

BITCOIN HASHRATE AND BITCOIN PRICE: IS PRICE PREDICTION POSSIBLE?



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Blockchain and CryptoAsset(K) Ltd.

Authored by: Patrick Kiragu Mwangi BA, BSc., MA



Background

In order to understand the hashrate and its functions, one needs a basic understanding of Bitcoin (BTC) mining. Bitcoin mining is a computerised process with three main functions: a) to confirm transactions made on the Bitcoin network; b) to issue new Bitcoins, and; c) to ensure the Bitcoin network remains secure.

New Bitcoins are “issued” to miners via a block reward for solving a block. Within each block is contained the transaction data of thousands of transactions made by participants on the blockchain network. The confirmation of these transactions is done by miners via the mining process.



Mining is done by using special hardware (mining equipment) to solve a complex computational problem, which produces a hash — a random 64-character output. To get this number requires numerous attempts. Once the hash is found, the block is closed and added to the chain of already mined blocks, hence the

term ‘blockchain’. For their effort, the “miner” who solves the block is rewarded with newly-created Bitcoins (which are then added to the supply of Bitcoin already in circulation) and transaction fees.

To increase the chances of solving a hash, miners acquire more advanced and expensive computers for mining. BTC mining is exclusively on an ASIC equipment as this is the most efficient way to solve these computational problems. Mining is, therefore, the process by which transactions are verified and new Bitcoins added onto the blockchain.

Hashrate represents the computational power that Bitcoin miners need to employ to confirm transactions on the blockchain or the speed at which a miner arrives at a hash i.e the number of times a hash function is computed per second. As more miners mine Bitcoin, this causes a surge in the hashrate. The higher the hashrate becomes, the higher the mining difficulty as miners compete to be the first to solve the algorithmic problem and receive newly-mined Bitcoins.

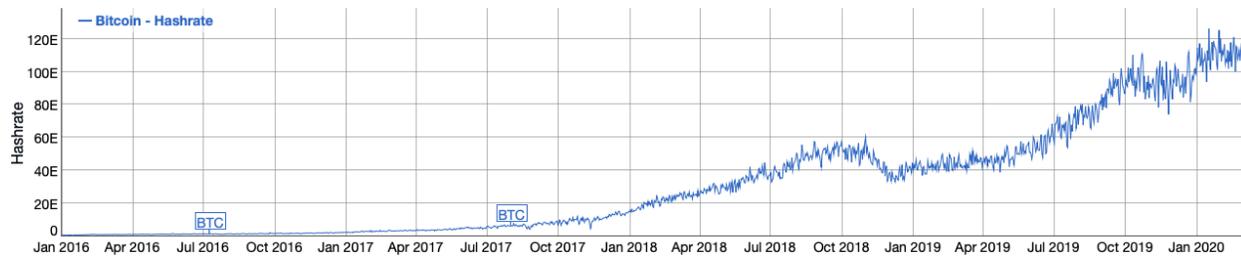
The increase in hashrate also represents higher security in the network, ultimately, increasing the confidence potential investors have in Bitcoin. It is a general indication of a healthy Bitcoin mining environment and means a growing number of miners are using the most efficient mining hardware they can afford and competing with each other to process transactions and solve the block reward puzzles. This proof-of-work (PoW) makes the Bitcoin blockchain secure and immutable.

From an investor’s point of view, the hashrate is an interesting metric to follow as it shows that miners are investing in and deploying new equipment, possibly in anticipation of a rising Bitcoin price. A growing number of Bitcoin and cryptocurrency investors also see the hashrate as offering wider macro insight and as a measure of adoption. Greater adoption means the increasing use of Bitcoin and hence a resultant increasing demand for mining power and capability to verify the increasing number of associated transactions.

A number of factors affect the hashrate:

- ✘ increased adoption of Bitcoin

- ✗ the cost of the electricity used to mine
- ✗ efficiency of the mining equipment
- ✗ event studies or project-specific events like halving



Hashrate (quintillion hashes per second) from Jan. 2016 - Mar. 2020. Source: [Bitinfocharts](https://bitinfocharts.com/)

Correlation vs Causation: the difference

Correlation and causality can seem deceptively similar. While causation and correlation can exist at the same time, correlation doesn't necessarily imply causation. Causation, explicitly, applies to cases where action A causes outcome B. On the other hand, correlation is simply a relationship. Action A relates to Action B—but one event doesn't necessarily cause the other event to happen. A causal (cause-and-effect) relationship can only be assumed where a dependent event is the result of an independent event. One cannot simply assume causation even if two events are observed happening seemingly together. There are, therefore, many other possibilities for an association, including:

- The opposite is true: **B actually causes A.**
- The two are correlated, but there's more to it: **A and B are correlated, but they're actually caused by C.**
- There's another variable involved: **A does cause B—as long as D happens.**
- There is a chain reaction: **A causes E, which leads E to cause B (but one only sees A as causing B).**

Even where a causal relationship is suspected, it is still necessary to confirm this through a robust analysis so as to avoid an erroneous result- namely, a false positive where a causal relationship appears to exist but actually isn't there. Extensively testing the relationship between a dependent and an independent variable before asserting causality is therefore critical to identifying a real underlying relationship between the two variables. Without rigorous testing, the investor runs the risk of basing important investment decisions on the wrong observed behavior.

The case for causation

Bitcoin mining is a war of attrition for resources. As Bitcoin continues to gain adoption, the hashrate rises and there is more competition on the network which means that it becomes more expensive to mine. As a result, revenue margins are eaten away. Such a heightened hashrate may indicate that more miners are looking to sell BTC because their operations are more expensive. They need the extra cash to fund continued operations thereby creating a downward pressure on prices. As a result, prices fall due to the increase in the hashrate and a causal relationship can, therefore, be said to exist.

If there weren't new investors entering the market the price of BTC would continually decline. During periods of market bullishness, demand to buy Bitcoin driven by hype exceeds this miner downward-selling pressure and the price rises. When this cycle ends and markets enter a period of bearishness, miner-selling amplifies investor-selling.

Conversely, an increasing hashrate may be seen by miners as a bullish price signal, forcing them to hoard rather than sell newly-mined coins, reducing the downward pressure and raising the price floor. Miners also need to keep selling Bitcoin above a certain threshold to remain profitable putting positive pressure on the BTC price. Not only that, but due to the mining difficulty mainly adjusting to the upside, this means it becomes more and more expensive to mine a single Bitcoin as miners need to spend additional resources (mining equipment and energy) in order to validate a block and earn the fees and the block reward. Thus, the threshold price level is raised even higher.

Looking at mining activity can provide critical insight into forecasting the price of and demand for Bitcoin, which helps investors identify good opportunities to enter the market.

According to some industry analysts, both the increase in mining difficulty as well as the increase in hash power are long-term bullish indicators for the price of Bitcoin. Anecdotally, the rise in mining difficulty marked the start of bull cycles in 2013 and 2016. Further, as the hashrate reached an all-time high of 178.6 EH/s on 30 December 2020, so did the price of Bitcoin about a week later at \$41,660.

In the above instances, the changes in the hashrate cause a change in the price of Bitcoin.

However, many industry experts argue that the causality is always unidirectional going from the Bitcoin price to the hashrate (or its proxies), with lags ranging from one week to six weeks. These findings are consistent with a large literature in energy economics which shows that oil and gas returns affect the purchase of the drilling rigs with a delay of up to three months.

A higher Bitcoin price means more profit is earned for every coin mined. This suggests the pick-up in the hashrate is expected because of the rising value of the Bitcoin price. Miners will expand their operations in order to make the most of the higher prices. As more Bitcoin passes hands in the market, more miners continue to mine on the network steadily increasing the hashrate. As long as the price maintains momentum, the hashrate will likely stay high.

This snowball effect can continue to occur until there is an external variable such as negative news from the community (FUD) or price activity in another cryptocurrency market to cause the price to decline and lure miners away from the market. As a result, when the price starts to dip, there is a drop in the network's hashrate which means that as the price falls it became less and less profitable for miners to mine on the network leading them to turn off their mining equipment.

Although this pattern is more of the miners' reaction to the market and less of a long-term strategy, the level of mining activity can be a key indicator of the direction of the price of Bitcoin and whether it is on the cusp of a bull or bear run.

A high hashrate is also a good indicator of a healthy Bitcoin network- a miner's vote of confidence in Bitcoin. The more time and resources miners allocate to mining Bitcoin, and thus confirming transactions, the more confident they are that the Bitcoin price will increase. Thus, expectations of a future rise in price will incentivise miners to invest in the expensive equipment necessary to mine meaning that it is the expected future rise in price that causes the hashrate to also rise.



It is also the case that perceptions of increased future prices of Bitcoin, due to greater adoption of Bitcoin, lead to a greater supply of miners. This leads to increased competition for mining resources and a consequent increase in the cost of mining and, ultimately, the hashrate.¹

A lead-lag relationship (not necessarily a causal one)

Some asset managers argue that Bitcoin is structured in a way that the hashrate follows price but that the price change does not necessarily cause the change in the hashrate. The relationship is, therefore, merely a lead-lag relationship without there being any causation. They argue that there is a lag between price increases and increasing hashrates as miners need to order and install new, more efficient mining equipment as the block rewards become more lucrative with Bitcoin price rises. Thus, the rise in Bitcoin price merely precedes the rise in the hashrate.

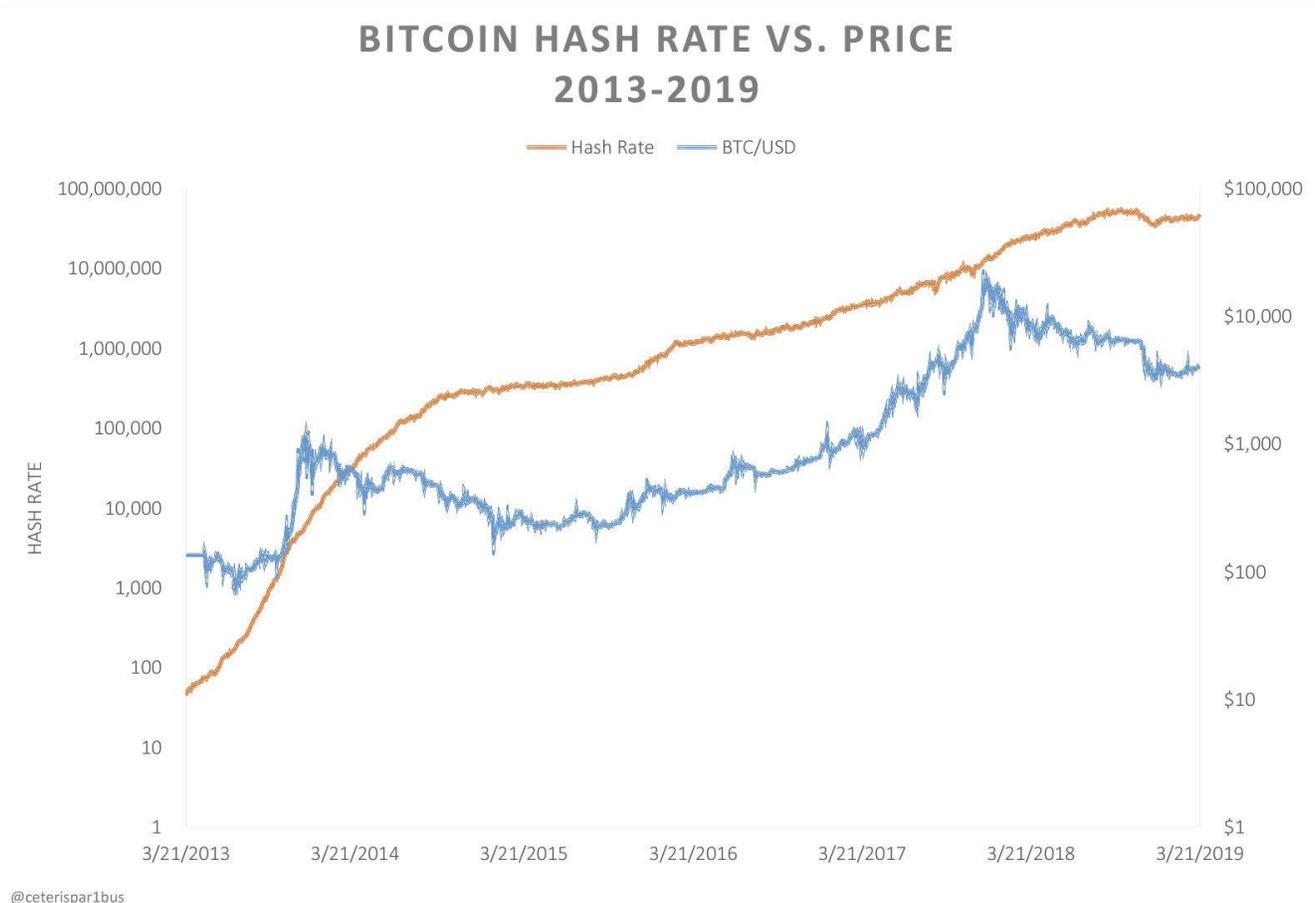
Additionally, they argue that the hashrate follows the price because miners are paid in Bitcoin while incurring local currency costs. This means that increasing the hashrate during a non-profitable mining environment would not make economic sense for a miner. Thus, in times of low Bitcoin prices, the hashrate is correspondingly low as miners stay away from incurring local currency costs in the face of a declining price in Bitcoin.

The case for correlation

Experts have continued to differ on the correlation between the price of BTC and the Bitcoin network's hashrate. In order to unpack any such relationship, one needs to revisit the cause of an increase in the hashrate in the first instance. Where this is due to greater adoption and hence increased demand for Bitcoin, a rise in the price of Bitcoin will be independent of the hashrate as the price movement will be to a degree driven purely by the increase in the demand for Bitcoin. At the same time, as a result of the increase in demand for fulfilling Bitcoin transactions following a higher adoption rate, the need to process an ever-increasing volume of Bitcoin transactions will lead to a greater hashrate. Thus, both the price of Bitcoin and the hashrate will rise independent of each other with both increases being driven by a third factor- adoption. A (positive) correlation may be said to exist, but clearly not a causation.

¹ However, it is worth noting that such an increase in the cost of mining may easily be offset by a correspondingly higher increase in the price of Bitcoin.

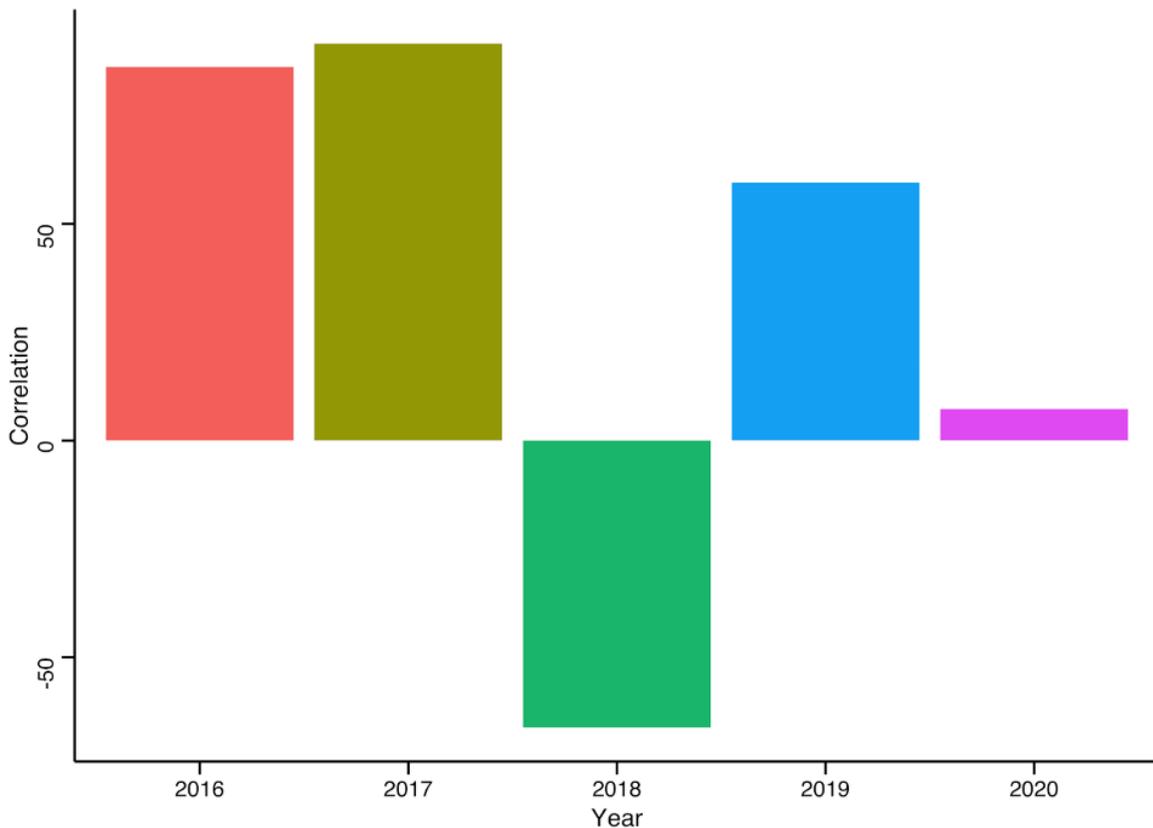
What is clear is that there is a relationship between these two metrics that investors need to be aware of and should keep an eye out for. For example, if the hashrate is on the rise and the price of Bitcoin is rising alongside it this could mean that miners are anticipating the rally to continue and are mining coins to take advantage of the higher prices. Such a scenario would establish a (positive) correlation between the two metrics but, again, not necessarily a causal one.



Source: Bitcoin Core Project

Across the years the correlation between Bitcoin price and the hashrate has been very high, suggesting a relationship between the two variables. In 2016, these two variables were positively correlated at 0.86, while in 2017 this positive relationship was even greater at 0.92 - the highest between 2016 and 2020.

However, in 2014 and 2018, negative correlations were observed between hashrate and Bitcoin price with the correlation standing at -0.66 in 2018. In 2019 the positive correlation stood at 0.6.



Correlation between Bitcoin price and its hashrate

A correlation of 1 means that the Bitcoin price and the hashrate move perfectly in tandem in the same direction, while a -1 correlation means they are perfectly inversely related. A correlation of 0 means that the variables are not related in any way.

Event studies and 'corporate' actions

Bitcoin Halving

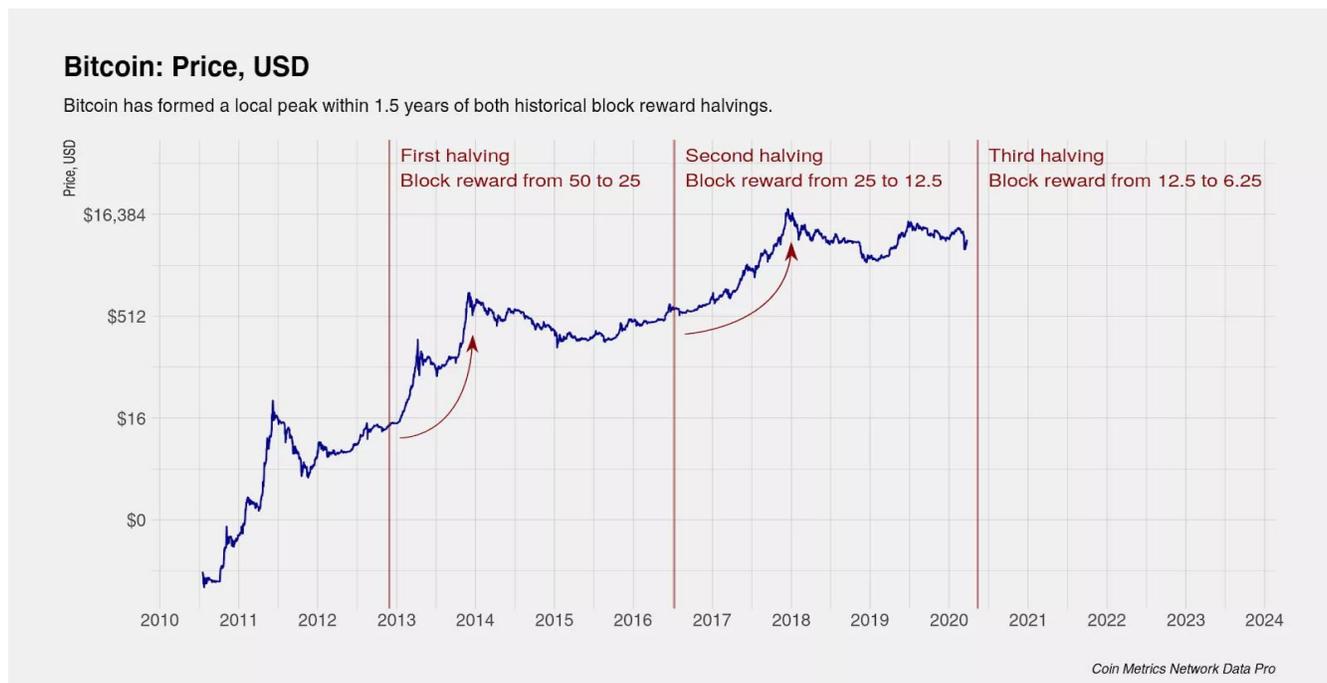
Bitcoin halving is a pre-coded monetary event that occurs on the Bitcoin blockchain every four years where the number of new Bitcoins that are created via the block reward is reduced by half. With fewer Bitcoins being created, due to the subsequent halving events of 2008, 2012, 2016 and 2020, the increasing Bitcoin supply shortage has meant network participants are now bidding for a significantly reduced supply available on exchanges. For a given level of demand, if the rate of supply of Bitcoins has reduced, then the price of the asset should rise naturally.

Following halving, miners' profitability per hash is naturally reduced since to obtain the same amount of BTC as before miners will have to spend at least twice the power input or double the computational power. In other words, after the halving event, miners receive half the number of Bitcoins as reward for their mining effort. This may have two contrasting effects. On the one hand, the slashing of rewards means that miners would need double the computational power required before the halving to get the same amount of Bitcoin reward. This may be assumed to increase the hashrate.

On the other hand, however, a reduction in the reward available to miners due to halving may force miners to capitulate as their profit margins drastically fall off due to the reduced block rewards. Miners may, therefore, decline in number leading to less competition and less investment in mining

equipment and a resultant fall in the hashrate. In addition, the halving event may dissuade miners from participating in verifying Bitcoin transactions leading, similarly, to a fall in the hashrate.

In the former instance, the increased hashrate will potentially create miner-selling pressure (i.e. miner pressure to sell Bitcoin to offset rising mining costs) leading, therefore, to a price fall in Bitcoin. An alternative view, however, is that halving events put additional pressure on the 'threshold' price² miners need in order to break even leading potentially to a rise in the price of BTC. All this notwithstanding, the reduced supply of Bitcoin due to the halving in the first instance may lead to a price action that is independent of the hashrate. Thus, a halving event may lead to a price increase due to the reduced supply of Bitcoin without the hashrate (either an increase or decrease) playing a part in the price action. Indeed, data shows that Bitcoin mining-related events produce conflicting short-term price action but long-term gains.



Source: Coinmetrics

Network security upgrades

As more miners join the Bitcoin network, the hashrate increases. A high hashrate is indicative of a secure blockchain and makes it more difficult for bad actors to perform a 51% attack. A 51% attack occurs when miners or nodes get enough power to control the majority of mining (hashing) power and, consequently, manage most events on the network. They can, therefore, monopolise the generation of new blocks and receive rewards since they are able to prevent other miners from completing blocks and can manipulate and reverse transactions to allow double-spending. In essence, as more participants join the network, Bitcoin becomes more secure.

Additionally, any network security upgrades help to increase user and miner confidence in the network hence boosting both adoption and mining activity. Both of these have the effect of raising the hashrate. Bitcoin price may rise in tandem, but this is not always the case where other factors

² However, such a price move may be undercut by higher fees to accommodate for increased mining difficulty reducing the need for a rise in the 'threshold' price level.

including the prevailing market sentiment are at play. However, suffice to say, greater participation in the network by miners is a sign of their confidence in the future price of Bitcoin and such confidence is further augmented where the network takes action to increase its security features.

Exogenous factors



Other exogenous factors like the cost of electricity also influence the hashrate. Since touching then all-time highs on October 18th 2020, productivity on the Bitcoin network slumped to 109.348 million TH/s by October 26th 2020. Mining data aggregators attributed this slump to the end of the wet season in the Sichuan region of China which is one of the world's largest hubs for mining activity. Every year miners flock to Sichuan to take advantage of cheap

hydro-electricity rates available during the wet season and just as quickly leave when it is over. When the wet season ends, miners move to other regions of China and the rest of the world to focus on capturing fossil fuel-based electricity. This leads to an inevitable migration period and recovery phase before machines are switched on again connected to different power sources. In such times, the price of Bitcoin will move independent of the movements in the hashrate and any association is purely coincidental. Thus, the October 2020 period saw a booming BTC price happening alongside a dipping hashrate.

Hashrate was also able to grow in 2020 due in part to cheaper financing becoming available for ASIC mining equipment. This allowed larger mining operations to take out loans to bulk order newer generation mining hardware with reports of miners being able to secure sub 10% interest loans. In 2019 the common rate was 20%. Here also, movements in the hashrate may happen independent of those in the price of Bitcoin as a result.

Aside from the increased adoption of Bitcoin and the speculation in Bitcoin by retail investors, other factors including the increasing interest by global financial services companies like Paypal to integrate cryptocurrency trade, a weakening US dollar (driving demand towards what are regarded as store of value assets) and the entry of increasing numbers of institutional investors into the cryptocurrency space have all increased demand for Bitcoin leading to a surge in price in late 2020 and early 2021. This price surge is happening alongside an equal surge in the hashrate but there is little evidence that there is a causal relationship between the two.

Risks and caveats

Thus far, Bitcoin has followed the consensus algorithm model- Proof-of-Work (PoW), where the key factor is computational power, to verify transactions on the network. Other protocols like Ethereum are mulling the adoption of a different consensus algorithm- Proof-of-Stake (PoS) which is, instead, dependent on the validator's economic stake in the network. This has implications for how the network is secured as hashrate may no longer be a factor when assessing the impact on Bitcoin price.

Ownership of hash power can be a concern. Research from October 2018 suggested that over 80 percent of Bitcoin mining was conducted by just six groups of miners, five of which were directly

managed by individuals or companies from China. Theoretically, this gives one region of the world undue influence over the Bitcoin network.

The mining industry has transformed from a passive hobby into a capital-intensive battleground where the only successful mining entities are well-funded organizations. These firms are continually reinvesting their capital to gain a competitive advantage over the rest of the miners in the ecosystem. Thus, the mining sector is becoming heavily consolidated with just a few meaningful participants. This has raised concerns over the decentralized nature of the Bitcoin network while also creating several barriers to entry for new users who want to enter the Bitcoin mining industry.

Conclusion

Much more data needs to be collected over a longer period of time for a definitive answer to be reached as to whether a causal relationship exists between Bitcoin hashrate and the price of Bitcoin. When employing regression models to determine the influence of hashrate on Bitcoin's price, conflicting non-significant results are observed meaning it is difficult to reach a conclusion about the relationship between the two.

Both a positive correlation as well as a negative correlation between Bitcoin hashrate and Bitcoin price in the period since Bitcoin's inception are observable but this is no indication that a causal relationship exists. Although analysts have argued that an increased hashrate causes a rise in Bitcoin price and vice versa, for the reasons mentioned above, there is no conclusive evidence on either of these two being the case. What is observable is a correlation between the two but other factors are also at play and this correlation does not always hold true. It is also the case that both hashrate and the price of Bitcoin can move wholly independent of one another, in which case no correlation is observable here. Thus, the price of Bitcoin may oscillate up and down in a volatile market while the hashrate moves uniformly in one direction.

What may be, however, established with a degree of certainty is that a lead-lag relationship does indeed exist which serves to strengthen the case for correlation. Our standing is that Bitcoin miners, who typically would have inside information on and greater insight in the Bitcoin market, are able to anticipate a bullish trend before it takes place. Thus, they invest more in mining equipment as well as increase the level of competition among themselves in anticipation of the price rise. In such instances, the hashrate will invariably precede the rise in the price of Bitcoin and indeed may be seen as a predictor of Bitcoin's price movement. The converse is the case where miners anticipate a bearish trend and, therefore, divest their mining resources helping to drive the hashrate downwards.

It is also plausible that the hashrate may follow price instead and, indeed, there are instances where hash rate has followed price-action. Nevertheless, it appears miners do tend to signal intentions through their mining activity before price moves. For instance, after the Bitcoin price dip in late December 2018 miners started pumping the hashrate before the big price move that started around February 2019.

It is also clear that a relationship also exists between hash rate and security, one that attracts long-term investors and hence positively impacts the price.

In conclusion, due to the increasing security of the Bitcoin protocol and due to Bitcoin price normally following the growing hash rate, it is increasingly evident that Bitcoin will continue reaching new all-time highs.

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