodes, Bitcoin (also known as Bitcoin, XBT or BTC) is the medium of exchange required for transacting across the Bitcoin Network. Bitcoin is the currency of the Bitcoin Network Economy. Much like real-world economies, by measuring the overall level of activity within the economy (similar to GDP) we can evaluate its overall utility or value.

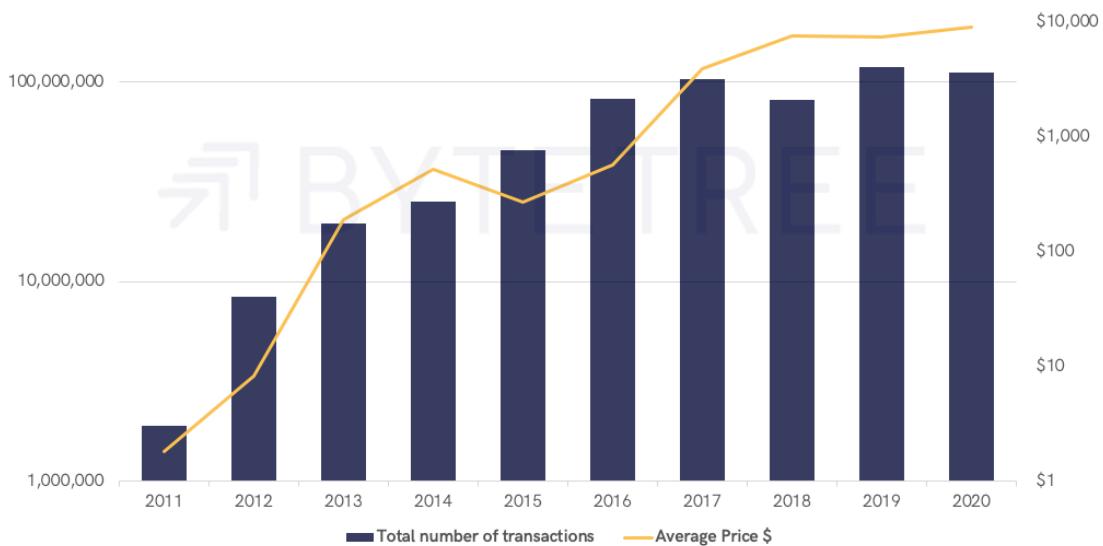
Bitcoin is the world's first fully internet-based economy. As an internet economy, its success is directly linked to the level of activity that takes place across its network, which benefits from the size and expenditure of the user base active on the network. The more vibrant the network, the greater the overall value.

At ByteTree, we measure the level of activity within the Bitcoin Network Economy as a proxy for its growth and relative valuation. This chapter explores some of the primary metrics that we track before demonstrating how to apply them to a relative strength model for Bitcoin's economy.

As the network evolves and provides value added services beyond payments, the correlation with certain metrics fades as other value contributors step in. Take the number of transactions each year as an example against the average Bitcoin price.

In the early days, this simple link was powerful, but has since slowed down as batched transactions became more widely adopted. Some visibility on the total value transferred has been lost. Still, with over 100 million transactions processed each year, Bitcoin has become a substantial operation.

⚡ Bitcoin price has appreciated with transaction growth



Source: ByteTree.com. Data for 2020, estimated as at 31st July 2020.

The network's purpose has evolved over time. Early dreams of unlimited low-cost transactions have faded, as transaction fees on the main chain render micropayments unfeasible. In 2012 a transaction cost one cent, rising to 11 cents in 2013. That remained stable until 2017 where it ballooned to \$5.26. Fees continue to be volatile and touched \$5.50 in May 2020, shortly after Bitcoin's third halving.

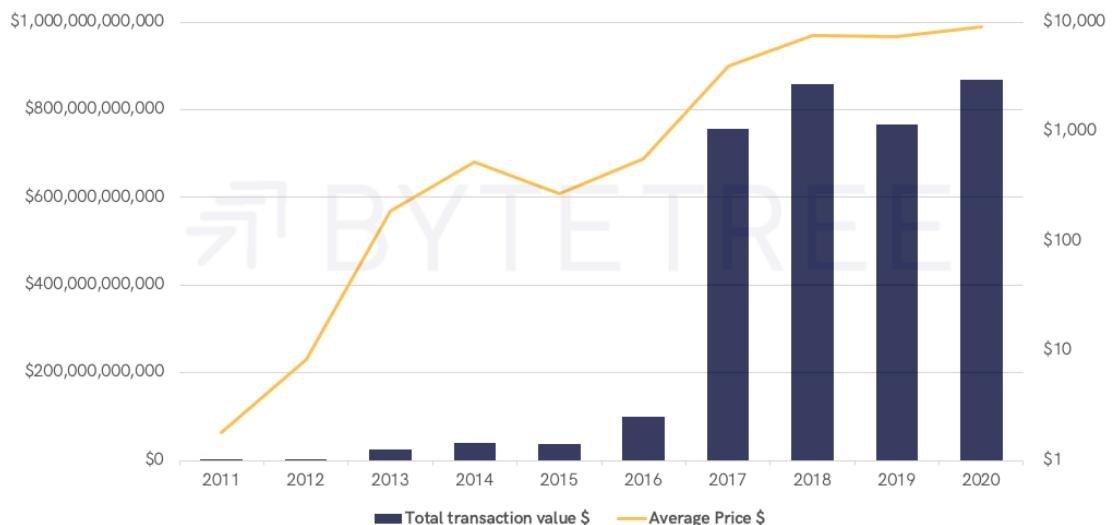
Average Fees over Time

| Year | Average transaction fee \$ |
|------|----------------------------|
| 2011 | 0.00 |
| 2012 | 0.01 |
| 2013 | 0.11 |
| 2014 | 0.10 |
| 2015 | 0.05 |
| 2016 | 0.16 |
| 2017 | 5.26 |
| 2018 | 3.48 |
| 2019 | 1.30 |
| 2020 | 1.30 |

Source: ByteTree.com.

While the number of transactions has been constrained by fees (and partly veiled by batching), the value transferred across each transaction has not. The total value transferred across the 100 million annual transactions continues to grow, which has underpinned the fundamental value of Bitcoin.

⚡ Transaction value approaches \$1 Trillion



Source: ByteTree.com. Data for 2020 estimated as at 31st July 2020.

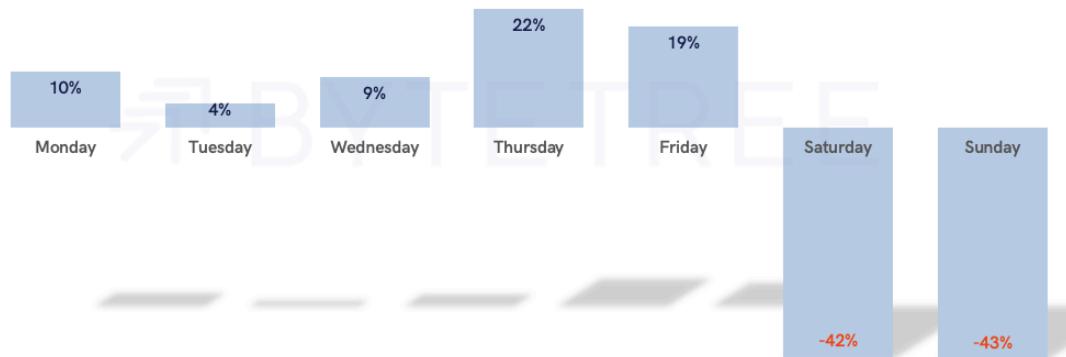
In 2017, the total value transferred across the network reached \$828 billion. In 2020, ByteTree data forecasts a new record will be reached at \$853 billion. That is happening despite prices below their 2017 peak. Although the all-time high exceeded \$19,000 in 2017, the average price in 2017 was \$7,519. In 2020 so far, the average price is a record \$8,542.

ByteTree research has concluded that the relationship between the Bitcoin price and the total value transferred over the network is the most stable economic relationship out there. Unlike transactions, and many other data points mentioned, it worked in the early days, and it still works to this day. We'll demonstrate the link and use it to create a hypothetical fair value for Bitcoin. First, it's important to understand the biases prevalent in the data. While Bitcoin is available 24/7, the people and entities using it are not.

Weekday Bias

When analysing blockchain data, it is important to acknowledge the weekday bias. It is a fact of life that the network is stronger during the week than at weekends. Network activity can be buoyant over the weekend, but it is normally quiet, and exchange liquidity is materially lower. The chart shows the median daily network traffic in 2020 against the week's average.

⌚ Even bitcoin rests at weekends



Source: ByteTree.com.

In a typical week, 84% of traffic occurs on weekdays with just 16% at weekends. The impact of this is hugely important when calculating averages on blockchain metrics as they must be a multiple of 7 days. If not, a bias will appear in the results. We have seen blockchain data research papers that use 30 or 80 day periods in their optimisations. A more robust result would use 28 or 77 days, as they are multiples of 7.

At ByteTree, we use the rolling week or multiples of the rolling week, even if the data is delivered in real-time. Any average shorter than that will be heavily skewed by the weekday bias. The data we publicly display is one week, 5 weeks, which approximate a month and is more stable than 4-week data, and 12 weeks which approximates a quarter.

The Data Points

In measuring growth, the most important data points are shown below with the short form in brackets:

- Number of transactions (transactions)
- Number of coins transacted (transaction value)
- Amount of dollar value transacted (transaction value USD)

We will show these in turn using data from 15th June 2018, which is the start of the new era after the 2017 market peak. This period is just over two years which begins once the bubble had unwound, with a start point during a period of consolidation and relative calm. The period is also useful as there are frequent changes in the trend.

Transactions

Below we show the price of Bitcoin with a 1, 5 and 12-week moving average of

transactions. The short-term data is volatile, and the longer-term data more stable. Over this period studied, Bitcoin returned 43% and had a maximum drawdown of -61.7%.

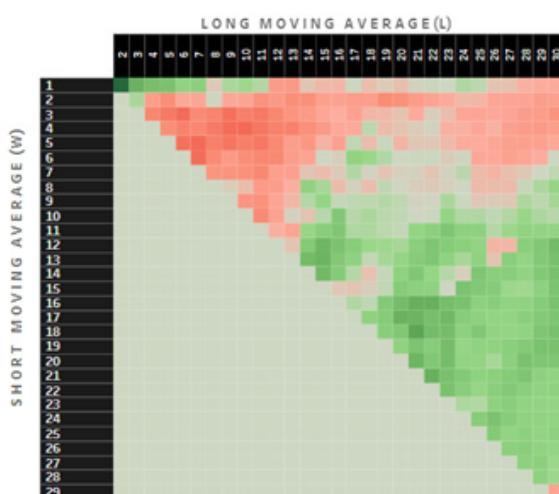
Transactions have broadly moved in line with price since the beginning, but these days, the link is tenuous much of the time. Transactions can be batched, and much traffic can occur off-grid. In particular, the price crash in November 2018, coincided with growing transactions. Yet by the summer, the price had broadly doubled in line with transactions, so there is still a link, even if it is weak.

⌚ Transactions influence price, with exceptions...



Source: ByteTree.com.

The box below shows the results for back tests over the period 15th June 2018 to 20th June 2020. A buy signal occurs when the shorter moving average crosses above the longer moving average, and vice versa for a sell signal. These test not only the 1, 5, and 12-week strategies, but all possibilities from 1, 2... to 30 weeks. There are green and red squares which show each strategy's performance. The best performing strategies are dark green, and the worst are dark red. The studies assume no transaction costs. In the case of transactions, the results are relatively unimpressive.



Source: ByteTree.com.

However, there is an exception which stands out as being effective and repeatable: the 1 and 2-week transaction crossover. This strategy has a high turnover and has traded 49 times to return 97.9%. The max drawdown was 44%. Although costly to implement, it delivers improved risk-adjusted returns as can be seen below.

Short term transactions lead price



Source: ByteTree.com.

ByteTree View

On-chain transactions have some merit for trading strategies, but not much. They do not include activity on the Lightning Network or sidechains, but more importantly, a transaction could be for \$1 or \$1 billion. Clearly, the economic value will have a greater impact. That said, falling transactions will normally reflect a falling network and vice versa. The one and two-week transaction crossover is definitely something to be aware of.

Transaction Value

This measures the number of Bitcoins that are transferred over the network. The results are volatile, and we find that absolute levels of activity are more useful than trend signals from crossovers.

⚡ More bitcoins need to move on price weakness to sustain economy



Source: ByteTree.com.

Some long-term signals can be effective, but only in identifying material network contraction. One difficulty of using the number of coins on the move is that their value is subject to material change. And when the Bitcoin price halves, twice the quantity must be transacted to maintain the same dollar value, as occurred in November 2018. Like transactions at the time, there was a divergence. However, 12-week average transaction value provides a reasonable gauge of network strength, but it isn't a particularly effective trading strategy.

Transaction Value USD

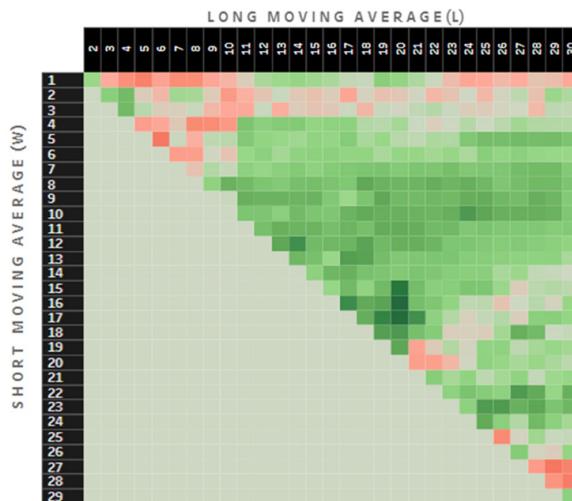
The number of coins transacted, multiplied by their price at the time of transactions, gives us the transaction value USD. The link to price is close, in part because price is part of the calculation. But more importantly, the entire point of Bitcoin is to transfer monetary value. So by measuring that, there ought to be a close link to the network value, and therefore price.

⚡ Dollar transaction value is correlated with price



Source: ByteTree.com.

The correlation is high, and longer-term readings (such as 12 weeks) are stable. In the results table, I haven't focused on the highest returns but risk-adjusted returns. Time series of 5 weeks or longer have generally delivered improved risk-adjusted returns. Interestingly, however, strategies that utilise short-term transaction value USD crossovers do not deliver impressive short-term results.



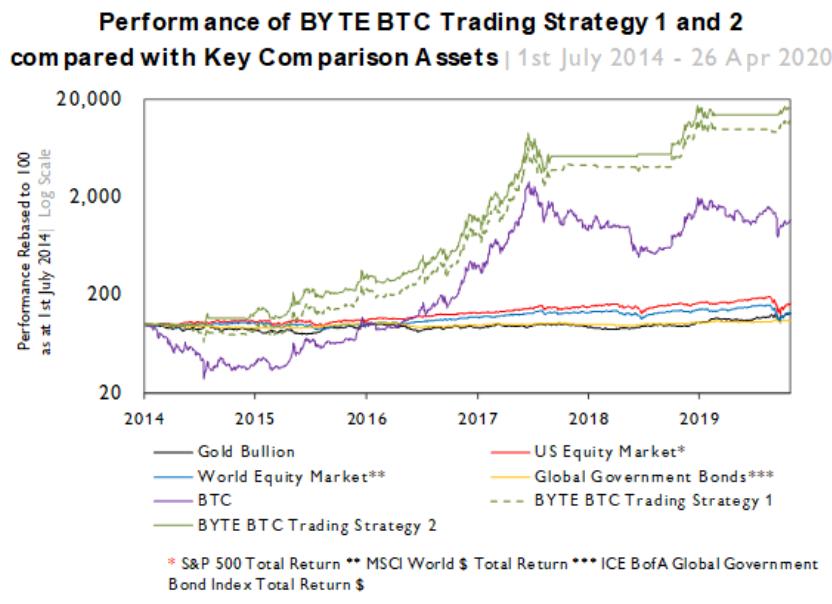
Source: ByteTree.com.

ByteTree Network Demand Model

With the operational risks around digital assets largely resolved, investors are looking for improved methodologies for tackling the price risks faced in the market. Our approach at ByteTree is to apply a series of demand-side metrics to evaluate the relative strength of the network. When the network is growing, we are long, when it is contracting, we move back into cash.

Using the data extracted through the ByteTree terminal, we also determine when the price of BTC is overvalued and when it is trading at a discount to fair value. The goal of both of these approaches is to help investors and traders improve overall risk-adjusted returns, enhance their ability to conduct due diligence on their digital asset exposure and protect against the risk of large drawdowns when trading or investing in BTC.

The results of this approach have been strong through the back-testing period and since the live implementation on the Ethereum-based TokenSets Protocol. The table below shows the long-term return of these strategies rebased to 100 as at 1st July 2014.



Source: ByteTree Network Demand Indicators_BYTE; May 2020. Performance of BYTE Bitcoin Network Demand Ensemble Trading Strategy 1 and 2 compared with key comparison benchmarks, including; BTC, Gold Bullion, World and US Equities, and Global Government Bonds.

The following table summarizes the statistical performance of the two ensemble trading strategies compared with the performance of trading strategies constructed using the underlying network demand indicators and key comparison benchmarks.

| | 01.Jul.14 to 26.Apr.20 | BENCHMARKS | | | | ENSEMBLE | | BTC NETWORK DEMAND INDICATORS | | | | | | | |
|----------------------|------------------------|--------------------|------------------|---------------------|--------------------|-----------------------------|-----------------------------|----------------------------------------------------------------|----------------------------------------------------------------|--------------------------------------|--------------------------------------|--------------------------|------------|-------|-------|
| | | Gold Bullion | US Equity Market | World Equity Market | Global Govt. Bonds | BYTE BTC Trading Strategy 1 | BYTE BTC Trading Strategy 2 | Transaction Value \$ Short-Term MA > Short-Term MA > Medium MA | Transaction Value \$ Short-Term MA > Short-Term MA > Medium MA | Fees \$ Short-Term MA > Long-Term MA | Fees \$ Short-Term MA > Long-Term MA | Velocity 12W > Medium MA | MRI > 600% | | |
| | | CAGR | 8.9 | 5.0 | 1.5 | 52.9 | 128.5 | 140.6 | 60.6 | 70.7 | 116.9 | 136.1 | 104.3 | 78.0 | |
| RETURN | | Standard Deviation | 15.8 | 21.4 | 18.0 | 7.0 | 83.2 | 69.3 | 682 | 65.9 | 73.9 | 65.2 | 67.6 | 76.3 | 79.4 |
| RISK | | Maximum Drawdown | -21.4 | -33.8 | -34.0 | -11.2 | -83.1 | -59.2 | -59.2 | -63.6 | -60.1 | -47.8 | -59.2 | -69.1 | -76.9 |
| RISK ADJUSTED RETURN | | Sharpe Ratio* | 0.1 | 0.3 | 0.1 | -0.3 | 0.6 | 1.8 | 2.0 | 0.9 | 0.9 | 1.7 | 2.0 | 1.3 | 0.9 |
| | | Calmar Ratio | 0.2 | 0.3 | 0.1 | 0.1 | 0.6 | 22 | 24 | 1.0 | 1.2 | 2.4 | 2.3 | 1.5 | 1.0 |

Source: ByteTree Network Demand Indicators_BYTE; May 2020. BYTE Bitcoin Network Demand Ensemble Trading Strategy 1 and 2 Performance Statistics compared with BYTE Bitcoin Network Demand Indicators Trading Strategy performance and key comparison benchmarks. Risk-free rate used for Sharpe Ratio = 3.5%.

Results colour-coded using heatmap; red = bad; green = good.

Summary

Bitcoin is an inherently volatile asset, over four times as volatile as World and US Equities and around twelve times as volatile as Global Government Bonds. Even when traded using the Ensemble trading strategies, the Maximum Drawdown associated with trading this asset class is around twice that of the World Equity Market, measured over the same period.

Notwithstanding, investors who have been able to tolerate the risk of trading BTC have found that the returns from doing so have been more than commensurate for the risk

taken. This is shown by the risk-adjusted performance of the Ensemble BTC trading strategies, compared with traditional asset classes such as World and US Equities, Global Government Bonds and Gold Bullion. The risk-adjusted performance of the Ensemble Strategies stands head-and-shoulders above the latter.

The work we do at ByteTree is centred on the principle that the Bitcoin Network is an internet economy. Its relevance is directly related to the size and value transferred across its network. We started working on the Network Demand strategy to demonstrate that the “Network Effect” is significant for assessing its relative and fundamental value.

The historical and live performance of these trading strategies gives us confidence that the BYTE set of indicators can be used to successfully capture the Bitcoin Network Effect and deliver better risk-adjusted returns and lower drawdowns than a passive holding of BTC. We look forward to working with other data providers and analysts across the digital asset industry to continue to improve our understanding of this magnificent new age economy.

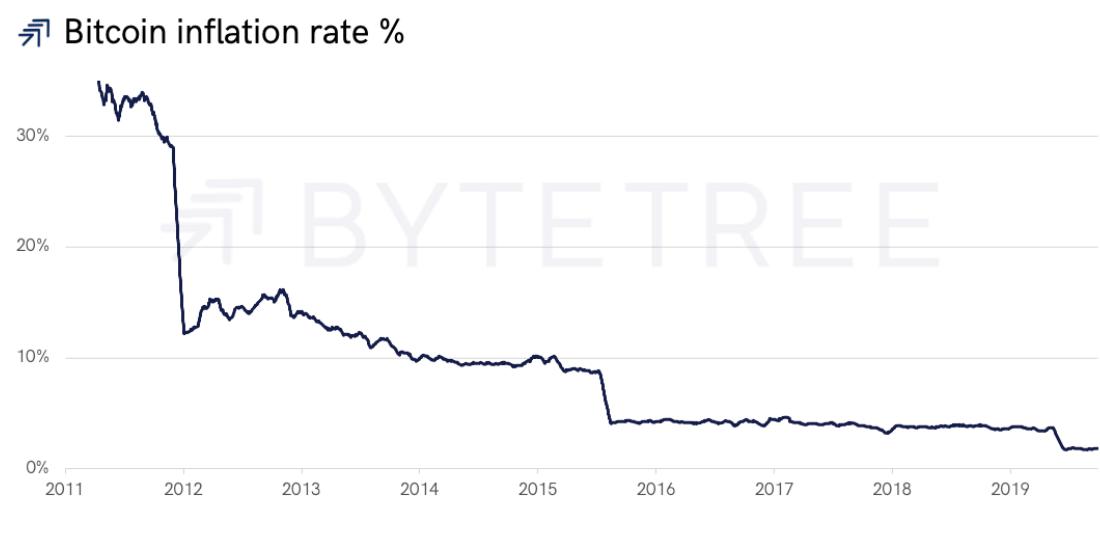
Chapter 4

Debunking Stock-to-Flow

Charlie Morris, Co-Founder and Chief Investment Officer

Stock-to-flow (S2F) models link halving events to price appreciation. The basic idea is that asset scarcity leads to a squeeze. If there are fewer available Bitcoins to buy, then the price will rise, assuming demand is constant. At ByteTree, we enjoy the stock to flow debate, but in this piece, I will demonstrate why the price of Bitcoin is driven by the demand side. In short, the supply side does not create value and has only a modest impact on price.

Before I begin, I'll recreate the basic S2F model. The chart shows Bitcoin's rate of inflation, or the annualised growth rate in new supply. Having been above 30% in 2011, it is now below 2% and heading towards 0% over the coming years. The series used looks at all the coins mined.



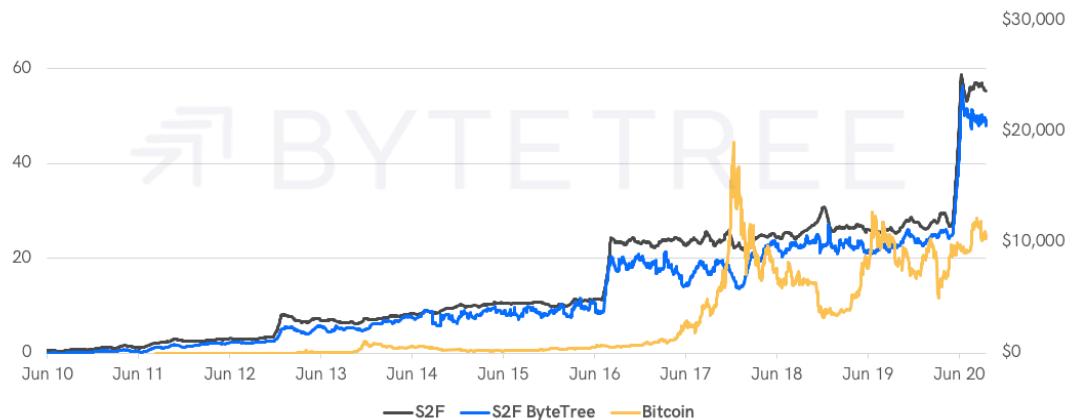
Source: ByteTree.com.

Inflation is the rate of growth of new coins, or the flow to stock on an annualised basis. The S2F is the inverse:

- 100% inflation becomes $1/100\% =$ a S2F of 1.
- 10% inflation become $1/10\% =$ a S2F of 10.
- 1% inflation becomes $1/1\% =$ a S2F of 100.

I'll show S2F against price, and I'll also add S2F ByteTree, which uses coins distributed by miners (first spend) as opposed to coins mined.

⌚ S2F shows inflation inverted



Source: ByteTree.com.

S2F is simply the inflation chart inverted, and given coin supply is shrinking, it will rise over the rest of the 21st century. The halvings stand out in 2012, 2016 and 2020 with jumps in the S2F ratio. As Bitcoin has caught on, the price has risen a great deal, as has the S2F. The difference is that S2F would have risen regardless of whether Bitcoin caught on or not. Using log scales, it becomes clearer, as the moves in the earlier days are more visible. But then again, log scales can be deceptive as I readily admit in the earlier chapters.

⌚ Log scales improve the visual correlation



Source: ByteTree.com.

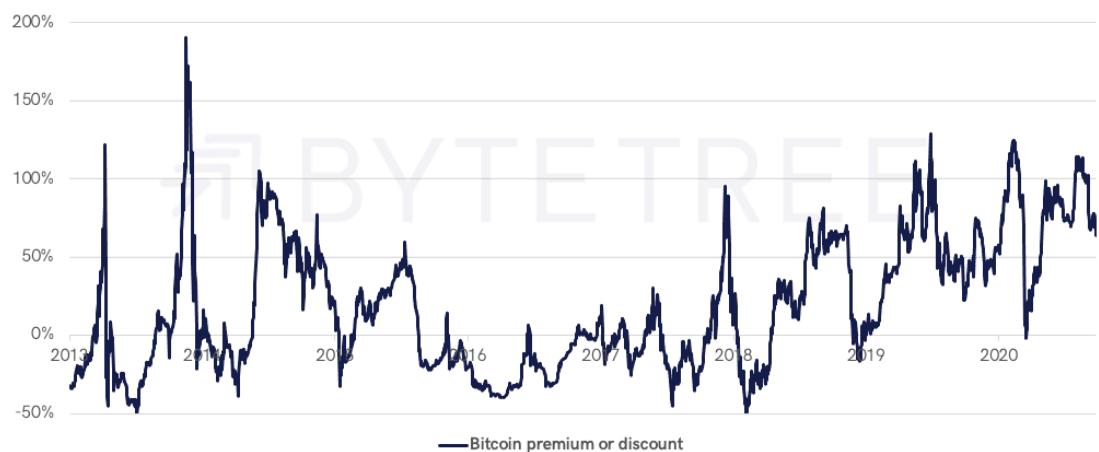
The halving events in 2012, 2016, and 2020 are clearly shown by the jumps in S2F. The best years were 2013 (5,428%) and 2017 (1,351%), both of which followed halvings. We are still waiting for a surge in 2020, and if it comes, then S2F will start to look more credible. And if that follows through with another boom in 2024, then we should all pay attention. But with just 2012 and 2016 in the bag, and 2020 still pending, S2F has no credible track record at all.

Voting Machines and Weighing Machines

The father of value investing, Benjamin Graham, said that "in the short run, the market behaves like a voting machine, but in the long run, the market behaves like a weighing machine."

He was talking about stock markets, but the same logic applies to all freely traded markets. The point he was making was that market prices overshoot, and then undershoot, yet revolve around the intrinsic value of the asset. In chapter 4, I showed the link between the network and the Bitcoin price. Taking this a stage further, you can use this methodology to estimate fair value.

 Bitcoin premium to fair value



Source: ByteTree.com.

In 2013 and 2014, Bitcoin moved to a 150% premium (above fair value) twice and above 200% once. Since 2017, we have seen two +100% moves to a premium, and on the bear side, it has reached 40% discounts on multiple occasions. Bitcoin has swung between discounts and premiums on a regular basis, yet always reverts to fair value in the end. That is because fair value is a fundamental measure that attempts to calculate the intrinsic value of Bitcoin.

When you observe the halving years 2012, 2016, and 2020 on this basis, it is less obvious that halving events have had any influence at all. Booms and busts come in different shapes and sizes and for different reasons and at different times. A growing network, institutional flows or improved crypto infrastructure may cause prices to rise just as scandals, bubbles, and regulatory pressures may cause prices to fall.

S2F doesn't attempt to calculate intrinsic value. It merely links a reduction in supply to a rising price. In Ben Graham speak, this is a voting machine argument. By tightening the available supply, the price ought to rise assuming demand is constant. After all, this happens in the oil market when there is a supply shock.

But oil prices don't remain high because more oil is produced and demand subsequently falls. There's an old saying in the oil market that the best cure for a high oil price is a high oil price. That holds true because markets adjust on both the supply and demand side until equilibrium is reestablished. In Bitcoin, supply can't be changed, yet demand is free to do whatever it likes, and if prices are too high, demand will fall. It is as simple as that.

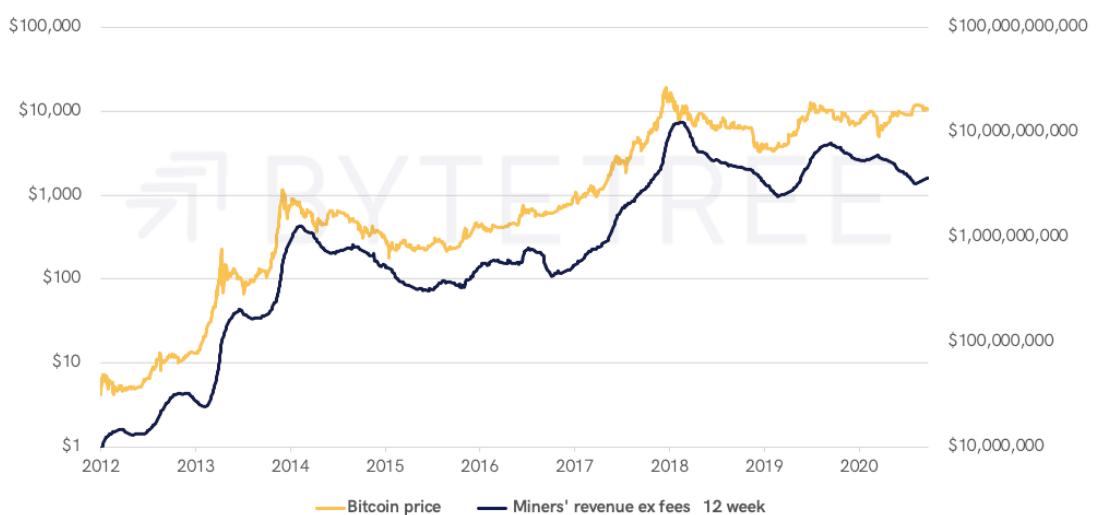
Miners Aren't the Only Sellers

The S2F implication is that the miners produce fewer coins each year, and so there are fewer for new investors to buy. It is true that there are fewer Bitcoins to buy from the miners, but anyone who owns Bitcoin is free to sell.

When the network has a large stock and a relatively small flow, it is the stock that matters. As the flow diminishes, it becomes less important in influencing market prices. S2F was more influential when the flow was high, and the stock was low; the situation pre-2012. But now the stock is high, and the flow is low (and forever falling), the S2F model becomes less relevant over time.

At the top of the market in late 2017, the miners were making \$10bn per year (run rate) from block rewards, excluding fees. The chart shows the divergence between the miners' revenue and price. Since the 2020 halving, Bitcoin is rising while the miners' revenue is declining as they receive fewer Bitcoins.

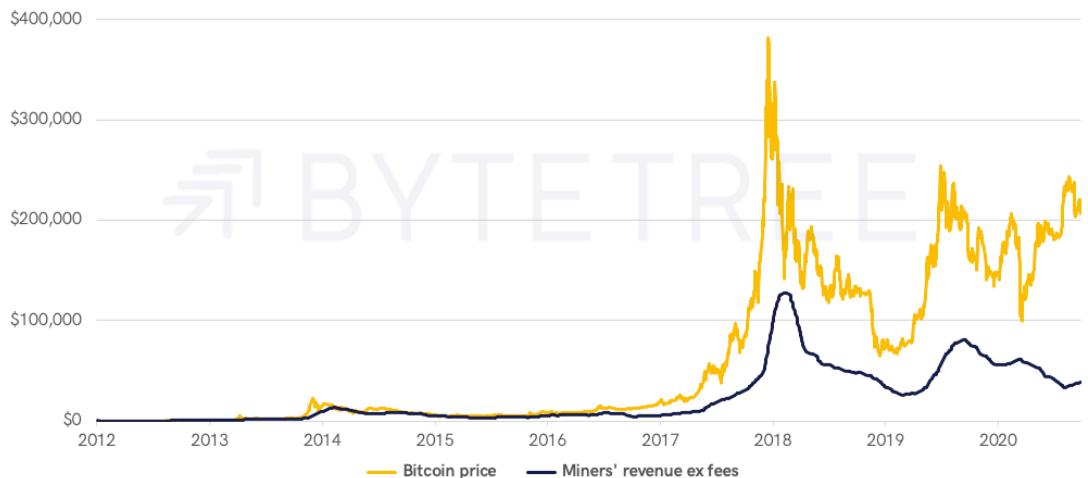
 Bitcoin miners' revenue



Source: ByteTree.com.

When those two series are rebased to 100 from the start of 2012, the divergence is significant. Bitcoin appreciation has outperformed miners' revenue by 6.8x. That number will keep on rising with each halving.

⚡ Miners' revenue has lagged price by 85% since 2012



Source: ByteTree.com.

To put that another way, the miners are becoming less influential in driving the Bitcoin price. Obviously, they carry out important work that facilitates the network, but their economic footprint is diminishing. Here I show the miners' revenue as a percentage of market cap and annualised transaction value.

⚡ Miners have become less influential market participants



Source: ByteTree.com.

Miners' once earned 50% of the market cap each year. At that time, they had a huge influence on price, but at 1.7%, they don't. Similarly, they used to account for 68% of all the transaction value, which has fallen to 3.9%.

In the beginning, the miners were the only actors in the space, and they had to find buyers to make a market. Today the market is deep and liquid, and their influence on price is much more modest. One day, the miners' impact on price will be negligible.

S2F in the Gold Market

The S2F situation in the gold market is remarkably similar to Bitcoin. That should come

as no surprise as Bitcoin's supply characteristics were modelled on gold. According to GoldHub, 3,463.7 tonnes of gold were mined last year, bringing the total above ground supply to 197,576 tonnes, which is a 1.7% rise. Bitcoin's inflation rate is now similar to gold's, and for the remainder of the 21st century, both gold and Bitcoin will see the growth in their stock fall, and hence both enjoy rising S2F ratios.

Yet few discuss mine supply as a significant driving force behind the gold price. That is because the gold market has huge liquidity and trades around \$145bn each day. New gold supply from the mines is just \$500m per day. In the great scheme of things, mine supply is irrelevant. What drives the gold price is inflation, real interest rates, monetary policy, the dollar and speculative cycles. Gold has an active role as an alternative asset.

In 1900, mine production was under 400 tonnes. Since then, supply has grown 8-fold, while the price has risen 100-fold. All that mined gold over the last 120 years has grown the market to what it is today. If supply had steadily fallen towards zero, the gold price may be higher as a collectors' item, or alternatively, it may be lower because gold would be a marginal asset at best. But either way, liquidity would be poor, and that would damage the investment case for gold as a vibrant alternative asset. In that sense, gold's liquidity outshines its physical qualities.

Burn That Masterpiece

To put it another way, imagine you were fortunate enough to own an impressive art collection including Monets and Van Goghs. Would you burn a couple each year to boost the scarcity of the rest of your collection? Should other collectors join you and do the same, so the fewer remaining masterpieces are worth more? If the aim is to maximize value, I would think the great artists should paint as much as possible.

Summary

In the case of Bitcoin, value is not created through scarcity; it comes through demand which reflects the value created by the Network Effect. In the early days, Bitcoin had a low S2F (high inflation) and a small network, which meant the miners were dominant players. Today, Bitcoin has a high S2F (low inflation) and a vast network, which has made the miners less relevant. The S2F thesis sees the miners as the dominant price driver; something that cannot possibly be true as their influence wanes.

In valuing gold, Bitcoin, or any other asset, the focus must be on the asset itself as market influences will only ever be temporary. I would argue that Bitcoin represents a powerful digital network that is thriving. It is a sort of technology stock without profits or a CEO, but with high security, growing distribution and application. There are many reasons why the price of Bitcoin can rise or fall, but S2F is not one of them.

Chapter 5

The Infrastructure Critical to Running the Bitcoin Network

James Bennett, Chief Executive Officer

Introduction to the Concept of Bitcoin Network Distribution

A public blockchain like the Bitcoin Network runs on a series of distributed nodes. The number and location of those nodes, as well as the ownership of the entities that control them, is a good indication of the network's censorship resistance. As the most valuable cryptoasset network, by total hash power committed, total value settled, and market capitalisation, it is important to monitor the ongoing distribution of the Bitcoin ledger. One way to observe this is through monitoring the number of nodes connected to the network at a given time.

Both listening and full nodes are important to the existence of the network. Participants hosting a node, a copy of the blockchain on their local server, are enabling the 24/7 access to Bitcoin's ledger – crucial to its overall censorship resistance. The more copies of the ledger that exist, the more difficult it becomes for any central authority, state, private or otherwise, to erase the history of transactions written onto the Bitcoin Ledger.

With the existence of the Bitcoin Network contingent upon nodes, the number and distribution of these nodes are essential. Without them, there is no Bitcoin Network.

BITNODES

Bitnodes is currently being developed to estimate the size of the Bitcoin network by finding all the reachable nodes in the network.

GLOBAL BITCOIN NODES DISTRIBUTION

Reachable nodes as of Mon Aug 31 2020
11:04:39 GMT+0100 (British Summer Time).

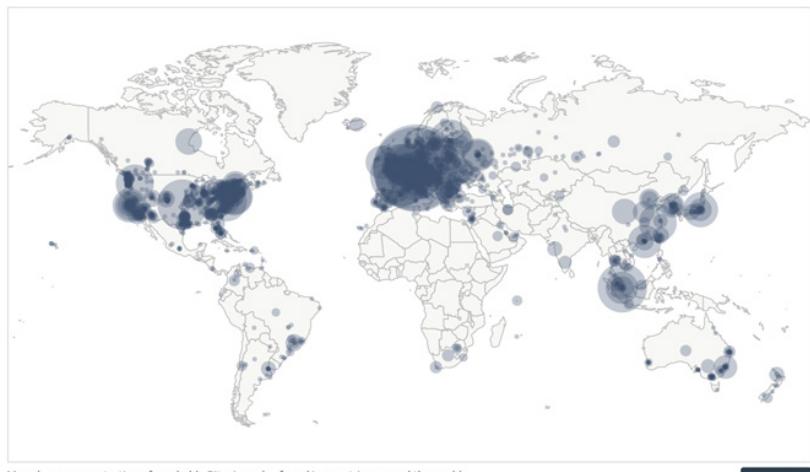
10137 NODES

24-hour charts »

Top 10 countries with their respective number of reachable nodes are as follow.

| RANK | COUNTRY | NODES |
|------|--------------------|---------------|
| 1 | n/a | 2315 (22.84%) |
| 2 | United States | 1898 (18.72%) |
| 3 | Germany | 1773 (17.49%) |
| 4 | France | 563 (5.55%) |
| 5 | Netherlands | 437 (4.31%) |
| 6 | Canada | 295 (2.91%) |
| 7 | Singapore | 252 (2.49%) |
| 8 | United Kingdom | 244 (2.41%) |
| 9 | Russian Federation | 233 (2.30%) |
| 10 | China | 173 (1.71%) |

More (99) »



Map shows concentration of reachable Bitcoin nodes found in countries around the world.

LIVE MAP

Source: [Bitnodes](#). Monday 31st August 2020.

The map above shows there are more than 10,137 listening nodes online across more than 100 countries. This number is updated to include only listening nodes, those

updating their copy of the blockchain with each new transaction. The United States has the highest density of known online nodes with 19%, followed closely by Germany with 17%. France is the only other country with over 500 online nodes. Despite having a significant proportion of the network's mining power, China currently has only 173 known online nodes, just 2% of the total, although, it may be that these are harder to identify through the Great Firewall.

Hash Power and Distribution of Hash Power by Entity

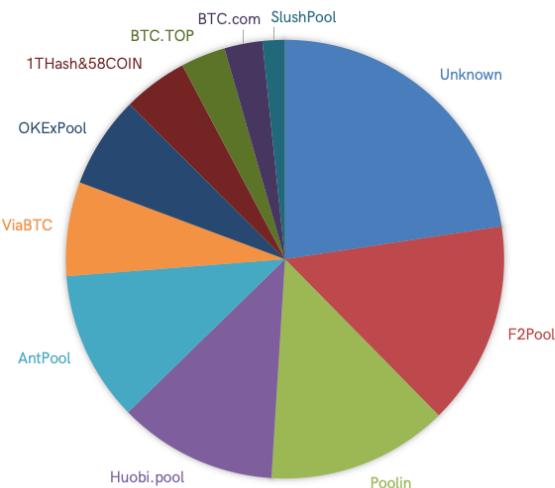
While the number of nodes tells us about the distribution of Bitcoin's ledger, the network hash power represents the overall cost involved with maintaining it. Hash power refers to the computational task required to add new information onto the ledger. Bitcoin was designed to provide a "single source of truth" that could be read by anyone, from anywhere, at any time. This level of responsibility requires a high degree of integrity in the process through which actors can add information onto the chain. The mechanism that Bitcoin uses to incentivize this was born from the principle of messaging "spam".

The difficulty with stopping spam is that the economics of it are so compelling. The cost of delivering a message via spam is next to nothing, meaning that if even a tiny percentage of targets respond, a spam campaign can be successful economically.

The Bitcoin Network requires a costly computational task to be run in order to prevent network spam from occurring; a task that requires hash power. The hashrate is an indication of the total computing power competing to secure the network. By increasing the total hash power, there is a barrier to entry for nefarious actors. An important metric for monitoring hash power is its distribution by entity.

The distribution of hash power is a key metric for assessing censorship resistance. Bitcoin's mining algorithm requires a minimum of 51% of the network to collude for a successful attack. By monitoring the distribution of mining capacity across competing pools, we are able to identify the current viability of a 51% attack.

⚡ Hashrate distributed across 10+ major mining pools



Source: Blockchain.com. An estimation of hashrate distribution amongst the largest mining pools, Monday 31st August 2020.

Applying data from the week leading up to 28th September 2020, the largest known mining pool is F2Pool with 14.9% of SHA-256 hashing power. Poolin is the second largest known pool with 13.3%, followed by Huobi.pool 11.6% and AntPool 11.0%. BTC.com, which held a significant 21% of hash power in May 2019, currently controls just 2.8%

Incentives for Bitcoin Miners; Revenues and Fees Following the May 2020 Reward-Halving Event

Bitcoin miners are rational economic actors. This means that they are financially incentivized to participate in securing the network. The incentive paid to miners for producing new blocks is generated through two revenue streams; Coinbase, a reward of newly minted Bitcoins which is retrieved from each new block, and fees, the price paid by an actor that wants to write a transaction onto the Bitcoin ledger. Both Coinbase, which we call “generation”, and Fees are distributed to miners in the network’s native currency, Bitcoin (BTC).

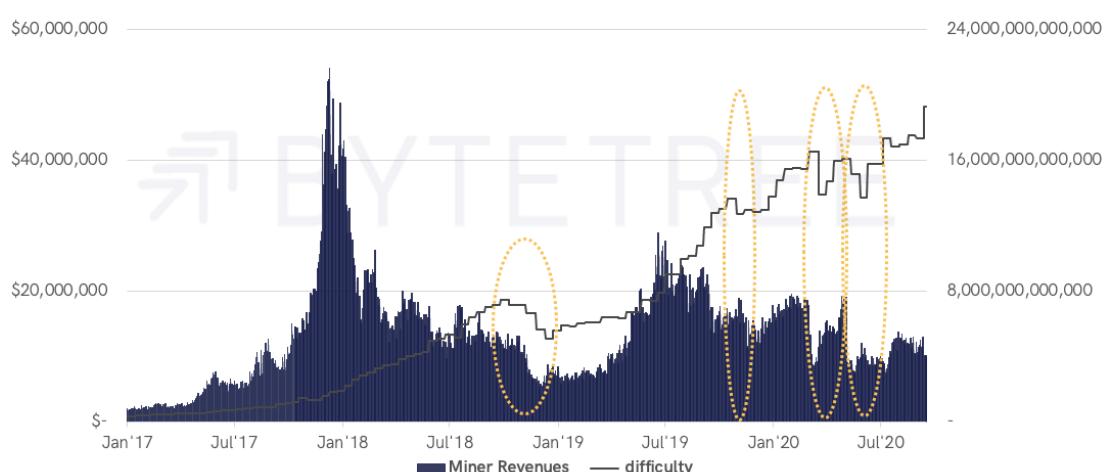
With the majority of miners’ capital and operational expenses being payable in Fiat currency, miners must actively manage their BTC treasury to ensure their operation remains liquid. We will explore some of the miners’ behaviour for inventory management in the following chapter.

Revenues incentivize miners to dedicate computer power to the network, so if revenues fall below the cost of production, miners become unprofitable. As with any business operation, running at a loss is only sustainable as long as the balance sheet allows – causing miners to “go offline”. This reduces the amount of hash power allocated to the network, lowering the network’s overall security. At ByteTree, we monitor the type and

value of revenue generated as an indicator of the ongoing health of the mining economy. When revenues drop sharply, miners can very quickly find themselves making a loss. For smaller operations with less resilient balance sheets, this leads to ceasing their operation, turning off their mining rigs so as to limit their operational expenditure.

The chart below shows how a sharp fall in miner revenues precedes a drop in the network Hashrate, which subsequently leads to a drop in the network difficulty level. In each case, the network difficulty responds to the reduced network hashrate by readjusting the target difficulty level – reducing the marginal cost of production and thereby allowing miners to become profitable once again.

Miner revenue versus difficulty



Source: [ByteTree](#). Monday 31st August 2020.

Although the difficulty rate and the Bitcoin price are related, our work has concluded that price is the leading indicator, and difficulty follows price. While useful information for many reasons, it is unlikely to forecast future price moves because the miners respond to changes in price. For example, low prices excite the smart investors, yet deter the miner. This also makes the network difficulty rate counter-cyclical as cheap Bitcoins are unattractive to mine, whereas expensive Bitcoins are compelling.

The difficulty rate can be forecasted by measuring the number of blocks added to the ledger per day versus the price of Bitcoin. Since miners are paid in BTC, a higher USD:BTC value encourages greater miner participation, as revenues are also rising. We can see this in action on the chart below where increasing miner revenues [dark blue line] lead to a higher number of blocks produced per day [light blue line].

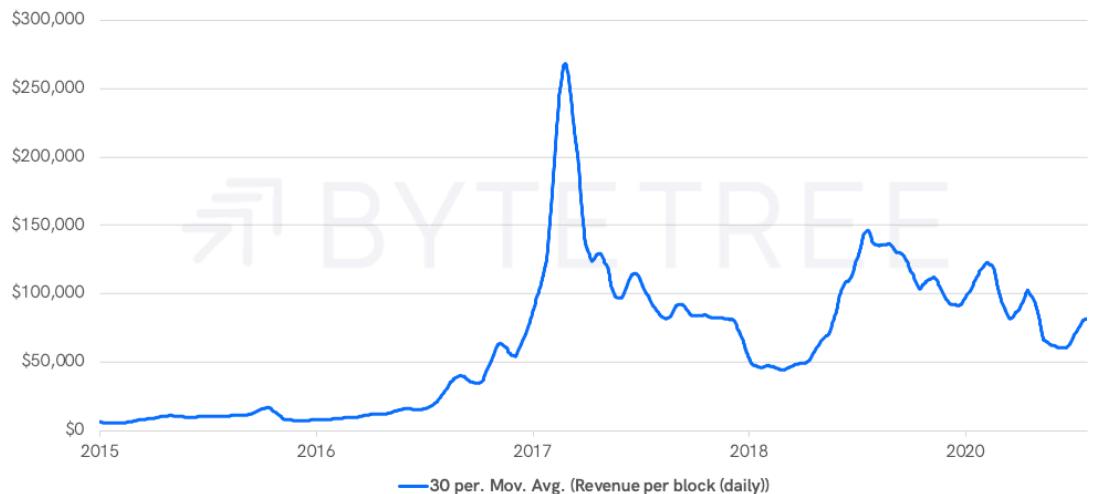
⚡ Miners respond quickly to their P&L



Source: [ByteTree.com](#). Monday 31st August 2020.

We can view the revenue generated per block on the chart below. The revenue per block is driven by a combination of the hash power allocated to the network, the difficulty level, and the price of Bitcoin. The upwards trend indicates that incentives for Bitcoin miners are steadily increasing – now close to breaking a downtrend started in August 2019. This is a strong signal for Bitcoin miners that revenues in a post halving era remain strong.

⚡ Miner revenues continue to rise after 2018 bear market

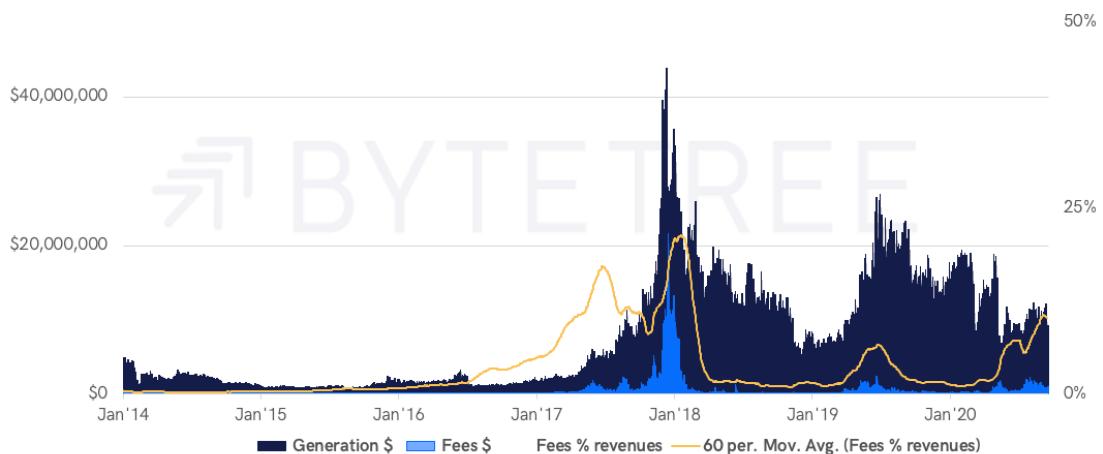


Source: [Bytetree.com](#). Monday 31st August 2020.

The distribution of revenues between generation and network fees is part of an ongoing debate about Bitcoin's future. When the Bitcoin Network was first conceived, the low density of network traffic meant that the fee paid per transaction was very low. This meant micro-transactions could be sent through the Bitcoin Network and be economically viable. As network traffic increased, competition within Bitcoin's limited block space increased, which drove fees up. Fees are paid by users to prioritise the order that transactions are added to the chain. The chart below shows that fees as a percentage of total revenue rises during periods of increased activity, typically bull

markets, but has continued to increase since March 2020. This is attributed to both rising fees and falling generation (USD) as a result of the latest reward halving.

⌚ Fees now contribute a significant share of miner revenues



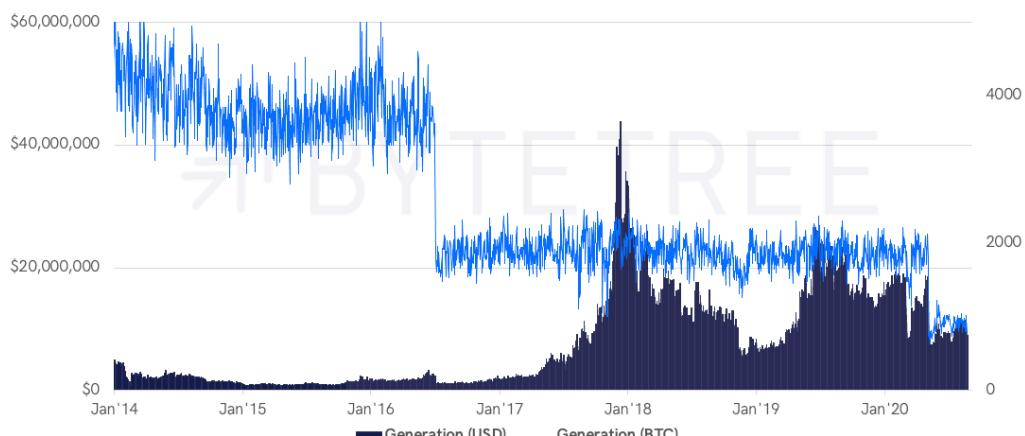
Source: [ByteTree](#). Monday 31st August 2020.

Higher fees have broadly been blamed by Bitcoin advocates for limiting the ubiquity of access. However, they also provide a rising share of total revenues as block rewards fall.

Bitcoin underwent its third halving period in May 2020, where the amount of Bitcoins rewarded to miners for each block fell from 12.5 to 6.25 BTC. The reward has halved every 210,000 blocks, or approximately 4 years, and will continue to do so until all 21 million Bitcoins have been generated. From this point onwards, the only economic incentive for miners will be transaction fees.

While the block reward has halved in BTC terms, the increasing USD value per Bitcoin has led to an increase in the total USD value of the Bitcoin generated. Demonstrated by comparing the grey line (Generation BTC) and the blue bars (Generation USD) on the chart below:

⌚ Bitcoin adoption offsets the falling reward from halvings



Source: [ByteTree](#). Monday 31st August 2020.

The total amount of hash power connected to the network has repeatedly hit an ATH throughout 2020. As the mining landscape evolves, it has become harder for the average “hobbyist” miner to make a profit. While this does not support the native development of the hobby industry, the increase in hash power reflects a more robust and long-standing Bitcoin Network infrastructure.

The Maturation of the Bitcoin Mining Industry

In the early days of Bitcoin, there were only two ways to gain exposure to the asset class; mining it and buying it. This now seems like “old-news”. Financial derivatives and hash power contracts are emerging as the latest way for both retail and institutional investors to gain exposure to Bitcoin.

Bitcoin Futures Based on Hashing Difficulty

FTX's new futures product aims to allow speculation around Bitcoin's Hashrate difficulty. FTX was launched in May 2019 as a cryptocurrency derivatives exchange, intending to bring institutional-grade financial products. One of their backers is Alameda Research, which, according to BitMex Leader board, are the fourth-best trader nationally. FTX's new product launched in May 2020, allowing users to leverage Hashrate difficulty with quarterly settlements.

Hashrate Contracts

As cloud mining increased retail exposure to the Bitcoin mining ecosystem in 2017, hashrate contracts are now broadening institutional exposure to the space.

Digital asset fintech company, Bitooda, started brokering hash power contracts in January of this year between large mining centres and institutional buyers of Bitcoin. These contracts enable companies which wish to hedge both their mining power and Bitcoin exposure to buy and sell contracts for a pre-agreed amount of hash power over different time periods.

Institutional investors looking to access a steady flow of Bitcoin without the significant capital and operational expense associated with mining can purchase hashrate directly from those operating the equipment. Conversely, large technology companies with access to reliable, low-cost electricity and hefty balance sheets can utilise their infrastructure without exposure to the price volatility of Bitcoin.

The Bitcoin Network is heavily reliant on the mining infrastructure which supports it. The shift to more scalable and less volatile mining operations is ultimately a bullish move for the future for the flag bearer of decentralised technologies.

Summary

As the mining industry continues to mature, the entities controlling the mining operations have become increasingly savvy with the distribution of the Bitcoin that they mine. Observing miners' inventory levels from a high-level has given us some insight into the behavioural trends of miner's in different market environments. The following section explores the relationship between miners' inventories and the Bitcoin price.

Chapter 6

An On-Chain View of the Miner's Economy

Charlie Morris, Co-Founder and Chief Investment Officer

Tracking the Miners' Inventory

Bitcoin miners support the network and have a number of data points associated with them. Mining difficulty is widely talked about, but our research suggests it is a lagging indicator. Price leads difficulty because a valuable Bitcoin is more desirable and attracts competition. Difficulty tells you much about mining economics but little about the outlook for the Bitcoin price.

That said, there is valuable information that comes from the Bitcoin supply side. The 18.5 millionth Bitcoin was recently mined, which leaves just 2.5 million to come. Less well known is how many coins are moving around the system, and how many are being hoarded by miners and have never been spent. At ByteTree, we were keen to understand more about this dynamic and came up with "first spend", although some critics feel a more accurate description would be "first send".

First Spend Explained

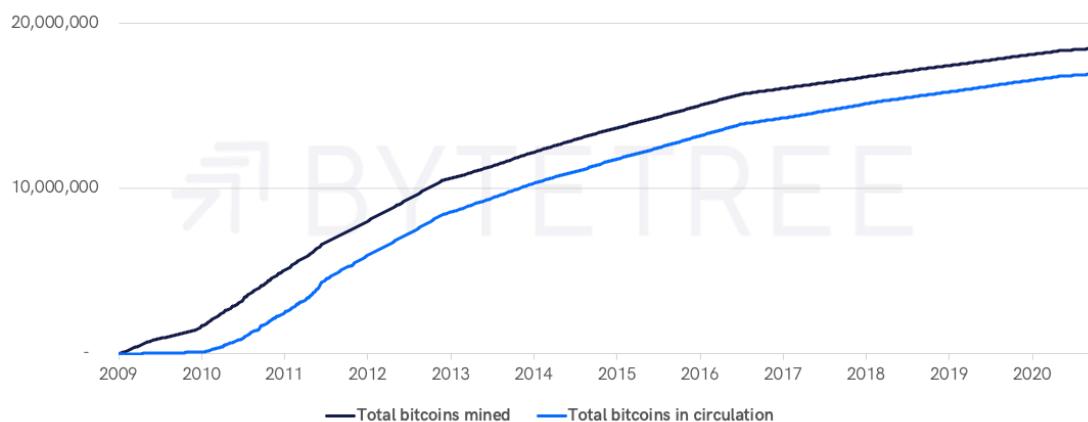
When a miner solves a block, they receive the block reward plus fees. The block reward contains newly minted Bitcoins that have never been spent (or transacted) before. ByteTree data shows unspent coins as "unspent inventory", which we shorten to inventory. Once they have been spent for the first time, they show up in the first spend calculation. A spent coin will never again become unspent, so this can only happen once.

It is likely that when a miner sends a Bitcoin for the first time, it is being sold at an exchange for cash or distributed to the mining pool. There may be other reasons for the transfer, but given the high costs associated with mining, they will need cash. Certainly, in the oil and metals business, miners do not stockpile because they tend not to have a view on the price and turn their product into cash as soon as possible.

As of September 2020, Bitcoin has an inventory of 1.5 million against a total mined of 18.5 million. That means 17 million Bitcoins have been released into the network, while 1.5 million remain in the same address that they were first mined. It goes without saying that many of those unspent coins belong to Satoshi and his close allies. The difference between the total mined supply and the adjusted supply is shown below.

Bitcoin Supply

_ONLY "spent" bitcoins make it into the network



Source: ByteTree.com.

Most coins mined in 2009 remain unspent. Recall from chapter 5 that in the early days, the miners dominated network activity. At the time, there wasn't much you could do with your Bitcoins and so they were largely HODLed. The next chart shows the inventory, and how it has changed over time. It accelerated to 2.5 million Bitcoins by 2011 and has been falling ever since.

Bitcoin Inventory

Bitcoin inventory

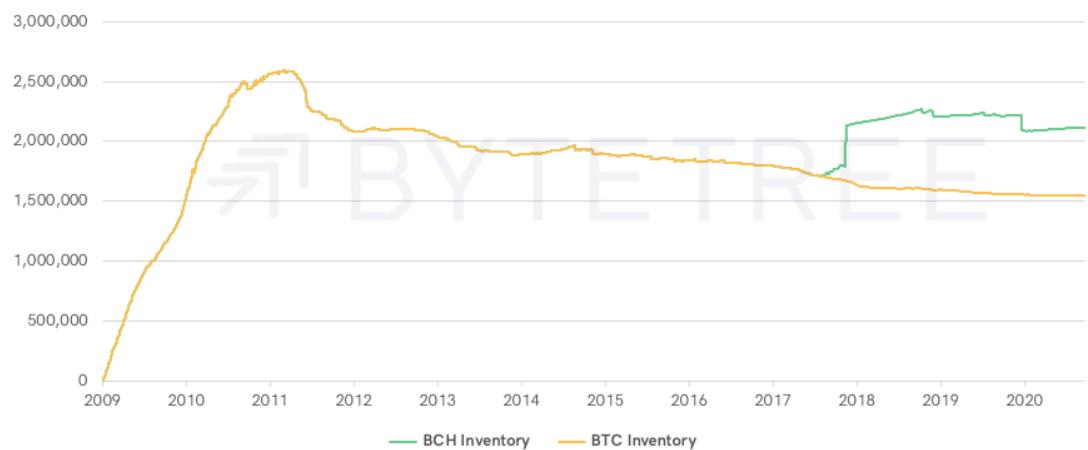


Source: ByteTree.com.

Comparing Bitcoin to Bitcoin Cash (BCH), you can see identical paths until the time of the fork in late 2017. For whatever reason, the BCH miners decided to HODL and now hold over 2 million coins. It might be that the BCH miners are bullish and wish to hold more inventory or it could be that the marketplace is too soft for them to sell into.

BCH Inventory Rose After the Fork

 BCH Miners retain more influence by holding greater inventory



Source: ByteTree. BTC and BCH inventory since 2009.

Looking back at the early days is interesting but doesn't help to forecast the future price. To extract more useful information, we follow the miners' current inventory levels and how they change over time.

Miners Rolling Inventory (MRI)

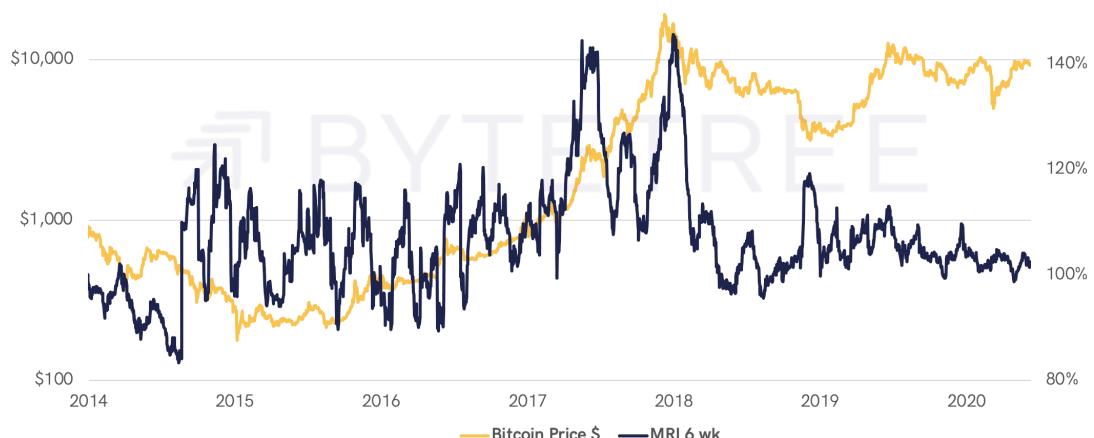
MRI measures the changing Bitcoin inventory levels held by the miners. We typically observe a rolling six-week window, and count the number of coins they mined and the number of coins they spent. An MRI of 100% means they have spent all the coins they have mined. A reading above 100% means they have spent more than they have mined, and thus drawn down inventory. A reading below 100% means the miners are hoarding Bitcoins.

Example

Over a six-week period, the miners generated (mined) 76,963 new Bitcoins while first spend saw 78,342 Bitcoins join the network for the first time. Therefore 2% more Bitcoins have been "spent" than have been mined. ByteTree would describe this as Bitcoin's six-week MRI is running at 102%. The next chart is noisy, but you can broadly reconcile low MRI readings with weak price action.

MRI and Price

Miner's Rolling Inventory (MRI) and Price



Source: ByteTree.com.

MRI has been tested for its impact on price. The natural assumption would be to associate a high MRI (heavy miner selling) with downward pressure on price. Equally, many might assume that a low MRI would be positive for the price because prices may rise when there is less selling pressure. Certainly, the stock to flow thesis would share that view, but ByteTree does not.

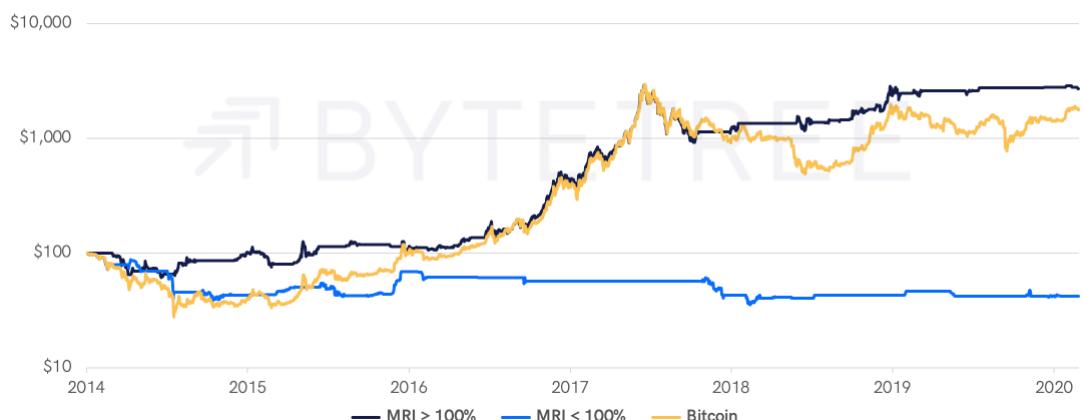
Remarkable as it may seem, ByteTree's research has found the opposite to be true. It turns out that a high MRI doesn't put downward pressure on price. Instead, it is reflective of a strong market bid that the miners are willing to accept. And when that bid fades, the miners hold back, in the knowledge that their selling will negatively impact price.

When you come to think about it, this is logical. When Bitcoin goes through a period of low demand, there is a weak market to sell into. As a result, the miners would wait for the market bid to improve and let their inventory grow.

I can demonstrate that with a backtest. If you were invested when MRI was above 100%, there is evident outperformance over Bitcoin buy and hold. However, more striking is how rare it is to see price appreciation when MRI is below 100%, which occurs around 20% of the time.

Hold Bitcoin When the Miners Are Selling

↗ Hold bitcoin when the miners are selling



Source: ByteTree. Miners' rolling inventory (MRI) since 2014.

I am not making the pitch that you should own Bitcoin when the MRI is high, but I am suggesting that a low MRI is a statistically riskier time to be invested. MRI is an effective risk management tool as it has consistently been associated with periods of market weakness. An MRI below 100% may not confirm a bear market, but you are unlikely to miss out on a great opportunity and can employ capital elsewhere.

In fact, you can allow MRI to go as high as 106%, which means you would only be invested when the miners are selling down their stock quite aggressively; something that occurs around half of the time. It is a defensive strategy that has avoided the worst of the bear markets, yet lets you know when you need to be in the market.

Summary

Blockchain data gives valuable insights. In the case of MRI, it is telling us about the state of the market bid. The miners are savvy market participants, who have invested time and money into their operations. It stands to reason that they want to achieve good prices to maximise profits. Regardless of their market views, they have costs that need to be met, and so they are continuous sellers. However, they want to tread carefully and do not want to impact the market, and so they hold back when it is weak. It is only when it is strong that they run down their inventory.

MRI is a useful market health tool. If the reading is low, then it makes sense to be cautious. A high MRI signal won't necessarily lead to immediate riches, but as a process to follow, it is something to embrace.

Chapter 7

ByteTree's Vision for the Future of Bitcoin

Tom Salter, Digital Asset Analyst

Scaling Bitcoin; The Lighting Network

Bitcoin's sluggish payment network has been a "noose" around its own neck. High fees and confirmation bottlenecks make payments expensive and untimely, and micropayments uneconomic. Some view the network as archaic in comparison to the more traditional fiat payment systems. With all this said, the Bitcoin Network is still the largest crypto-assets, its market cap of \$200 billion shows that the consensus model of validating blocks has not broken the long-standing loyalty of HODLers and enthusiasts.

Scalability is now the primary concern taking over from the previous worries over "nefarious" actions on the network. At ByteTree, we believe that solutions to Bitcoin's scalability issues will gain more attention in the future. Scalability issues are not just Bitcoin's problem; Ethereum's change to Proof of Stake has been on the cards for three years. Ethereum 2.0 is in its final test net, and without significant improvements to the payment system of Bitcoin, we could expect to see the gap between Bitcoin and Ethereum close.

It may be hard to see the issue with the Bitcoin Network as a payment system, but comparing it to Visa shows the problem with scalability. The Visa network processes around 1,700 transactions a second, whereas the Bitcoin Network's maximum capacity is around seven transactions per second. This coupled with high fees, shows the need for improvement. It is fair to say that decentralised networks all face a similar problem between security and throughput. Increasing the number of transactions per second has typically been synonymous with increased weight (the size of the chain), which in turn limits how accessible it is to run a Bitcoin node. With that said, there are some promising innovations emerging from the Ethereum ecosystem, which utilise Zero Knowledge Proofs (ZKPs) to increase the overall performance of the system.

ZKPs have been successful in providing verifiably correct batch-processed transactions on decentralised exchanges such as Loopring. This has enabled higher throughput of 2,000 TPS, reduced cost per operation due to scale and all with a high degree of security.

Bitcoin has revolutionised the way payment systems are designed but has been temporarily hamstrung by the fee per transaction and confirmation times stunting its mass adoption in "real-world" applications.

The Lightning Network could help Bitcoin overcome this bottleneck. The Lightning Network was first proposed in 2015 by Joseph Poon (also responsible for OmiseGo, a

PoS blockchain) and Thaddeus Dryja (a research scientist for the MIT digital currency initiative) to create a solution to the growing scalability issues of Bitcoin. The Lightning Network is considered a layer-2 protocol, meaning that it is built on top of the Bitcoin Network (layer-1).

The Lightning Network is an off-chain scaling option, as opposed to sharding which is an on-chain scaling option proposed by Ethereum. This off-chain method allows users to lock funds in a multi-sig wallet on layer-1 (Bitcoin Network) for subsequent use on layer-2 (Lightning Network). This layer one multi-sig wallet acts, in essence, as an escrow for both users' Bitcoin. Layer-2 is comprised of a number of payment channels, and once a person on the Lightning Network transacts with another person, there is a constant payment link that is not required to be recorded on-chain. Every transaction after the first will therefore not be required to pay a fee, which would mean in theory that only two fees should be applied. Fees would only apply when the multi-sig wallet is created and additionally when the balance of the multi-sig wallet is settled.

E. Erdin, M. Cebe and K. Akkaya et al./Computer Networks 172 (2020) 107098

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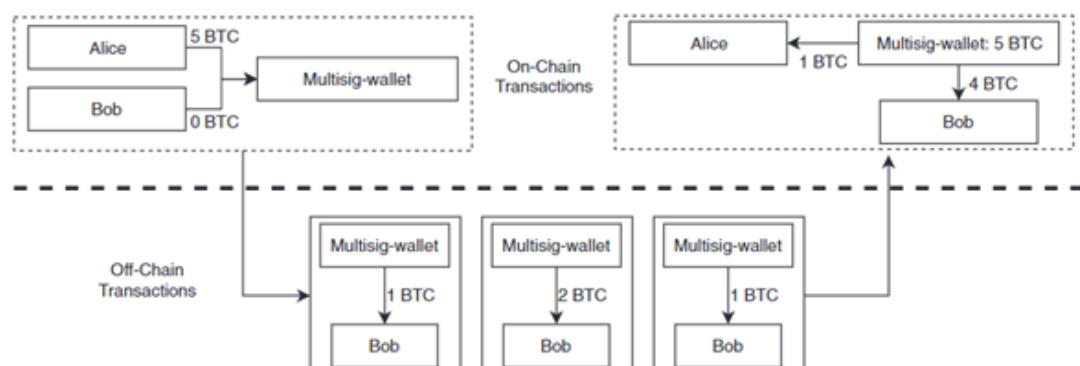


Fig. 1. Off-chain mechanism between two Blockchain nodes.

Source: [Erdin, et al.](#). Only the on-chain transactions will incur fees.

The Lightning Network is the most promising answer to the scalability issues that the Bitcoin Network faces, and we hope that it is implemented in the not too distant future. While this solution is scalable, it does take away the core ideals of a distributed ledger, as off-chain transactions are not available for everyone to verify independently.

Another challenge to the adoption of the Lightning Network is the level of skill required by its users. Sending a transaction requires a user to set up, or connect to, a lightning node, pre-fund an account with BTC and then remain online in order to receive any other inbound transactions. While "node in a box" solutions from the likes of Casa Hodl and Lightninginabox go some way to lubricating adoption, the total Lightning Network supports just \$12.4M of capacity as of 31st August [blue line]. While capacity is growing, it has yet to break above 1,100 BTC [orange line], as shown on the chart below.



Source: [Bitcoin Visuals](#). Lightning Network capacity, 31st August 2020.

One of the most exciting projects in Bitcoin today is tackling the Lightning Network's usability challenges head-on. Zap is a non-custodial application that allows users to send fiat over the Lightning Network in seconds. For the first time ever, users will be able to swap fiat for Bitcoin instantaneously without any custodians. Zap brings all of the benefits of the Bitcoin Network to a fully integrated, user-friendly and trustless payment application. We encourage you to join the beta and spread the word at [Zap](#).

Bitcoin Within Decentralised Finance (DeFi)

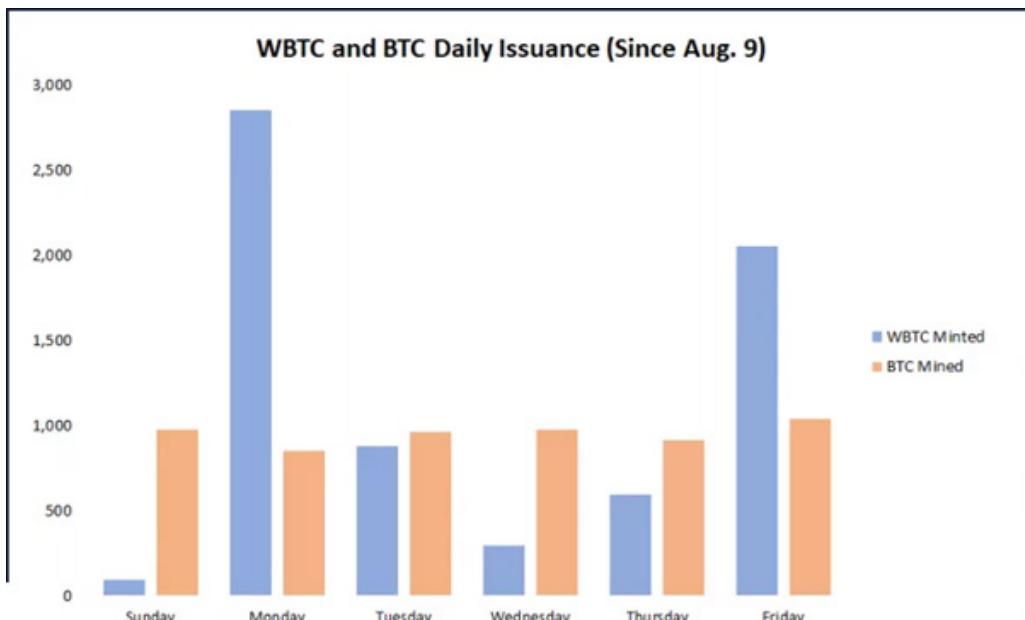
As we can see, there is a need for the Lightning Network; this is because the usability of Bitcoin is based on its ability to scale. However, some would agree that there is another solution to improving the usability of Bitcoin, through leveraging the Ethereum Network.

ERC-20 tokens are a by-product of decentralised applications, known as Dapps; these platforms are built to benefit from the Ethereum blockchain and its desired usability.

Ethereum's helping hand comes in the form of a tokenised version of Bitcoin or Wrapped Bitcoin (WBTC). WBTC is an ERC-20 token, it was launched on the Ethereum main-net in January 2019. The token has a direct relationship to Bitcoin, as it is "hard" pegged, meaning that for every WBTC there is a one Bitcoin. The underlying Bitcoin is locked in an Ethereum smart contract, which upon redemption of WBTC will be returned to the owner.

WBTC could be significant for the future of Bitcoin; the issues that the Lightning Network are trying to fix could be "outsourced" to the Ethereum network through WBTC. This "outsourcing" can make Bitcoin a more attractive asset to users because tokenising Bitcoin allows users to have sovereignty over their underlying Bitcoin while enabling them to take part in the DeFi ecosystem. As we can see from chart of below, the number of Bitcoins being mined is outweighed by the number of WBTC being

minted. Bitcoins and WBTCs relationship are similar to gold and the dollar when there was a gold standard in 1834. In this analogy Bitcoin is the gold (an asset with minimal uses), and WBTC is the dollar (an asset with usability).



Source: [CoinDesk](#).

At ByteTree, we expect platforms like Perpetual Protocol to help Bitcoin increase its use in the DeFi ecosystem. Perpetual raised 1.8 million dollars in August 2020 to launch its main-net in September. The platform allows users to leverage crypto-assets and provides them with the native token \$PERP. Depositing Bitcoin into the Perpetual smart contract, supplies users with vBTC - a tokenised version which entitles users to either long or short any asset, including gold. The Platform rewards users with their governance token \$PERP, these tokens can be staked for rewards. Perpetual will be a welcome addition to DeFi, acting as a “one-stop” shop for the variety of features which have made competing platforms so successful.

DeFi will become a larger part of Bitcoin's future. At ByteTree, we believe that looking at network demand can help to show whether a crypto asset is succeeding. WBTC, and platforms such as Perpetual, will increase Bitcoin's demand and therefore are likely to be positive drivers for the long-term future of Bitcoin. As the industry's longest-standing, least volatile, and most distributed asset, Bitcoin is the natural choice for a decentralised reserve asset across the economy of blockchains.

Bitcoin as a Reserve Asset

Gold is considered to be one of the safest stores of value available, but this security comes with limitations in how it can be used. Bitcoin, which shares many of gold's security properties, is natively digital. This lends itself to far wider application among the rapidly expanding internet economy. Bitcoin shares a finite supply with gold but

excels with relation to its portability and deflationary nature.

We have seen a shift in how Bitcoin is used, and its plan has changed from a world currency to a speculative asset class. Bitcoin's impracticality draws resemblance to gold as a digital reserve asset. It is similar in all ways except distribution; in gold's case, its flow is determined by central banks, whereas Bitcoin's flow is determined through rewarding miners. The increasing amounts of runaway inflation created by centralised flow may damage fiat currencies, making an appealing case for Bitcoin.

Digital gold token, or DGLD, is attempting to merge the digital positives of Bitcoin with Gold. DGLD was launched by Coinshares and MKS Pamp Group in late 2019; it aims to create a token based on the Bitcoin blockchain that will act as a digital proof of gold. Ownership of DGLD tokens entitles holders to redeem their tokens for physical gold, allowing you to digitally hold gold and transport it around the world. DGLD enables users to own fractions of a gold bar, simply owning 1 DGLD would entitle holders to 0.09 of a troy oz of gold which is held securely in a Swiss vault.

As Bitcoin becomes more widely accepted, we should see the tokenisation of more "real-world" assets on top of the world's most secure and decentralised transaction ledger – the Bitcoin Network.

The Merging of Traditional Finance with Digital Assets

At ByteTree, we believe that financial institutions will start to recognise Bitcoin as an alternative investment. Family offices and businesses have already begun to include Bitcoin as part of their capital allocation strategies – in part because of its hedge against inflation.

Most notably, Grayscale and MicroStrategy have been at the forefront of the institutional involvement with Bitcoin. The Grayscale Bitcoin Trust enables US citizens to own Bitcoin as part of their 401k, boosting their AUM to over \$5 billion. The fund has enabled traditional finance to gain exposure to digital assets without worrying about losing their private keys. In Europe, we have exchange trade products listed in Sweden, Germany and Switzerland. While still catching up with the US, they are showing steady growth.

MicroStrategy is a business analytics platform which was founded in 1989 and is currently listed on the NASDAQ exchange. They released a statement that they have purchased over \$425 million of Bitcoin. This is a revolutionary idea since buying MicroStrategy stock would allow investors to expose their portfolio to Bitcoin. To put this in context, the equivalent of 28% of the current market cap of Microstrategy is invested in Bitcoin, with plans to increase their stake over the next year. Essentially, this endeavour has created an exchange-traded product without the need for SEC regulations which are notoriously harsh towards crypto-asset investment products.

Summary

At ByteTree, we believe that the more accessible Bitcoin becomes, the better it is for the health of the network. With Nasdaq listed companies like MicroStrategy adding Bitcoin as a treasury reserve asset, the case for Bitcoin grows stronger by the day.

Conclusion

The number of Bitcoins mined has just last week exceeded 18.5 million. ByteTree's first spend data shows that the miners will soon have collected an aggregate value of \$20 billion for their collective efforts since 2009, while Bitcoin users have paid \$1.16 billion in transaction fees for the 600 million transactions executed. These numbers are substantial and would surprise many people who still wonder whether Bitcoin will ever take off.

In this report, we have looked at the cause of the surge in price, which put simply is down to the Network Effect. As the Bitcoin Network has ballooned, the price has surged. But as an asset matures, the external influences become ever more important. The dollar, the Fed, bond yields and inflation all seem to influence price. At least, there is some evidence that suggests the Bitcoin price has preferred certain conditions when it was free to appreciate, and others when it has struggled.

Unsurprisingly, it is linked to risky asset prices such as equities, especially those in the tech sector. It has some connection to gold, but less than many think because it can behave in opposite ways. Like equities, Bitcoin is a risk-on asset, whereas gold is a timeless risk-off asset. The proof is that a rebalancing strategy seems to deliver better risk-adjusted returns than either asset alone. The benefits of diversification only shine through when the assets are fundamentally different. Bitcoin is a reliable risk-on asset and has tended to outperform pretty much everything when general asset prices are rising. Having no CEO or profits, which can disappoint, can have its benefits.

A lack of cash flow doesn't mean an asset can't be valued. Art, commodities, and growth stocks, don't have income streams, but that doesn't make them worthless. They all have vibrant market dynamics, which demonstrates their value. In the case of Bitcoin, its value is proportional to the size of the network. If people bought Bitcoin but then never used it, the network would eventually crumble, liquidity would dry up, and investors would be disappointed. Yet so long as use cases and applications grow, market depth will remain strong, the network will grow, and the price will rise. Bitcoin is appreciating as it reflects the growth within the digital economy.

Some disagree and think that Bitcoin value creation comes from the supply side and look to scarcity for price appreciation. They believe that as fewer Bitcoins are minted, they will become harder to buy and the price will be squeezed higher. The trouble with this view is that the miners don't have a monopoly on sales, only their own sales. On the contrary, the influence of the miners is ever diminishing and will eventually become negligible. Anyone who owns Bitcoin is free to sell, not just the miners.

Yet the miners perform a vital task as they support, process and protect the network. As they receive fewer Bitcoins for their hard work, will fees be enough? They are growing in significance, but the economics of mining faces serious challenges. The usual solution

is a new chip design which does things better, faster, cheaper. History reminds us not to bet against human ingenuity.

The miners are smart, and ByteTree's MRI indicator measures how many coins they sell into the network (technically distribute, but generally sold). It turns out that heavy selling reflects a vibrant market. They sell because they can, in the knowledge that they won't impact the market bid. It is when they stop selling that the market turns out to be weak. They stand back because they don't want to collapse the price. The lesson is to be long when the miners are selling. Counter-intuitive perhaps, but a demonstration of the benefits of data and results over narratives and misinformation.

We created ByteTree to service the investor, especially the institutional investor who is coming on board. The aim was to publish on-chain metrics that influence price in real-time. These give investors a timely set of tools to better understand how to evaluate the market. The key is to accept that Bitcoin is a demand-driven story as the supply side is already known. Demand is logged on the blockchain and tells you what is happening, as it happens. The suite of metrics we track enables investors to make informed decisions within this fast-growing and exciting asset class.

We hope you enjoyed this report. Please keep in touch via our [mailing list](#).

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