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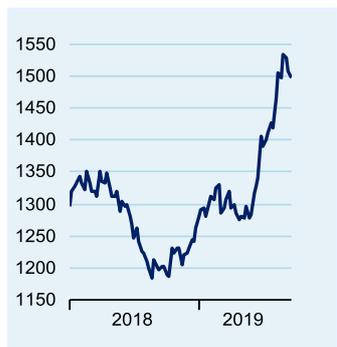
# Megatrend Digitalisation

Is Bitcoin outshining gold?

## Clear &amp; concise

- The stock-to-flow approach originating in commodity-market analysis serves to quantify the “hardness” of an asset. Applied to Bitcoin, an unusually strong correlation emerges between the market value of this cryptocurrency and the ratio between existing stockpiles of Bitcoin (“stock”) and new supply (“flow”).
- When it comes to making forecasts on the basis of this model, however, we would counsel caution. For even the best statistical model can fail miserably when seeking to predict the future. A major challenge for the stock-to-flow model is the next Bitcoin halving (50% reduction in supply growth) which is due to take place next year.
- Nevertheless, the stock-to-flow approach is a good heuristic for understanding Bitcoin. It becomes clear that Bitcoin is designed as an ultra-hard type of money. Next year, it will already exhibit a similarly high degree of hardness as gold. In 2024 (when halving is set to take place again), Bitcoin’s degree of hardness will again increase massively.
- Whereas gold has had to earn its high stock-to-flow ratio “the hard way“ over the course of millennia, Bitcoin’s purely digital character enables “supply engineering,” which causes the stock-to-flow ratio to rise at a breakneck pace.

Gold is very much in demand  
Weekly figures, US dollars per ounce



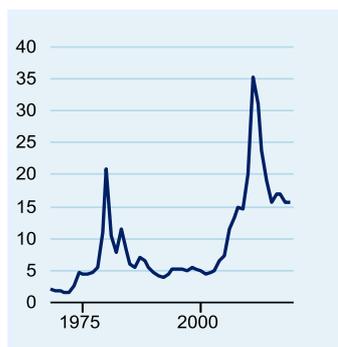
Sources: Refinitiv, BayernLB Research

Right around the globe, further extensive loosening measures are to be expected from central banks, and ever greater swathes of the bond universe (currently nearly USD 15 trillion) have yields in negative territory. Not very surprisingly, this is giving a lift to the oldest store of value in the history of mankind: in early September, the gold price (albeit only temporarily, as yet) broke out above the USD 1,550 mark (cf. left-hand chart). As is well known, gold’s appeal is that the supply side cannot be increased indiscriminately and, in addition, that the limited annual production of fresh gold (“flow”) only adds incrementally to an already very substantial stockpile (“stock“). Accordingly, the yellow metal has a high stock-to-flow ratio, a metric which can be regarded as quantifying the “hardness” of a given asset. As a result, gold is not in any danger of falling into the so-called “easy money trap”, where a price increase leads to significantly higher production, which, in turn, dilutes the existing stock to such an extent that a downward price spiral is initiated.

## Box 1: The Silver Trap

The Hunt Brothers fell into the “easy money trap” around 1980. They attempted to remonetarise silver, hoping that, by buying up the metal, they could push the price up far enough for it to once again be used as a monetary commodity. Initially, this plan worked out, and speculators significantly reinforced the upward price movement. However, production then adjusted to the new price, and the distinctly higher level of supply caused silver quotations to plunge again (cf. left-hand chart).

Historical price of silver  
Annual averages, US dollars per ounce



Sources: Refinitiv, BayernLB Research

The stock-to-flow ratio also serves as a quality criterion for monetary commodities. Historically speaking, it has invariably been the commodity with the highest stock-to-flow ratio at that juncture which has been used as money because this enabled the best value transfer over time. On this score, it is not the limited stock of an asset which plays the dominant role but rather the ratio of stockpiles to current “production.” In absolute terms, the stock of palladium, for example, is far smaller than the stockpile of gold (only 5% as high). However, this does not make palladium a harder asset because new production of palladium (“flow”) is high in relative terms and, in the event of a price hike, could easily dilute the metal’s stockpile (“easy money trap”). Many precious metals which are above all used as industrial metals, such as palladium, display low stock-to-flow ratios, i.e. yearly production roughly corresponds to the initial stock at the beginning of each year.

At this point, it also becomes clear that it is advantageous for a monetary commodity if it has few other uses except as money (means of exchange and store of value). Only in that way can a large stock pile up and be maintained over time.

## The stock-to-flow approach has made inroads into economic analysis of Bitcoin

- The stock-to-flow approach as a model with which to analyse Bitcoin

After the publication of the book by Saifedean Ammous (“The Bitcoin Standard”) the stock-to-flow approach - which had its origins in commodity-market analysis - has begun to be used as a tool to analyse Bitcoin. This is in line with the basic idea behind Bitcoin, which was explicitly designed as a new monetary good and geared to precious metal forms of money. Accordingly, new bitcoins cannot be mined indiscriminately. At the same time, Bitcoin is purely digital and is therefore frequently referred to as “digital gold.”

The stock-to-flow approach provides a simple quantitative framework for analysing the (price) trend followed by Bitcoin: it is a metric which has a high explanatory power and makes Bitcoin comparable to gold and its closer cousins. In particular, extrapolating Bitcoin’s stock-to-flow ratio into the future generates interesting insights: the inference to be drawn is that Bitcoin will already have a similarly high stock-to-flow ratio as gold in the coming year. How is this possible?

### “Unfair“ supply engineering in the case of Bitcoin

- Satoshi could determine Bitcoin’s degree of hardness at will

Given that Bitcoin is digital, the supply path could be determined at will at the beginning of the protocol. One could indeed say that the pseudonymous Satoshi “cheated” in his white paper because he specified such a drastic and abrupt decline in supply growth (set to halve every 4 years) that no physical element from the periodic system could possibly keep pace with it. Satoshi’s “stroke of genius” was to decouple supply from price and from mining efforts (in Bitcoin’s case: computing power). It is worth noting that this “difficulty adjustment” was absent in the case of all Bitcoin’s predecessors, e.g. Bit Gold. New bitcoins are generated (on average) every 10 minutes (the current figure is still 12.5). When the price rises (falls) and more (less) computing power enters the system, the difficulty of mining new bitcoins will correspondingly ratchet up (down). This safeguards the targeted bitcoin circulation irrespective of price fluctuations. A further special feature of bitcoin tokens, which is likewise due to their digital character, is that they cannot be hung around people’s necks (in contrast, for example, to a gold necklace) or used as an input in production. What would appear, at first glance, to be a disadvantage is, in fact, a feature and not a bug from the point of view of the stock-to-flow approach. Given that there are no other uses at all for bitcoins, no other demand-side developments (e.g. demand for gold in connection with the spread of smartphones) can distort price formation. Due to the deterministic trend in supply, there are naturally no supply-side shocks either (cf. Box 2).

#### Box 2: The Canadian Gold Rush

Starting in 1896, a total of around 100,000 gold prospectors descended on the Klondike River near Dawson City. Motivated by a striving for material gain but also by the high unemployment in the USA, many adventurers set out for north western Canada. The gold rush lasted until 1899 and enlarged the supply of gold on the world market sufficiently to ensure a temporary decline in the gold price.

- By contrast, gold’s high stock-to-flow ratio has been hard-won

Gold has had to earn its high stock-to-flow ratio “the hard way” over the course of millennia. Moreover, there have been no shortcuts for the yellow metal: a higher stockpile could only have accumulated in a shorter space of time if it had been easier to mine gold. In that case, however, gold would not have qualified as a store of value and, in turn, nobody would have held the yellow metal. Only thanks to the high production costs, ample time, and presumably a first-mover advantage (natural gold deposits existed, meaning that the metal was available as a monetary commodity at a very early date) did gold manage to elevate itself into the sole global monetary standard for roughly 30 years, from the mid-1880s until the beginning of the First World War.

Due to the “supply engineering”, Bitcoin will probably already succeed in attaining a stock-to-flow ratio similarly high to that of gold in the coming year - i.e. within the space of just 11 years. The supply profile determined by Satoshi is guaranteed by a global peer-to-peer network and by the centripetal forces at work within such a network: it is as good as impossible to get the whole network to shift to a new supply profile (i.e. software protocol), especially since the incentives of individual node operators would run counter to an inflationary profile (such a profile would dilute the value of their bitcoins).

**There is a strong correlation between Bitcoin’s market value and stock-to-flow ratio**

- ▶ Data on the size of the aggregate stock of Bitcoins is easy to gather

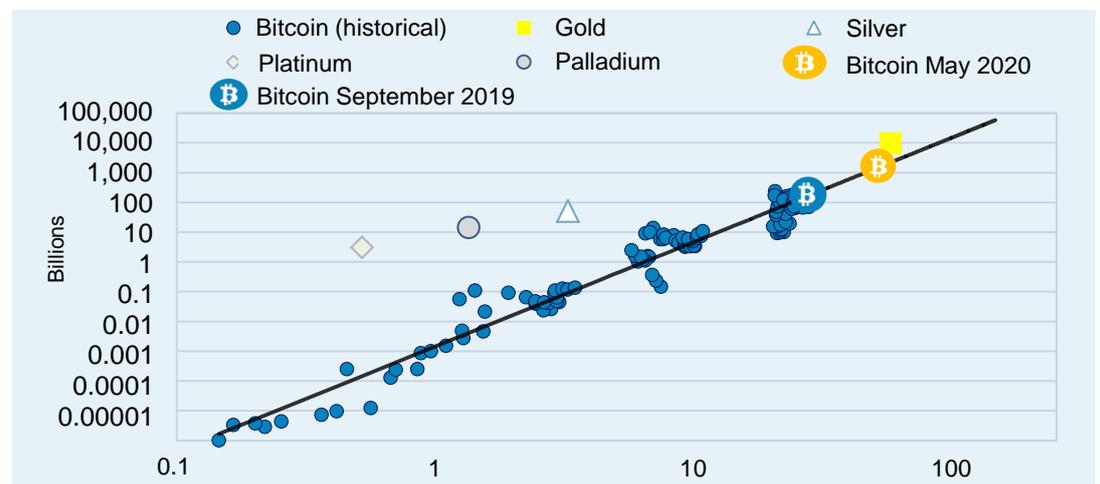
In order to demonstrate that Bitcoin’s market value can be explained by a stock-to-flow model, we have estimated this relationship econometrically (see the original article “Modeling Bitcoin’s Value with Scarcity” by @100trillionUSD, [link](#)). The data on the size of the aggregate stock and on additional supply is provided by the Bitcoin blockchain itself (it is, after all, a public database). In this context, it is sufficient to find out the number of blocks because the number of bitcoins per block is known. In addition, we required price data for the independent variable in our analysis (market value). This data has likewise been available since the establishment of Bitcoin exchanges in mid-2010.

- ▶ Collecting data on raw materials is a rather more complicated affair

In order to validate the plausibility of the estimates we arrived at, we additionally plotted the market capitalisations and stock-to-flow ratios of gold, silver, platinum and palladium. Our sources here were the standard publications reporting stocks and production volumes. The special problem confronting us here was to decide what is the appropriate production figure for each commodity. So as to keep the data-collection process simple, we only regarded mining output as production, i.e. the process which propels the raw material to above ground-level or, in other words, which adds a new commodity to the economic circuit.

Bitcoin is hard on gold’s heels

Logarithmic scales, x-axis: stock to-flow ratios, y-axis: market capitalisation in US dollars



Sources: BayernLB Research, bitcoinblockhalf.com (Bitcoin), Gold.org (gold), platinuminvest.com (platinum), Statista.com (palladium), bullionbypost.co.uk (silver), Refinitiv

One problem encountered when collecting stock data involves “lost coins” (or, to be more precise, lost private keys), because nobody knows how many have vanished. In our calculations, we have assumed one million (i.e. the 1 million bitcoins allegedly owned and not drawn on by Satoshi himself). The same uncertainty does, of course, exist about precise stock levels in the case of precious metals.

A linear regression of the (logarithmised) data generates the correlation which can be seen in the chart above left: Bitcoin’s market value increases in a linear fashion as the stock-to-

flow ratio rises. Or to put the point differently: the harder Bitcoin is, the greater the value attributed to it. The (blue) points lying close to the regression line already show that the correlation is very close. Test statistics confirm this as well. For all those interested in econometrics, it is worth pointing out that this is not a “spurious regression” in which the test statistics are unreliable because the variables are cointegrated meaning they share a common stochastic trend. To invoke the famous explanation of cointegration using the example of the drunk and her dog (see “A Drunk and Her Dog: An Illustration of Cointegration and Error Correction” by Michael Peter Murray, [link](#)), a simple way of putting it is that the stock-to-flow ratio is the road on which a drunkard (Bitcoin’s market value) staggers around without ever crashing out through the road barriers (see “Falsifying Stock-to-Flow As a Model of Bitcoin Value” by @phraudsta for this analogy and an extensive cointegration test documentation, [link](#) and “Reviewing ‘Modelling Bitcoin’s Value with Scarcity’ – Part II: The hunt for cointegration” by @BurgerCryptoAM for another cointegration test documentation, [link](#)).

If one takes a closer look at the chart, it is striking that platinum, palladium and silver are all lying clearly above the regression line. This suggests that their market value is primarily - or, at least strongly - based on their utility value (as industrial metals) and that they command only low monetary premiums. By contrast, gold is to be found pretty close to the regression line, which is only logical: in the case of the yellow metal, it is exactly the other way round - it is in heavy demand as a store of value but subject to little industrial demand.

- ▶ Bitcoin is poised to take a big leap forward in 2020

The most intriguing question, of course, is what the future will bring. What is certain is that Bitcoin’s stock-to-flow ratio will increase drastically in May 2020 - i.e. after the next halving - from around 25.8 at the moment to almost 53. By contrast, gold’s stock-to-flow ratio (currently in the vicinity of 58) will only be insignificantly (if at all) higher next May. If the May 2020 stock-to-flow ratio for Bitcoin is factored into the model, a vertiginous price of around USD 90,000 emerges. This would imply that the forthcoming halving effect has hardly been priced into the current Bitcoin price of approximately USD 8,000 (the current model value is roughly USD 7,500).

### Conclusion: Bitcoin was conceived to be an even harder asset than gold

- ▶ The model is going to have to face a major acid test in the coming year

As a forecaster, one knows only too well that even the best statistical model can fail miserably when attempting to predict the future. Undoubtedly the biggest acid test for the stock-to-flow model will be next year’s halving. In the meantime, the stock-to-flow approach will serve, at any rate, as a good heuristic for understanding Bitcoin. It becomes clear that Bitcoin has been conceived as an ultra-hard type of money. In 2024 (when the next halving is due to take place), its degree of hardness will inexorably increase even further, to a level unprecedented in human history (a stock-to-flow ratio of more than 100!). Nobody really knows what repercussions such a monetary standard would have. Only one thing is clear: if Bitcoin is indeed to become the money of the 21st century, it will be because its properties (above all its high degree of hardness) have been preferred to those of alternative types of money - after all Bitcoin is a completely open monetary system operating on a purely voluntary basis.

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## Imprint

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