COINMETRICS

BITCOIN ON-CHAIN INDICATORS PRIMER

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THE COIN METRICS BITCOIN ON-CHAIN INDICATORS PRIMER

Bitcoin represented (among other things) a huge step forward in terms of financial data transparency. Since all transactions are publicly recorded on-chain, a whole new set of fundamental indicators is available to crypto investors.

We take a look at some of the most telling indicators and the insights that can be derived.

Disclaimer: *Market analysis with on-chain indicators is a relatively nascent field, and indicators are still being developed and refined. It's important to note that past success does not guarantee future success; although these indicators have historically been informative, it does not necessarily mean this will always be the case. The green and red indicator zones on each chart are based off of past performance, but are not an exact science. While they have indicated past market cycles, Bitcoin and cryptocurrency in general is still in its early days, and things can change quickly. This report does not constitute investment advice - please conduct your own research and view these metrics as one piece in the larger picture.*

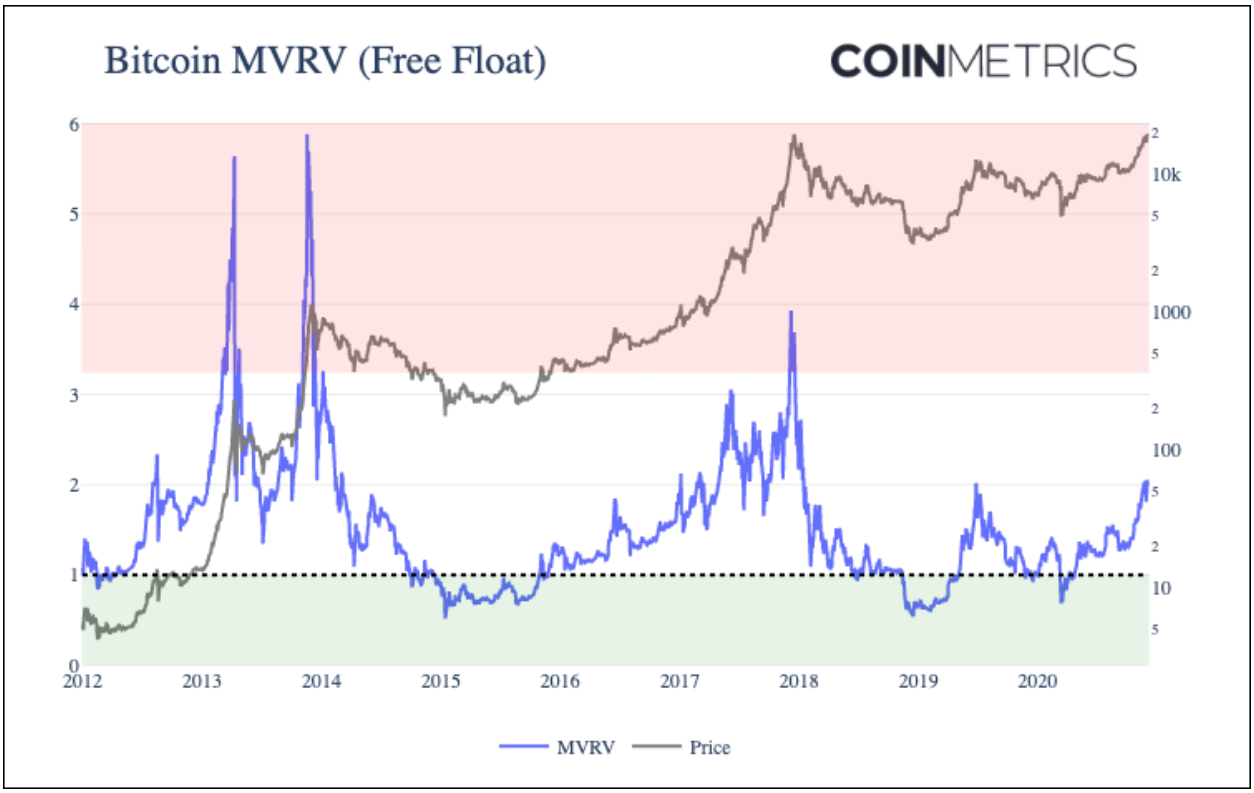
Bitcoin has created a new level of transparency and auditability previously unknown in financial and economic data. Since all Bitcoin transactions are recorded on a public ledger, we can analyze activity in a relatively comprehensive fashion. By creating metrics and analytics using data straight from the Bitcoin blockchain, we can gain novel insights into investors' behavior that are not possible with traditional, non-crypto assets.

There are a variety of different on-chain metrics that we can use to gauge bitcoin market cycles and signal when price is nearing local maximums and minimums. In this report, we go over five of bitcoin's most historically reliable on-chain indicators.

For each indicator we explain the metrics and calculations used to derive it. We also provide explanations for the mental models behind each of these indicators, and how to interpret the indicator's movements. Each indicator in the piece is based on prior outside research, which can be found in the "Further Reading" section at the end of the report.

MARKET VALUE TO REALIZED VALUE (MVRV)

Market value to realized value (MVRV) has historically been one of the most reliable on-chain indicators of bitcoin market tops and bottoms. MVRV is calculated by dividing bitcoin's market capitalization by its realized capitalization. In our variant of the MVRV calculation, we use free float market capitalization in place of the traditional version of market capitalization which is based on total on-chain supply. To understand MVRV it's important to first understand three key metrics: market capitalization, free float market capitalization, and realized capitalization.



Market Capitalization

Market capitalization (also often referred to as "market value" or "market cap") is the most commonly used metric for gauging bitcoin's total valuation and is often used to rank bitcoin against other cryptoassets. Market cap is derived from traditional finance where it is calculated by multiplying the total number of outstanding shares of a stock by its current market price - in crypto, this corresponds to multiplying an asset's total supply and market price.

In addition to reflecting bitcoin's total valuation, market capitalization can be thought of as the valuation of current market participants, and often swings wildly up and down as price and investor sentiment shift.

Free Float Market Capitalization

In the 1990s, traditional markets began to realize the importance of having a "free float" determination to account for the illiquid shares of certain equities. Crypto faces a similar problem, as bitcoin can be permanently lost. Additionally, some units of bitcoin have remained dormant and effectively out of circulation over the long-term, the most famous example being Satoshi's coins. Therefore market capitalization can grossly misrepresent a cryptoasset's underlying liquidity and capitalization by equally weighting units of supply that are effectively out of circulation.

Because of these deficiencies, we introduced free float supply to more accurately represent the supply of cryptoassets available to the market. Free float supply excludes units of supply that are provably lost or burned, in addition to tokens held by wallets that have been inactive for at least five years.

Free float market capitalization uses free float supply as an input instead of total supply, and is calculated by multiplying free float supply by current market price.

Realized Capitalization

Realized capitalization was introduced in 2018 and gives a more long-term, slow moving measure of bitcoin's total valuation. Realized capitalization is calculated by valuing each unit of bitcoin individually at the price that it was last transacted on-chain. Therefore it discounts the price of coins that were last moved during periods where price was relatively low.

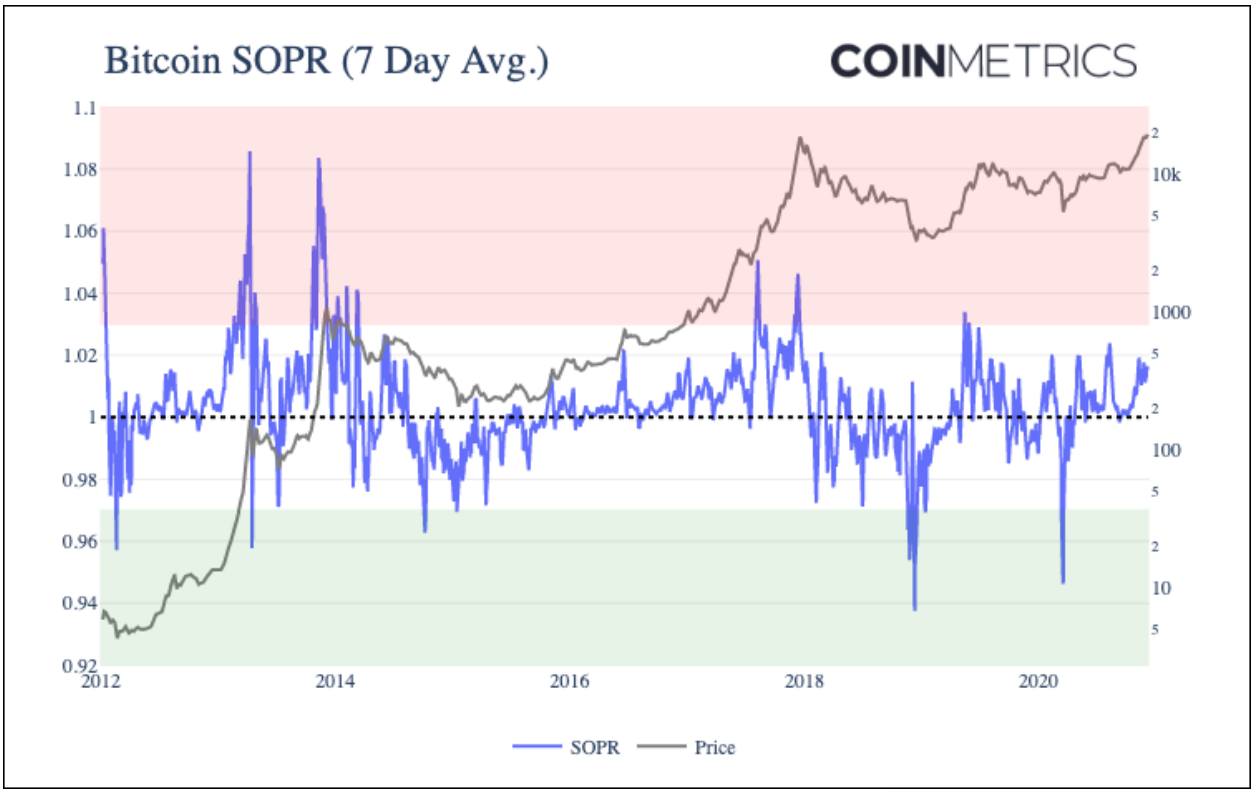
Realized capitalization can also be thought of as a gross approximation of bitcoin's aggregate cost basis, also sometimes referred to as its total "stored value." Theoretically, if each transaction was a trade, realized capitalization would reflect bitcoin's total cost basis, or in other words the total value stored in bitcoin in terms of U.S. dollars. In reality many bitcoin transactions are not trades, so realized capitalization is not a direct measure of bitcoin's total stored value. But it still gives an interesting approximation of long-term holders' sentiment.

Interpreting MVRV

Historically, a high ratio of market capitalization to realized capitalization has signalled that bitcoin price was near a local maximum, while a low ratio has indicated that price is near a local minimum. The few times that MVRV has dropped below one have historically been some of the best times to buy bitcoin. An increasing MVRV indicates that current sentiment is increasing fast relative to stored value, while decreasing MVRV signals the opposite.

SPENT OUTPUT PROFIT RATIO (SOPR)

Spent Output Profit Ratio (SOPR) gives another vantage point into bitcoin market cycles. Introduced by Renato Shirakashi in 2019, SOPR can act as a proxy for gauging whether holders are selling at a profit or at a loss.



Unspent Transaction Outputs (UTXOs)

Although we typically think of each bitcoin as a distinct unit, bitcoins are actually represented on-chain as discrete chunks known as unspent transaction outputs (UTXOs). UTXOs vary in size, and some are only tiny fractions of a single bitcoin while others are very large. Every time a bitcoin transaction occurs UTXOs are used as the transaction's input, and new UTXOs are created as an output.

To illustrate, if you have an address that holds "10 bitcoin", that bitcoin is likely composed of various different smaller chunks. For example, you may have received 5 bitcoin in one transaction, 3.5 in another transaction, and 1.5 in a third transaction. Although it appears as 10 bitcoin in your wallet, on-chain it is represented as three distinct units.

If you were then to transfer 9 bitcoin to a friend, those three chunks of bitcoin would be combined as inputs for your transaction. The output of the transaction is the 9 bitcoin that is sent to your friend's address. This is known as an "unspent transaction output" (UTXO) because your friend has not yet spent it (aka transferred it to another address). Another UTXO would be created for the remaining 1 bitcoin and sent back to the sender. While the 10 bitcoin was originally represented on-chain as three UTXOs of 5, 3.5, and 1.5 it's now represented as two UTXOs of 9 and 1.

Interpreting SOPR

SOPR is a ratio of bitcoin's price at the time UTXOs are spent to its price at the time they were created. In other words, it's a proxy for price sold divided by price paid.

Every time a transaction occurs, we can compare bitcoin's price at the time the UTXOs in that transaction were created to the price at which they were spent. Creating a ratio of the two gives a simple way to estimate whether the bitcoin in the UTXO was sold at a profit or loss. For example, if bitcoin's price when the UTXO was created was $5K and price at time spent was $10K, the ratio for the individual UTXO would be 2. If, instead, the price were $10K at the time the UTXO was created and $5K at the time it was spent, the ratio would be 0.5. In this sense, a ratio of over 1 indicates that the UTXO was sold to realize a profit, while a ratio of below 1 indicates it was sold at a loss.

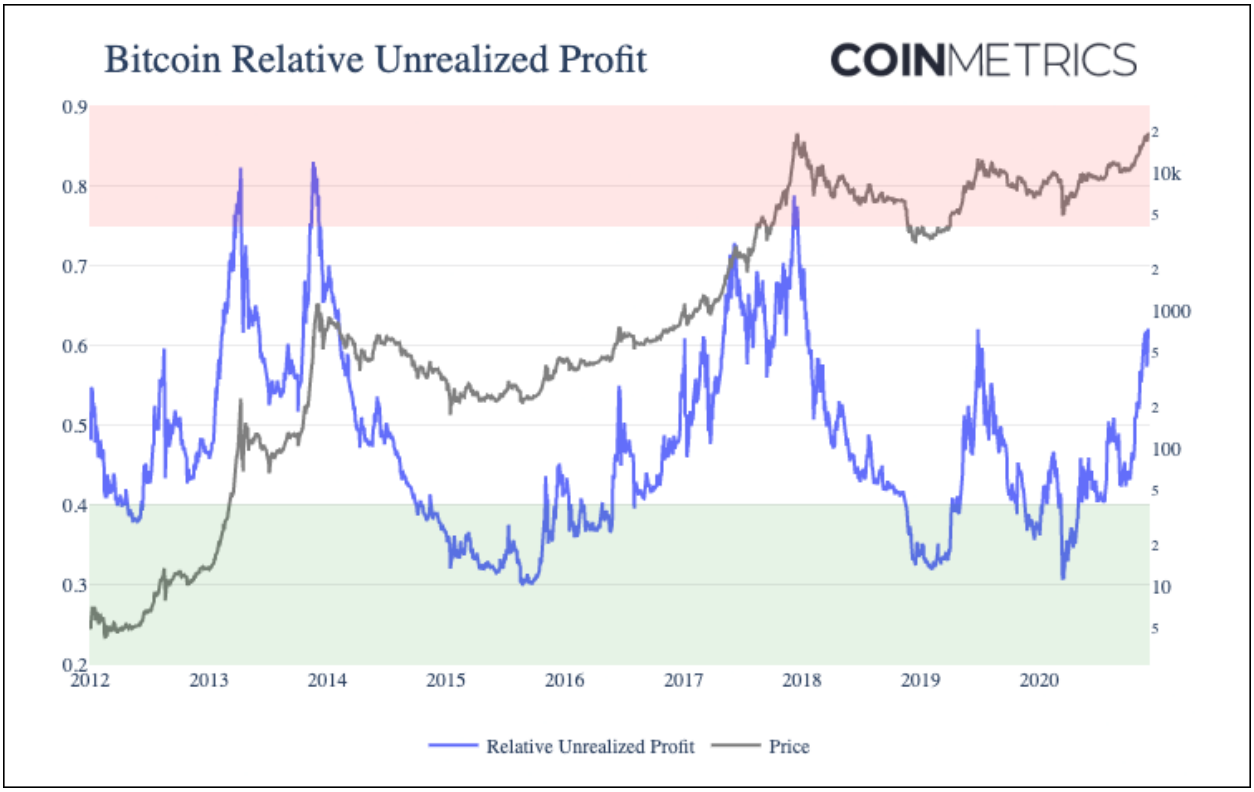
SOPR can be computed for individual UTXOs, but it can also be computed for a group of UTXOs. The above Bitcoin SOPR chart shows the combined SOPR ratio of all UTXOs spent, aggregated on a daily basis. The metric is also smoothed with a 7-day rolling average as SOPR tends to be relatively volatile.

Similarly to MVRV, though, it's important to note that SOPR is an approximation and not an exact measure of profitable transactions. Not every bitcoin transaction is a trade, which means that not every transaction represents selling in or out of profit.

Theoretically, a high SOPR signals that a relatively high amount of bitcoin is being sold for a profit. Historically, a high SOPR has signalled that bitcoin price is reaching a local maximum, and that a decline is coming. Conversely, a low SOPR theoretically signals that holders are selling at a loss, which has historically indicated a good time to buy. A SOPR of 1 is also particularly important to watch, as it signals the tipping point from selling in profit to selling at a loss.

RELATIVE UNREALIZED PROFIT

Relative unrealized profit also uses UTXOs to give information about the amount of unrealized profit of all bitcoin holders compared to bitcoin's total value. Relative unrealized profit is calculated by dividing the total "gross unrealized profit" of bitcoin UTXOs (in USD) by bitcoin's market cap. This version of relative unrealized profit is adapted from the relative unrealized profit/loss ratio, which is typically calculated using market capitalization and realized capitalization.



Gross Unrealized UTXO Profit

Bitcoin's gross unrealized profit is the total amount of profit that could be made if each holder sold their coins at current market prices. For example, if bitcoin's total supply was 18M and every single bitcoin was last bought for $1,000 (which would never happen, but makes for a simple example) and bitcoin's current market price was $10,000, the current total unrealized profit would be $162B ($180B - $18B).

In reality, different units of bitcoin supply are bought at vastly different prices. So to get a proxy for bitcoin's total unrealized profit we use a metric called "gross unrealized UTXO profit." Similarly to SOPR, gross unrealized UTXO profit estimates bitcoin's unrealized profit on a UTXO by UTXO basis.

Gross unrealized UTXO profit is calculated by first pricing each UTXO by bitcoin's price on the day that the UTXO was created. So if a UTXO was created when bitcoin's price was $5K, that individual UTXO would be priced at $5K. Each UTXO's creation price is then subtracted from the current market price, to determine each individual UTXO's profit (or loss) if it was to be sold at current market prices. All UTXOs that are in profit are summed up to get the gross bitcoin UTXO unrealized profit. Lastly, dividing gross unrealized UTXO profit by market cap gives the percent of bitcoin's market cap that represents potential profit.

Of course, there are typically some units of bitcoin that were bought when prices were higher than current price, and therefore represent a potential loss. However, gross unrealized profit excludes UTXOs that are being held at a loss, and only focuses on the potential profit that is being left on the table.

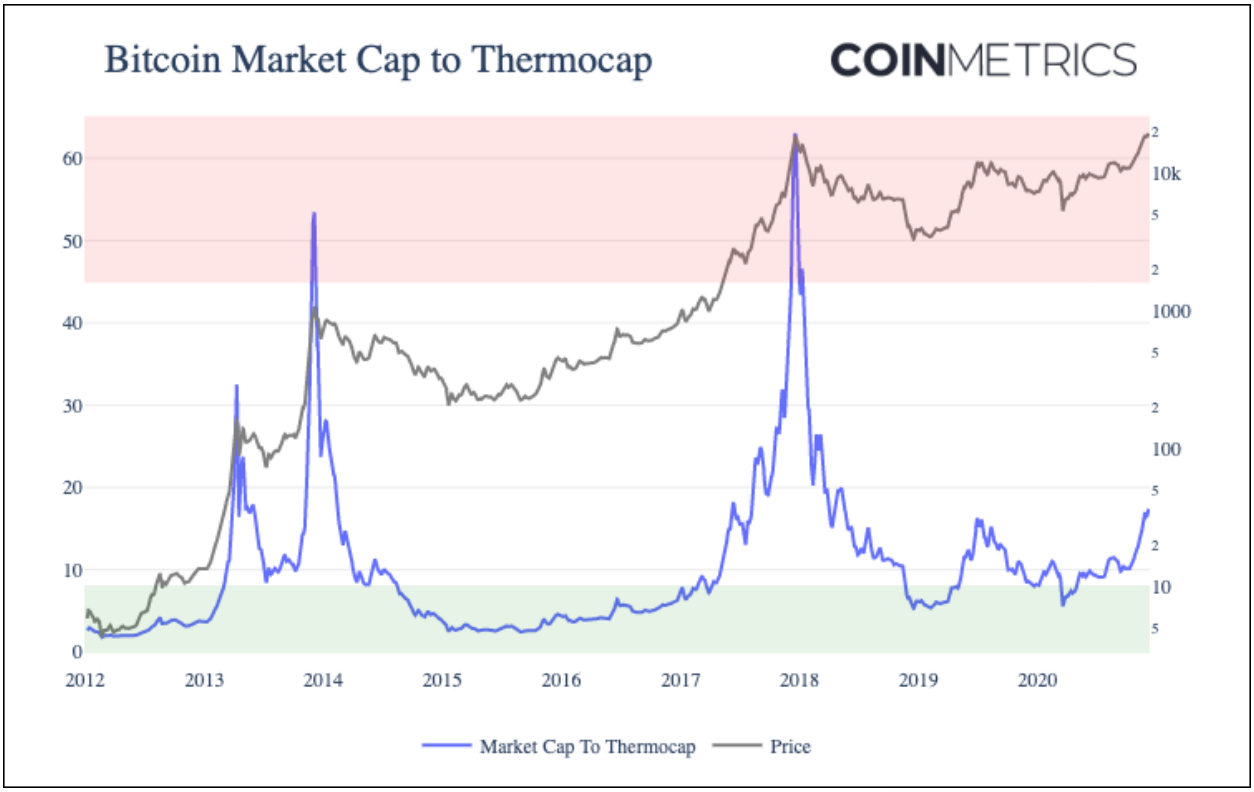
Interpreting Relative Unrealized Profit

A high relative unrealized profit has historically signalled that a market correction and local price maximum is near. A low relative unrealized profit signals that price is reaching a floor. A relative unrealized profit of under 40% has typically indicated a good time to buy. Historically, bitcoin price appears to have reached cycle lows at a relative unrealized profit levels of about 30%.

This can also be thought of as a type of a fear and greed index. A high relative unrealized profit may correspond to a high level of greed as investors sit on growing profit, which can indicate overvaluation. A low unrealized profit may correspond to fear as investors grow increasingly underwater, which can indicate undervaluation.

MARKET CAP TO THERMOCAP

The market cap to thermocap ratio is another on-chain indicator involving a ratio of bitcoin valuation metrics, similar to MVRV. The market cap to thermocap ratio is calculated by dividing bitcoin's market cap by its all-time miner revenue in USD, also known as its "thermocap."



Miner Revenue

Each time a miner successfully mines a block they are rewarded with newly issued bitcoin, commonly referred to as the block subsidy. Miners also earn the transaction fees for all of the transactions included in the block. Together, block subsidies and transaction fees make up miners' revenue. Bitcoin's all-time, cumulative miner revenue is often called its "thermocap," and is calculated simply by taking the running sum of daily miner revenue in USD.

Bitcoin mining has historically performed like it's a commodity industry. It can be relatively high margin for those who have streamlined, efficient operations, but it is highly competitive and can be relatively low margin (or unprofitable) for smaller entities. Miners have ongoing costs including

hardware (i.e. mining rigs), electricity, and rent. To cover costs and remain in business, miners need to constantly sell a portion of the bitcoin that they earn as revenue.

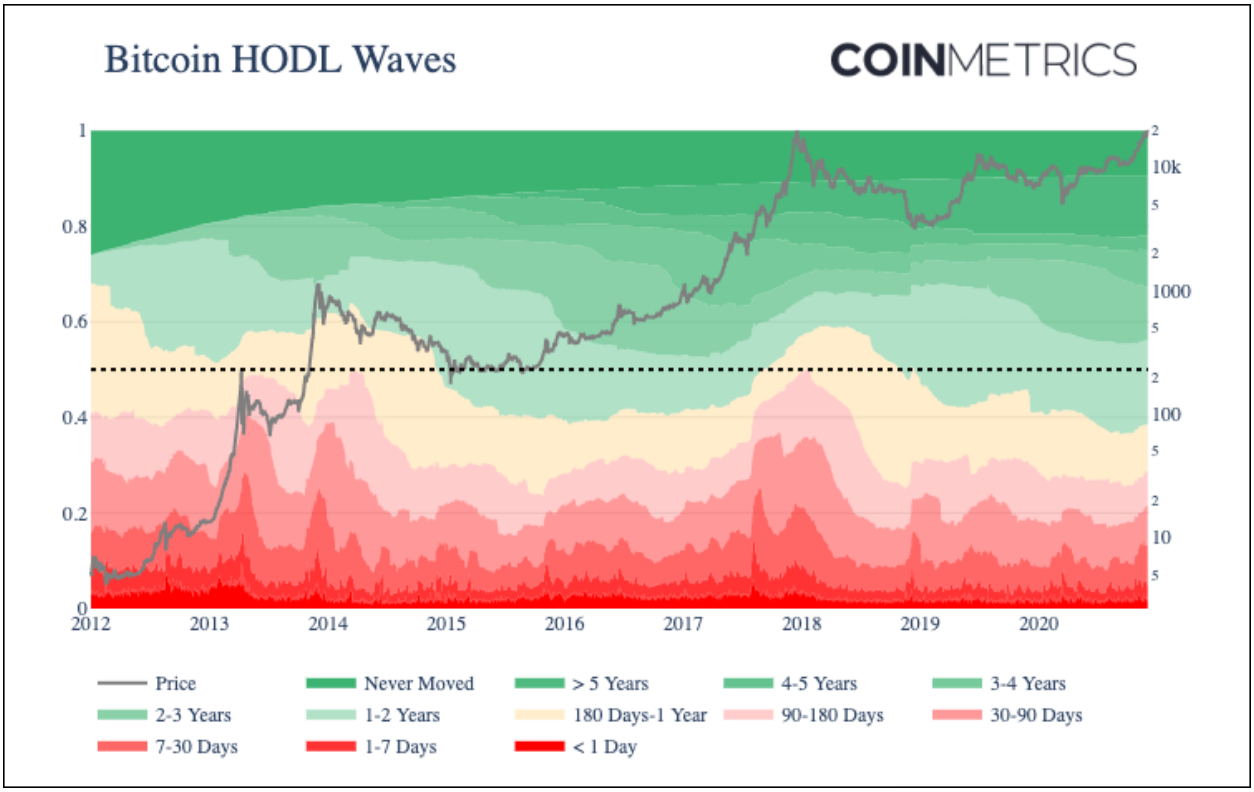
Bitcoin's total miner-revenue can therefore be thought of as an approximation of the optimistic upper bound of the total amount that miners have spent on securing the Bitcoin network. Because of this, thermocap is sometimes referred to as bitcoin's "aggregate security spend." The term "thermocap" derives from the idea that it's an approximation of the amount spent on energy for the mining rigs needed to secure the network. Market cap to thermocap can be thought of as an indicator of bitcoin's current market value compared to the aggregate amount spent to secure the network.

Interpreting Market Cap To Thermocap

A high market cap compared to total aggregate security spend has typically been an indicator that bitcoin is relatively overpriced. Similarly to realized cap, thermocap is relatively slow moving, and does not suffer from the same sort of volatility as market cap. Historically, a high market cap to thermocap ratio has signalled that bitcoin is near the top of a market cycle. Conversely, a low market cap to thermocap ratio has historically signalled a relatively good time to buy.

HODL WAVES

Bitcoin (BTC) age distribution bands, also known as "HODL waves," show BTC's supply grouped by the time since it was last moved on-chain. Introduced by Unchained Capital in 2018, HODL waves give a macro view of how BTC's supply has shifted over the years. Bitcoin's supply movements can be used as an indicator for market cycles.



Active Supply

Each unit of bitcoin supply can be classified by the time at which it was last active. We consider a unit of supply to be "active" if it was transferred on-chain as part of a transaction. For example, some bitcoin has been transferred from one address to another within the last seven days (i.e. active within the last seven days), while other UTXOs of bitcoin have sat dormant in a wallet for over five years.

Taking this idea one step further, supply can be organized into bands based on their last on-chain activity. For example, we can look at the total amount of bitcoin that moved within the last 1-7 days, bitcoin that moved within the last 7-30 days, bitcoin that moved within the last 30-90 days, and so on.

These active supply bands form the foundation of HODL waves. By dividing the amount of bitcoin in each active supply band by bitcoin's current supply, we end up with the percent of supply that has moved within that period of days. Doing this for all of bitcoin's supply gives a high-level overview of trends in supply movements. Or in other words, it shows the percent of bitcoin supply that has been held (aka HODLed) for different periods of time.

Interpreting HODL Waves

Reading from the bottom of the chart up, the red colored bands show the percent of supply that has been active relatively recently, ranging from less than a day to 90-180 days. The "1-7 Days" band is the percent of total supply that's been held for at least 1 day but less than 7 days, "7-30 Days" is the percent of supply that's been held for at least 7 days but less than 30 days, and so on.

Historically, short-term supply movement has peaked during market cycle tops. For example, in December 2017, over 32% of BTC supply had moved on-chain within the previous 90 days as the price of bitcoin neared $20,000. By August 2018, the proportion of supply moved within 90 days had dropped to about 15%.

Conversely, reading from the top of the chart down shows the supply that has not moved for relatively long periods. These long-term bands tend to grow wider as prices reach cycle lows and contract during cycle tops as long-terms holders begin to sell. The dark green band at the top represents coins that have never been moved on-chain apart from the transaction in which they were issued, constituting about 12% of the total supply.

During the 2013 and 2017 bull runs, the percent of short-term held supply (held for 180 days or less) reached about 50% which coincided with market tops. Periods where long-term held supply has reached over 60% have typically been good times to buy.

FURTHER READING

As noted in the introduction, on-chain indicators are continually evolving. Please conduct your own research and always consider on-chain indicators within the larger context of cryptoasset markets.

You can explore some of the data used in this piece using our free community charting tool. For access to all of the data in this piece, check out Coin Metrics Network Data Pro.

For more on the prior research that led to these indicators see the articles listed below:

- Introducing Realized Capitalization
- Bitcoin Market-Value-to-Realized-Value (MVRV) Ratio
- Introducing SOPR: Spent Outputs to Predict Bitcoin Lows and Tops
- A Primer on Bitcoin Investor Sentiment and Changes in Saving Behavior (Introducing Unrealized Profit/Loss Ratio)
- The Puell Multiple
- Bitcoin Data Science Part 1: HODL Waves

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