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Bitcoin Miner Metrics:

Hashrate and Thermocap



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INTRODUCTION

Bitcoin has brought a new level of information transparency to investors. Traditional assets allow investors access to real-time market data, but the economic and financial data that underpin price performance are typically subject to only monthly or quarterly updates. In contrast, Bitcoin allows for the real-time collection of metrics to inform investment strategies and decisions.

This note will cover three topics related to **“on-chain” metrics** which are data points that pull directly from or are close derivatives of proof-of-work (PoW) blockchains such as Bitcoin and Ethereum. Those topics are: **Hashrate**, **Hashrate Ribbons** and the **Thermocap Ratio**. These metrics apply to most PoW chains, but in this note we will specifically refer to Bitcoin as it is the largest asset by market capitalization with the largest miner community. These topics are all miner-focused and are associated with network security since miners power the network integrity of PoW networks. Miner metrics are crucial as network security is the backbone of longevity.

From an investors' perspective, an understanding of the definition and application of on-chain metrics is critically important. Some on-chain metrics such as circulating supply, active addresses, transaction density and coin days destroyed can stand without reference to market value to highlight the growth and investment potential of Bitcoin. That said, investors can glean additional insight when market price is considered in concert with on-chain metrics.

(Throughout, we capitalize the blockchain (Bitcoin, Ethereum) and use lower case or trading symbols (bitcoin/BTC, ether/ETH) for the asset. Dollars are U.S. dollars (USD): Nothing in this paper should be considered investment advice.)

Hashrate

Hashrate refers to the computational power that is being used to mine and process Bitcoin transactions. Higher hashrate implies greater security and growing hashrate is indicative of miner optimism and additional capital investment in computing power.

Bitcoin miners process transactions by grouping them into blocks and then racing to find the hash that satisfies a pre-established protocol requirement. Miners are rewarded for the computing work expended in successfully processing blocks with the issue of new bitcoins.

Hashrate is expressed as a number of hashes per second (h/s). For Bitcoin, hashrate is typically expressed in terahash (TH/s) for machines, petahash (PH/s) for miners and exahash (EH/s) for the network which represent 1 trillion, 1 quadrillion and 1 quintillion hashes respectively.

Although the Bitcoin hashrate is derived from on-chain metrics, determining it is **not exact**. We could theoretically determine the exact hashrate if all miners accurately reported their hashrate individually. However, there are simply too many miners operating all over the world for this to be feasible. Thus, it is industry standard to calculate a hashrate estimate from the expected rate of finding a block (one every 10 minutes), the actual rate at which blocks are found and the current difficulty (a parameter of the Bitcoin network that measures how hard it is to construct a valid block which **adjusts every 2016 blocks** to maintain one block being found per 10 minutes on average).

The estimated hashrate formula can be expressed as:

$$\text{estimated hashrate} = \frac{\text{blocks found}}{\text{expected blocks}} \times \text{difficulty} \times \frac{2^{32}}{600}$$

Diagram annotations:

- "per second" points to the denominator of the fraction.
- "number of possibilities for the correct hash" points to 2^{32} .
- "one every 10 minutes" points to the denominator of the fraction.
- "seconds in 10 minutes" points to 600.

The "blocks found" variable is the reason that this method yields an estimated hashrate. Bitcoin is designed so that finding a successful block is completely random. Due to this, miners could find blocks faster or slower than expected simply by chance.

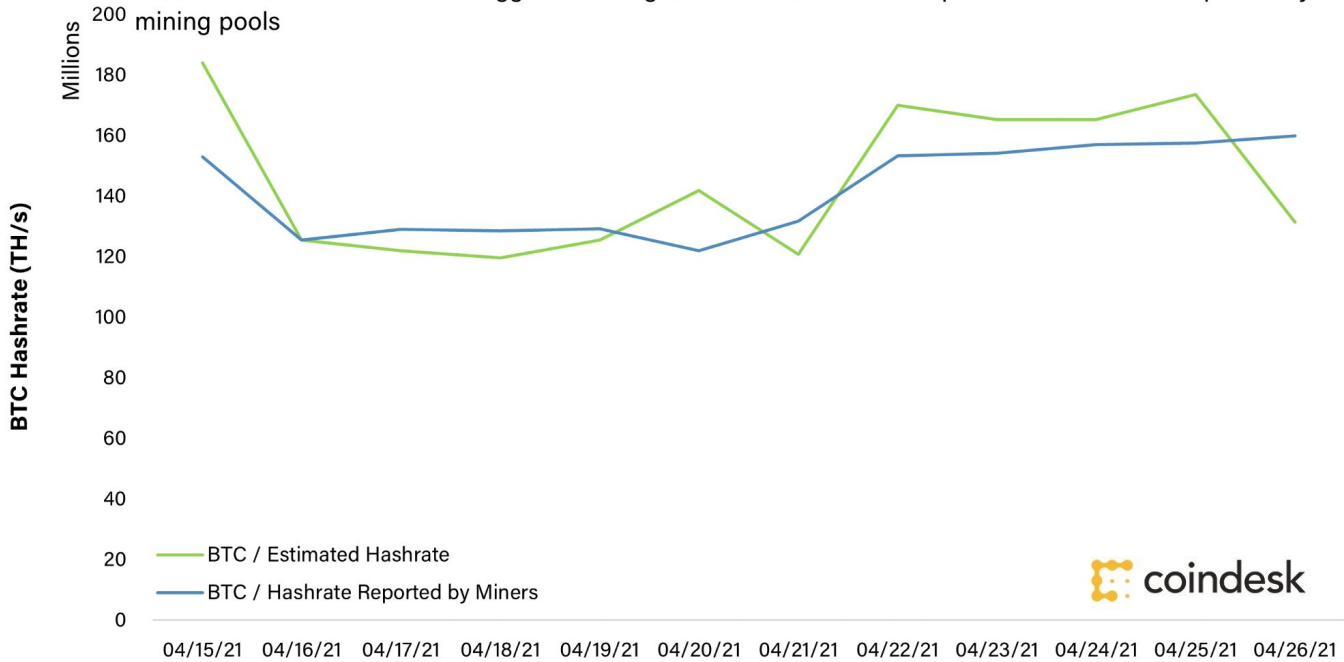
In addition to estimated hashrate, [mining pool hashrate](#) reporting can be helpful for spot checking hashrate changes during big exogenous events. For example, a 16 April 2021 [coal mine accident](#) in the Chinese province Xinjiang forced Bitcoin mining outages across the region due to blackouts. The actual hashrate drop was likely less drastic given what hashrate mining pools reported. Users, investors and miners could rest assured that hashrate had not dropped as precipitously as daily hashrate estimates suggested.

Hashrate is a lagging indicator for bitcoin. As the price of bitcoin increases or decreases, hashrate follows. In general, hashrate changes are less severe than price changes through market cycles. This likely occurs since, on the downswings, miners shut down fewer machines as they have invested in their equipment upfront and are willing to

operate at a loss in the short-term for the sake of long-term profitability. On the upswings, it takes additional time and capital to spin up new mining operations. By way of example, when Bitcoin's price plummeted 84% between December 2017 and December 2018, estimated hashrate fell 78%.

Bitcoin Estimated Hashrate vs. Hashrate Reported by Miners

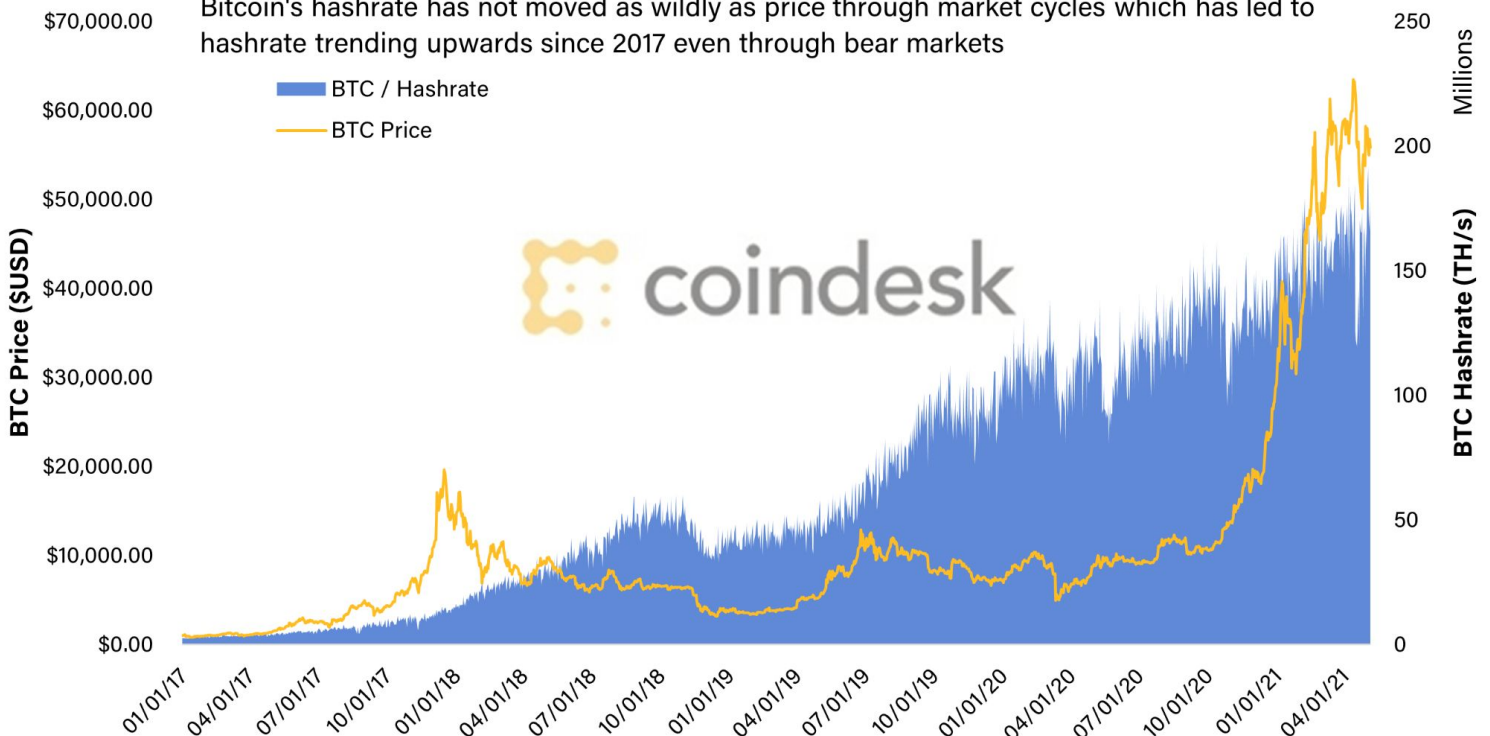
Estimated hashrate can overexaggerate changes in hashrate when compared to hashrate as reported by mining pools



Source: CoinDesk Indexes, <https://miningpoolstats.stream/bitcoin>

Bitcoin Hashrate and Bitcoin Price

Bitcoin's hashrate has not moved as wildly as price through market cycles which has led to hashrate trending upwards since 2017 even through bear markets



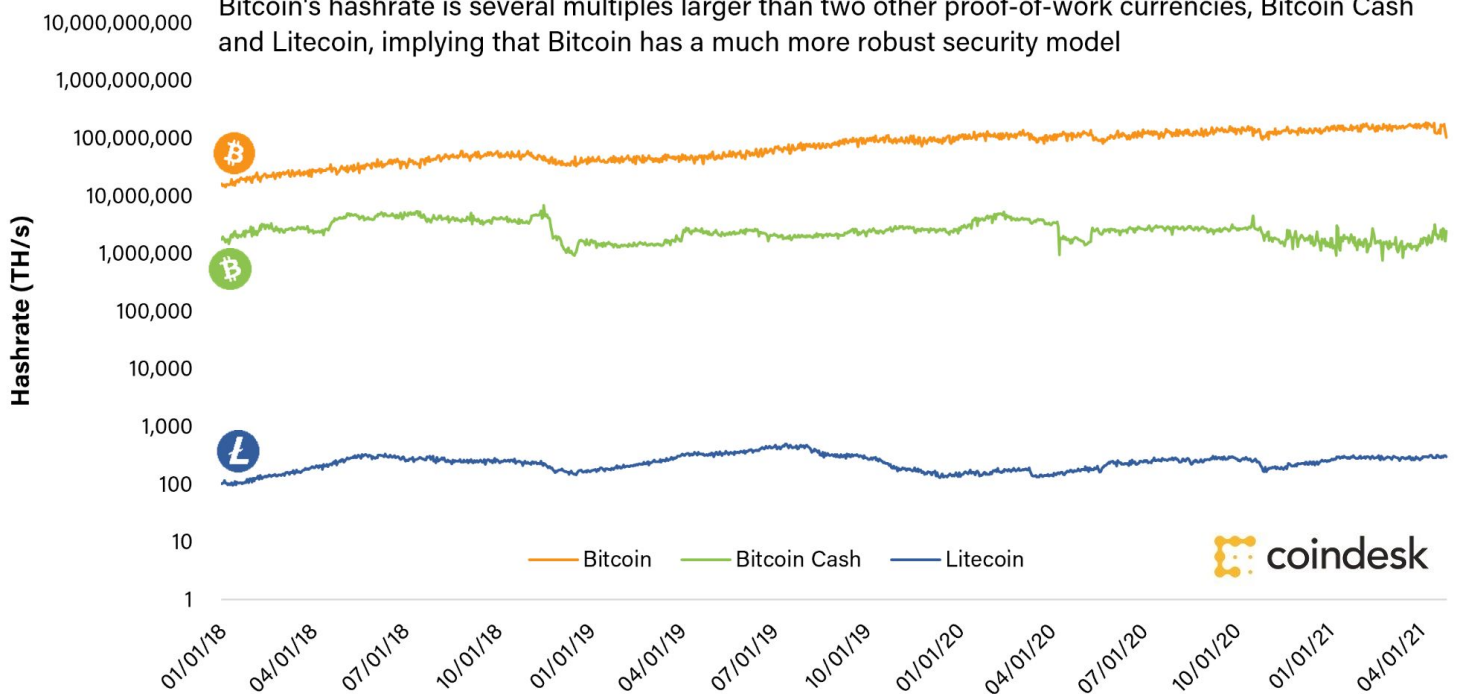
Source: CoinDesk Indexes

What we can do with hashrate is prove out a quick litmus test for network health. Absent any supply chain issues and chip shortages that might stifle onboarding of new miners, an investor should be wary if a large gain in Bitcoin price is not followed by a large gain in hashrate as it would signal deterioration of Bitcoin's security model.

When compared to other PoW-powered digital assets categorized as currencies, such as Litecoin and Bitcoin Cash, Bitcoin's hashrate dwarfs its competitors.

Hashrate Comparison of Digital Currencies

Bitcoin's hashrate is several multiples larger than two other proof-of-work currencies, Bitcoin Cash and Litecoin, implying that Bitcoin has a much more robust security model



Source: CoinDesk Indexes, Coin Metrics

Hashrate Ribbons

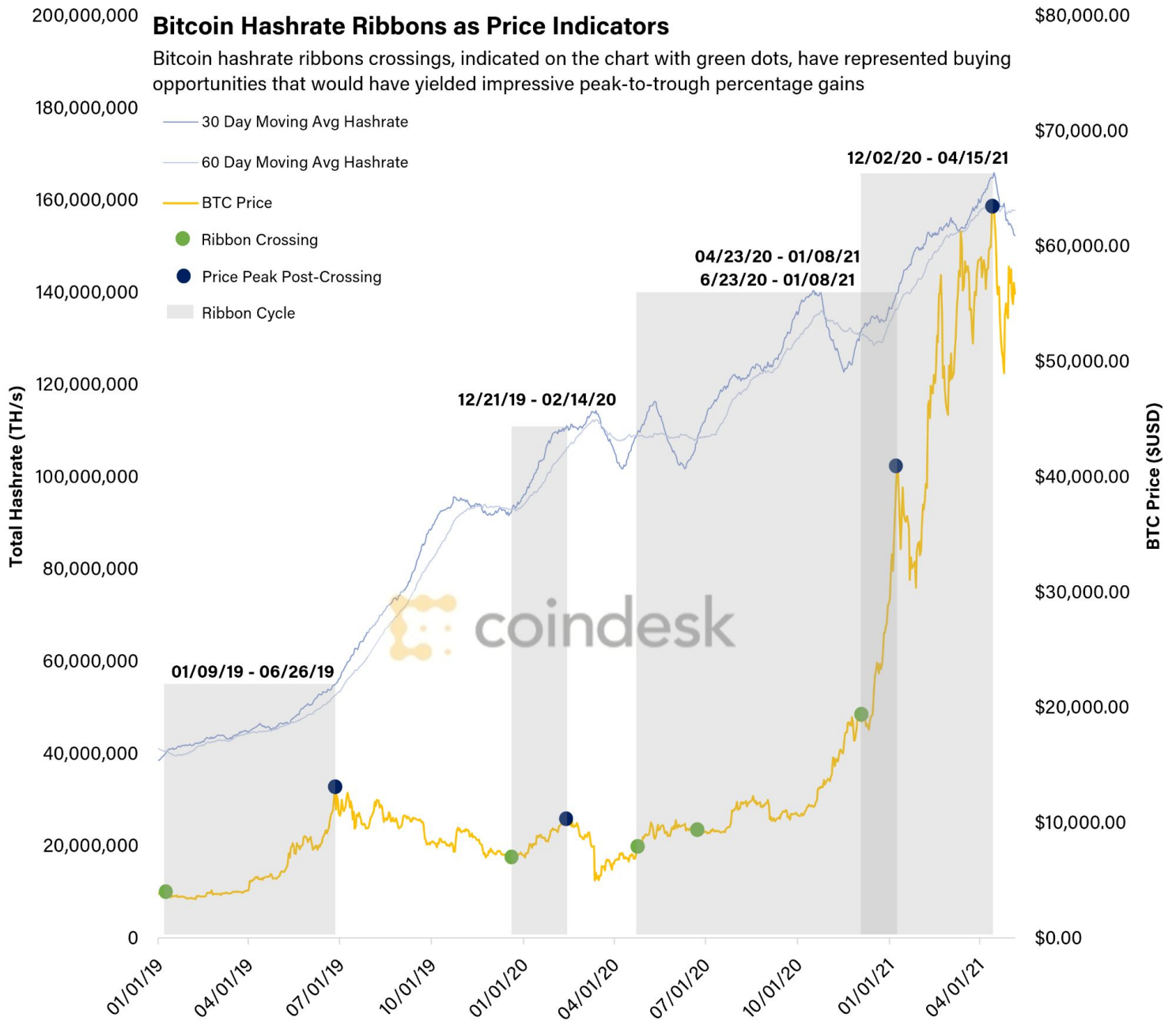
Analyzing changes in the moving averages of Bitcoin hashrate **can potentially** assist investors in identifying buying opportunities.

Miners either fund their operations through upfront fiat investment or by selling a portion of the bitcoin they mine. Stronger, more profitable miners are more resilient than weaker, less profitable miners. As the price of bitcoin increases, more weaker miners are able to mine profitably. When the price of bitcoin decreases, weaker miners exit the market as they are no longer economically viable. This is known as **miner capitulation**.

If we are able to pinpoint when miner capitulation ends, we can pinpoint potential buying opportunities. We can do this using **hashrate ribbons**. Hashrate ribbons are series of moving averages of different lengths that are plotted on the same chart to create an indicator that looks like a ribbon. We specifically look at the 30- and 60-day moving averages for hashrate in this note.

When bitcoin's price increases, the 30-day hashrate moving average exceeds the 60-day hashrate moving average. When bitcoin's price falls, the 60-day hashrate moving average will eventually exceed the 30-day hashrate moving average as hashrate decreases. When a market bottom is reached, the 30-day hashrate moving average will eventually cross over and exceed the 60-day hashrate moving average again. This crossover signals the end of miner capitulation and the beginning of a market recovery.

A useful mental model we can use to contextualize hashrate ribbons is to think of them like the yield curve. Just as the shape of the yield curve can be used to forecast turning points in economic cycles, so can crossing hashrate ribbons be used to forecast turning points in Bitcoin market cycles.



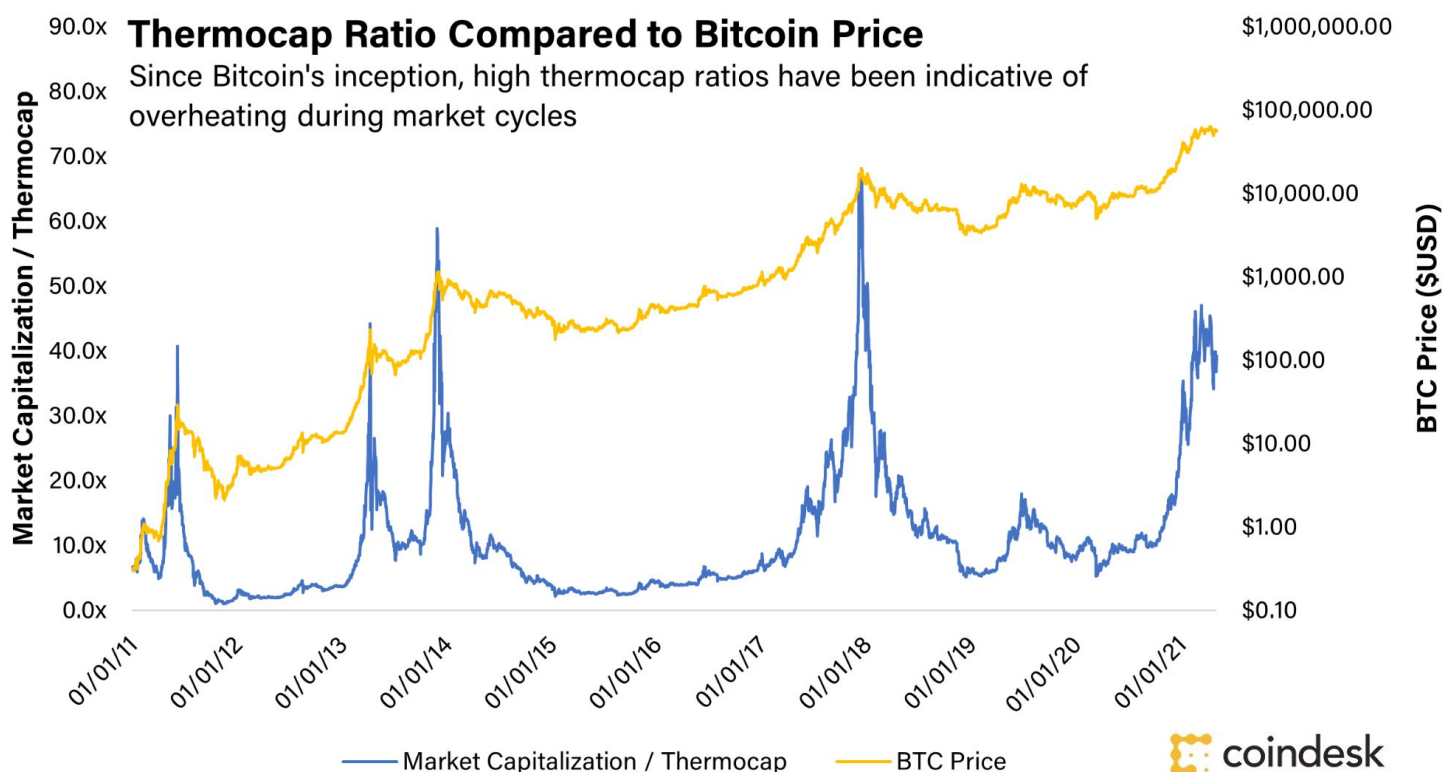
Source: CoinDesk Indexes, Coin Metrics

Thermocap Ratio

Thermocap is the cumulative sum of all mining income in fiat-denominated terms.

Since miners secure the network, thermocap can stand in as the amount miners are compensated to secure the Bitcoin blockchain. A decent parallel we can draw to a common economic metric is to think of thermocap as Bitcoin's accumulated GDP. Thermocap represents the total accumulated value generated by Bitcoin miners as they take in electricity and produce as output new bitcoins plus transaction fees, similar to how GDP represents the amount of output a country produces from its raw material inputs. It can be thought of as the organic value generated by the network over time.

If we then divide Bitcoin market capitalization by thermocap we calculate the **thermocap ratio**. Historically, a high thermocap ratio has signaled that bitcoin is near the top of a market cycle and a low thermocap ratio has signaled that bitcoin is near the bottom of a market cycle. At time of writing, the thermocap ratio is around 38.0x, compared to a peak of 68.1x on December 16, 2017.



Source: CoinDesk Indexes, Coin Metrics

Investors can use the thermocap ratio as empirical grounding to their sentiment of Bitcoin's relative value as **the ratio represents the premium the market is willing to pay at a point in time in excess of the "organic value," or the accumulated amount earned by miners to secure the network.**

That said, it is important that we take the thermocap ratio and compare it against the backdrop of what Bitcoin is doing beyond price performance. A higher thermocap ratio **could** be indicative of an overheated market. But, there could be a reason people are willing to pay more for bitcoin such as increased adoption or a new technological use case. An elevated thermocap ratio in those scenarios could be warranted and defensible.

CONCLUSION

When compared to traditional assets, digital assets are unique given the amount of information they reveal. Understanding that information is not straightforward and it takes time and creativity to become familiar with the methodologies that can be used to interpret that data.

In this note, we took a look at three miner-focused Bitcoin metrics that investors should pay attention to. These metrics are important, as miners maintain the network security and integrity. What's more, the techniques discussed can be extended to other PoW assets.

As we highlighted, blockchains certainly allow for transparency into what is happening. But understanding the value of that transparency requires analysis of off-chain metrics and real-world narratives.

Special thanks to [Ethan Vera](#) of [Luxor Technologies](#) for insight and corrections.

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