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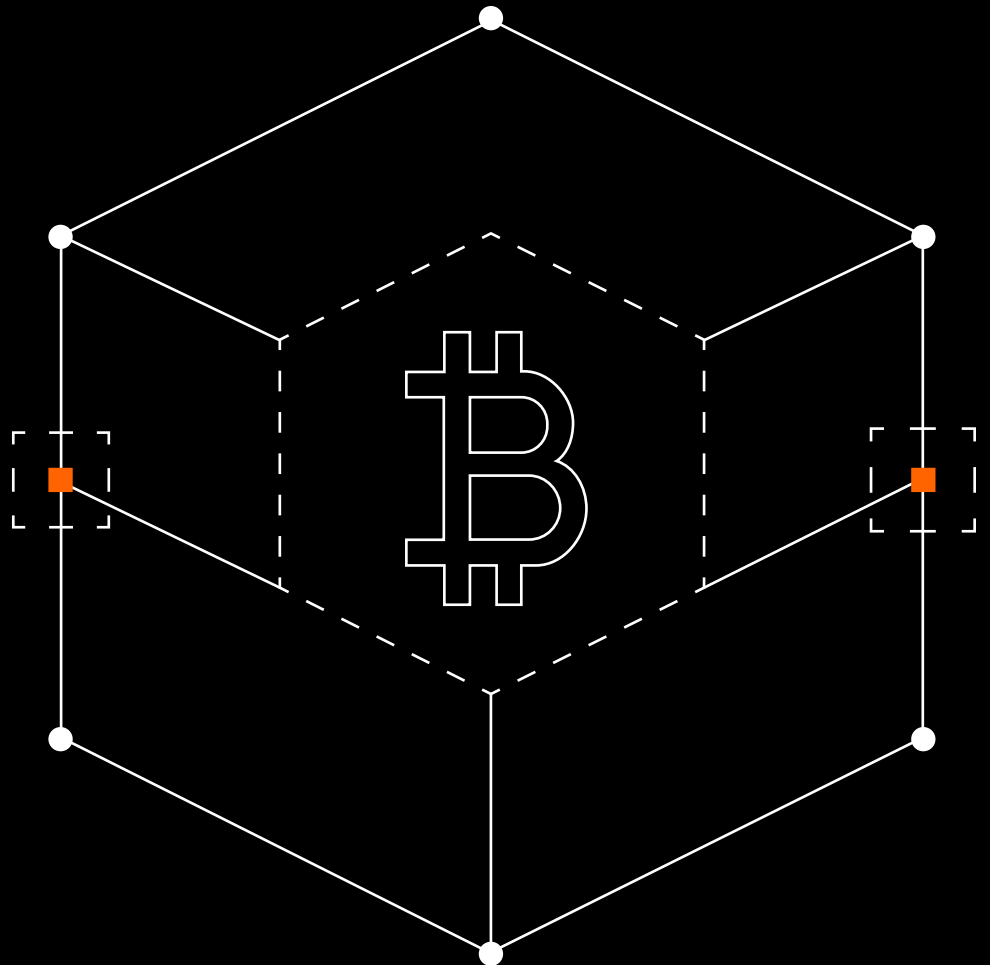
Galaxy Research

Bitcoin Halving
Digital Scarcity in Action

Author & Acknowledgements

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Bitcoin Halving Overview

The transparency and predictability of Bitcoin's issuance is a key characteristic that separates the asset from any other asset or currency in the world. No other asset has a calculable inflation schedule with a foreknown supply event that reduces the daily issuance by 50% overnight. Satoshi Nakamoto, the pseudonymous creator of Bitcoin, programmed the halving feature in Bitcoin as a countermeasure to the continuous debasement of fiat currencies.

> *"The root problem with conventional currency is all the trust that's required to make it work. The central bank must be trusted not to debase the currency, but the history of fiat currencies is full of breaches of that trust."*
>
> – **Satoshi Nakamoto**, Feb. 11, 2009

On April 20, 2024, Bitcoin will undergo its fourth halving on block number 840,000. During each halving event, the block reward (also known as the "block subsidy"), representing the number of newly issued bitcoins paid to miners per mined block, decreases by half. The block reward after Bitcoin's fourth halving will decline from

6.25 to 3.125 BTC (equivalent to a daily reduction from ~900 BTC to ~450 BTC). Consequently, Bitcoin's annualized issuance rate will decline from approximately 1.7% to around 0.85%. By the fourth halving, 93.7% of the total Bitcoin supply will be in circulation, according to data from Coin Metrics.

The halving occurs every 210,000 blocks (approximately every 4 years) and, after Bitcoin's fourth halving, the network will undergo 30 more halvings. The halving is programmed to occur until the last bitcoin is eventually mined, which is expected to take place sometime after 2140. Once all bitcoin is mined and in circulation, miners will no longer receive block subsidies and will exclusively rely on transaction fees and other forms of off-chain payments.

Bitcoin's programmed reduction in issuance approximately every 4 years is the backbone of its transparent, predictable monetary policy and makes bitcoin a provably scarce asset. Most importantly, Bitcoin's monetary policy is immutable code enforced by consensus among the network's stakeholders (miners, nodes, developers). Bitcoin's scarcity, and the predictability of its monetary policy, stands in stark contrast to the notable devaluation of the world's fiat currencies, and is what gives bitcoin the well-known moniker "digital gold."

Bitcoin Issuance Rate (Monetary Base Inflation) & Circulating Supply
Source: Galaxy Research
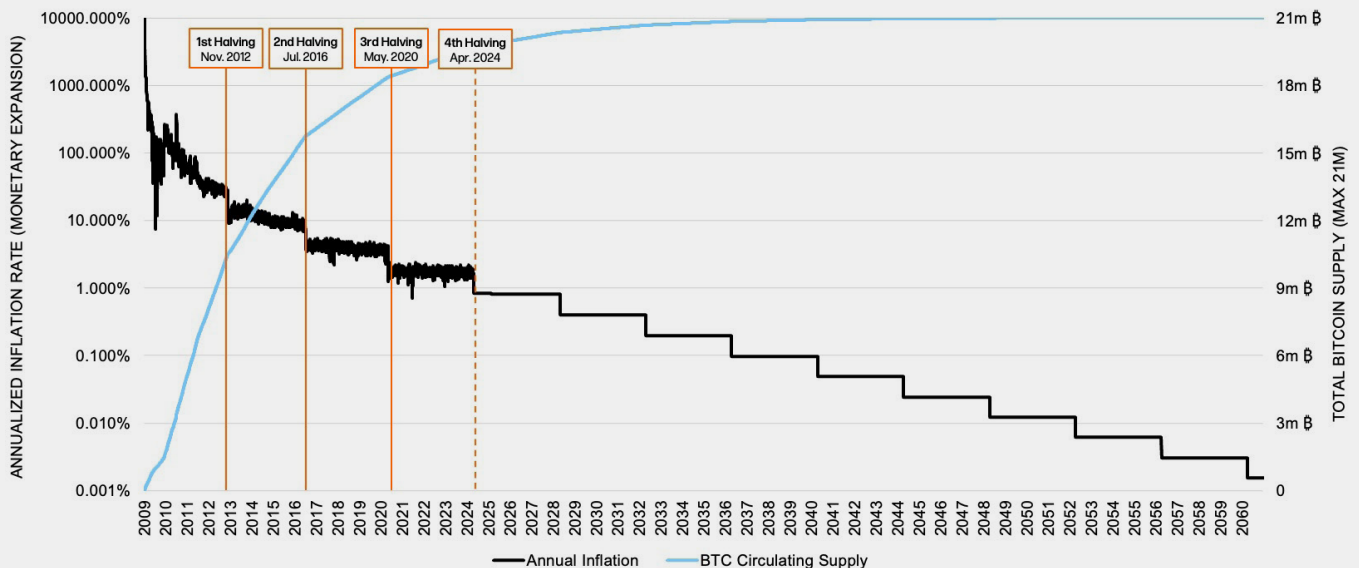
Data: Coin Metrics,. Galaxy Research
Inflation & circulating supply beyond Apr. 15, 2024 are predicted based on Bitcoin's block production & halving schedule

Visualizing the Halving in Bitcoin Core

Bitcoin Core is the open-source software created by Satoshi Nakamoto that sets the foundation for the Bitcoin protocol. Bitcoin Core is recognized by developers as the primary reference implementation of Bitcoin (although other software implementations are compatible with the network). As a result, all the functions and logic that define Bitcoin are present in Bitcoin Core.

The code in Bitcoin Core that enforces the halving consists of 7 lines of code written in C++. Breaking down the code line by line exceeds the scope of this report, however, it's important to visualize the code responsible for determining the block reward for the current block height:

- Line 1240: Calculates how many halvings have existed.

- Line 1245 – 1248: Determines the block reward for miners.

Code Behind the Halving in Bitcoin Core
Source: Galaxy Research

```
1238   CAmount GetBlockSubsidy(int nHeight, const Consensus::Params& consensusParams)
1239  ⊟{
1240       int halvings = nHeight / consensusParams.nSubsidyHalvingInterval;
1241       // Force block reward to zero when right shift is undefined.
1242       if (halvings >= 64)
1243           return 0;
1244
1245       CAmount nSubsidy = 50 * COIN;
1246       // Subsidy is cut in half every 210,000 blocks which will occur approximately every 4 years.
1247       nSubsidy >>= halvings;
1248       return nSubsidy;
1249  └}
```

Data: Github

Understanding Bitcoin Mining

Mining is a pivotal component of the Bitcoin network. When an individual wants to send bitcoin to another wallet, the transaction is first broadcast to the network and checked for validity by nodes. Before being added to a block, the transaction exists in a queue state inside the "mempool," a pool of transactions that are unconfirmed and awaiting inclusion by miners in a block. The block subsidy is both a means to incentivize miners to contribute compute power to the network to process and settle transactions, as well as the method of distribution for newly minted bitcoin supply. As the price of Bitcoin increases, the incentive to mine blocks for these rewards can also grow significantly.

Miners produce blocks by computing the correct hash for the next block. By virtue, miners with the highest hashrate, or compute power from Application-Specific Integrated Circuit (ASIC) machines, will have the highest probability to find the hash for the next block. The first miner to compute the correct hash is rewarded with the block subsidy and the transaction fees in the block. Typically, the time to compute the correct hash is approximately 10 min (Bitcoin's block time). The network ensures to miners that the block time will

always be around 10 min through difficulty adjustments. These adjustments are made every 2016 blocks (approximately every two weeks) as network hashrate increases or decreases. The greater the hashrate, the higher the difficulty to mine blocks will be. Consequently, the difficulty adjustment enforces consistent block production and Bitcoin's monetary policy.

"By convention, the first transaction in a block is a special transaction that starts a new coin owned by the creator of the block. This adds an incentive for nodes to support the network, and provides a way to initially distribute coins into circulation, since there is no central authority to issue them. The steady addition of a constant of amount of new coins is analogous to gold miners expending resources to add gold to circulation. In our case, it is CPU time and electricity that is expended."

– **Satoshi Nakamoto**, Bitcoin Whitepaper, Oct. 31, 2008

Annual Bitcoin Miner Revenue (USD)
Source: Galaxy Research
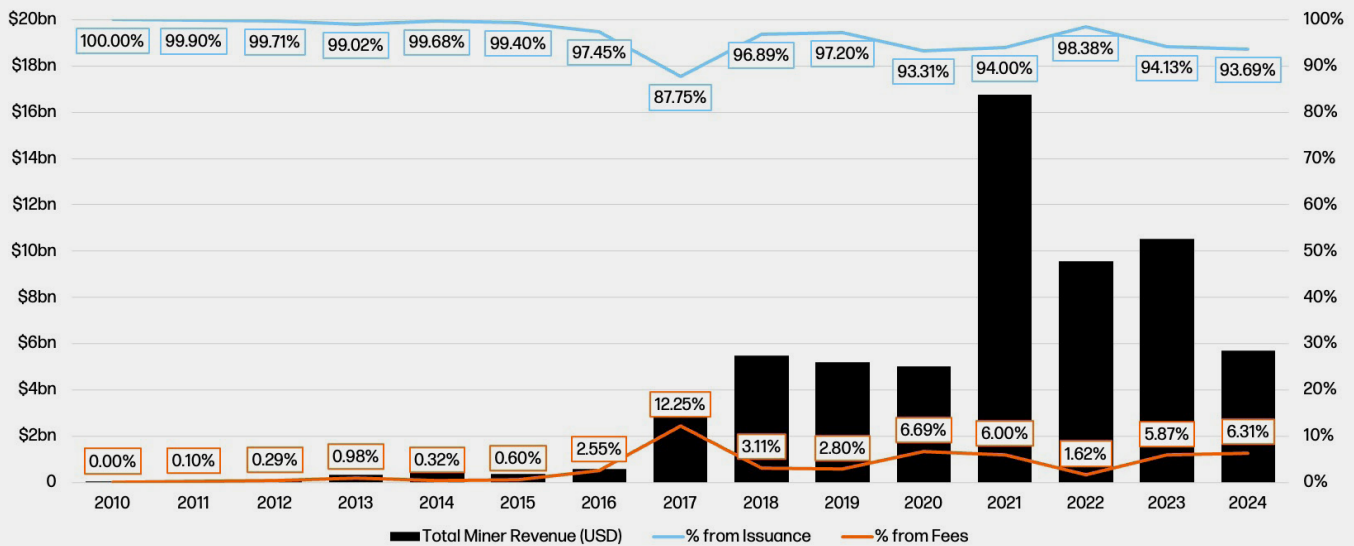
Data: Coin Metrics, Galaxy Research
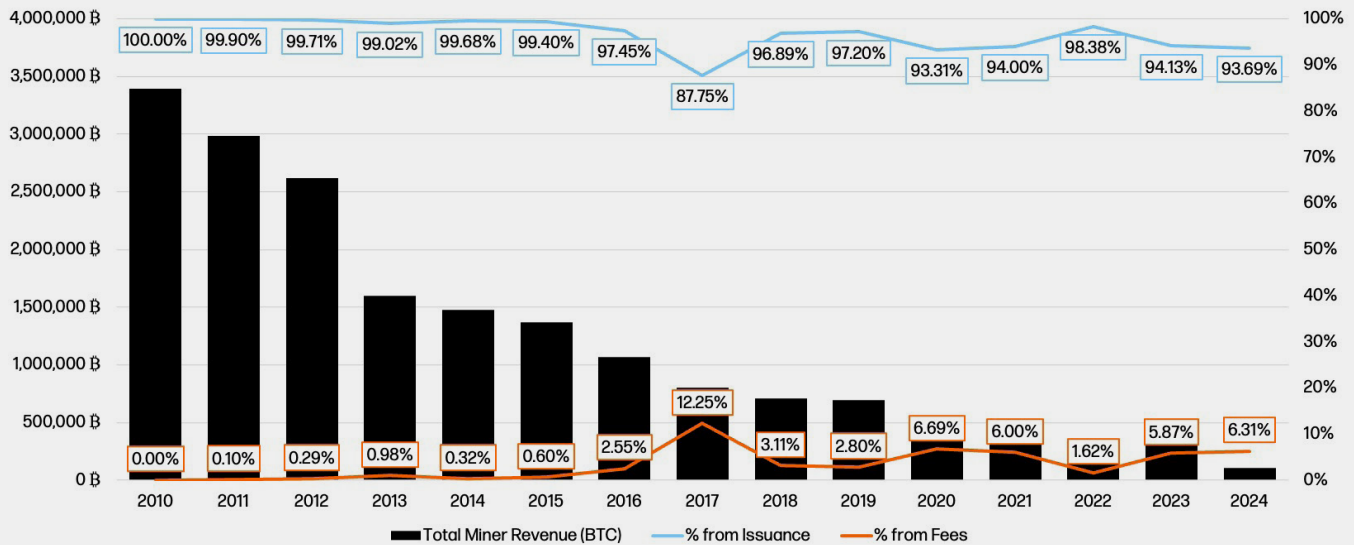Data for 2024 current through Apr. 14, 2024

The Halvings Impact on Bitcoin Mining

Bitcoin miner rewards are made up of the block subsidy and transaction fees. At the halving, Bitcoin's block subsidy will be cut in half from 6.25 BTC to 3.125 BTC. Holding bitcoin price and network hashrate constant, this results in Bitcoin miner revenues being nearly cut in half, as the block subsidy currently makes up a majority of total rewards.

For miners, this means that the same amount of computing power will yield approximately half of what it did before the halving event. Consequently, the cost to mine a single bitcoin is expected to roughly double post-halving, rendering some operations unprofitable for less efficient miners who will be forced to cease operations. As a result, network hashrate is expected to decline in the near term. Hashrate entails the total computing power miners are contributing to Bitcoin. The severity of this drop in network hashrate is contingent upon factors including bitcoin price and transaction fees at the halving.

Annual Bitcoin Miner Revenue (BTC)
Source: Galaxy Research

% from Issuance values: 100.00%, 99.90%, 99.71%, 99.02%, 99.68%, 99.40%, 97.45%, 87.75%, 96.89%, 97.20%, 93.31%, 94.00%, 98.38%, 94.13%, 93.69%

% from Fees values: 0.00%, 0.10%, 0.29%, 0.98%, 0.32%, 0.60%, 2.55%, 12.25%, 3.11%, 2.80%, 6.69%, 6.00%, 1.62%, 5.87%, 6.31%

Years: 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024

■ Total Miner Revenue (BTC)   —— % from Issuance   —— % from Fees

Data: Coin Metrics, Galaxy Research
Data for 2024 current through Apr. 14, 2024

The following table outlines the projected cost to mine one bitcoin for various commonly used ASICs (listed from least to most efficient) under different post-halving power cost scenarios. These calculations assume a network hashrate of 625 EH and transaction fees representing 10% of block rewards.

Cost to Mine 1 BTC
Source: Galaxy Research

| POWER COST | MACHINE TYPE AND EFFICIENCY | | | | | | |
	S19 34.2 J/TH	M30S+ 34.0 J/TH	M30S++ 31.0 J/TH	S19j Pro 30.5 J/TH	S19k Pro 23.0 J/TH	S19 XP 21.5 J/TH	S21 17.5 J/TH
$20/MWh	$20,734	$20,606	$18,788	$18,485	$13,939	$13,030	$10,606
$30/MWh	$31,100	$30,909	$28,182	$27,727	$20,909	$19,545	$15,909
$40/MWh	$41,467	$41,212	$37,576	$36,970	$27,879	$26,061	$21,212
$50/MWh	$51,834	$51,515	$46,970	$46,212	$34,848	$32,576	$26,515
$60/MWh	$62,201	$61,818	$56,364	$55,455	$41,818	$39,091	$31,818
$70/MWh	$72,568	$72,121	$65,758	$64,697	$48,788	$45,606	$37,121

Data: Galaxy Mining

In preparation for the halving, miners have been diligently enhancing operational efficiency by reducing costs and upgrading equipment. Numerous miners have announced substantial ASIC purchase orders and strategic site acquisitions, positioning themselves advantageously ahead of the halving. As highlighted in the previous table, at a $50/MWh power cost, S21s can mine at 50% cheaper levels than S19s, illustrating the importance of improving fleet efficiencies.

Ahead of the halving, miners have bolstered their cash reserves, maintaining sizable balances as "dry powder" to capitalize on discounted infrastructure purchases in a potentially rising bitcoin price regime. It's anticipated that mergers and acquisitions activity will surge post-halving, as assets transition to the hands of more efficient operators, consolidating the industry landscape and driving further optimization.

Overall, the impending Bitcoin halving represents a pivotal moment for miners. As the industry braces for a significant reduction in block rewards, miners are faced with the imperative to adapt and innovate in order to maintain profitability and sustainability in an evolving landscape.

The Halvings Impact on Bitcoin Price

The impact that the halving will have on bitcoin's price is an ongoing debate that occurs every halving. While historically, market participants viewed the halving as a bullish event for BTC price, opposing views believe that the halvings' impact on price is negligible. Here is a breakdown of the market's current bullish, bearish, and neutral views on the halvings impact on BTC price.

Bullish View
The 50% reduction in Bitcoin's block reward makes bitcoin scarcer overall as an asset while simultaneously reducing the absolute amount of selling from miners. Miners are considered consistent forced sellers of bitcoin as these operations are extremely capital intensive and BTC sales are miners' primary source of revenue. As a result, miners always sell a portion of their block rewards for fiat to pay for operational expenses like energy, labor, debt, and new machines. Many believe the reduction in supply growth corresponding to a reduction in sell pressure from the mining community led to an increase in the value of bitcoin following the November 2012, July 2016, and May 2020 halvings and could do the same following the fourth halving. Market participants that view the halving as a bullish sentiment on price also use the widely circulated stock-to-flow model that quantifies the price impact of Bitcoin's reducing supply schedule. Proponents of this view typically believe that investors have not properly accounted for the halving in their current valuations of bitcoin.

Bearish View
As bitcoin price is trading near its all-time high pre-having for the first time in history, market participants that view the halving as a bearish sentiment for bitcoin price believe that the market has adapted from the previous three halvings and already priced in this event. At this point prior to the last two halvings, BTC was down 42%+ from its previous all-time highs. Effectively, the bull runs of 2017 and 2020 hadn't yet begun at this stage in Bitcoin's supply schedule. The impact of the halving on BTC supply dynamics necessarily reduces by half each event, and the impact declines over time. For example, a decline in 900 issued BTC per day to 450 BTC per day is a much smaller reduction, in absolute terms, than reductions from 7200 to 3,600 BTC per day (first halving). Considering that Bitcoin's current daily issuance of 900 BTC is negligible compared to the asset's daily float, the new daily issuance of 450 BTC post halving will have a minimal effect on BTC price. Furthermore, bears argue, reducing miner revenue could lead to disruptions in the mining industry and make the bitcoin network less secure.

Neutral View
The efficient market hypothesis suggests that Bitcoin's past and future halvings are the opposite of "new information" and cannot be viewed as supply shocks. Bitcoin's transparent and predictable issuance schedule should always be priced into the market. Bull markets following halvings could are much more related to changes in demand and not supply and could even be more correlated to things like global market liquidity, central bank rates, and other macro conditions.

Bitcoin: Bull Runs Following Prior Halvings
Source: Galaxy Research

Data: Coin Metrics, Galaxy Research
Data as of April 16, 2024

Historically, bitcoin enters a bull market post halving during the hype stage, which lasts anywhere from 0 – 600 days. After the first halving in 2012 (cycle 1), bitcoin price reached its cycle top 367 days post halving. During the second halving in 2016 (cycle 2), price discovery post halving was slower and reached the cycle top 525 days after the halving. The third halving in 2020 (cycle 3) reached the cycle top 546 days after the halving.

If history repeats, we are currently in the end of the accumulation phase and will slowly enter the hype stage sometime in 2024.

For the first time in history, bitcoin price has traded above its previous all-time high pre-halving. During Bitcoin's previous two halvings in 2016 and 2020, bitcoin price was down 42.5% and 52.8% respectively from its previous all-time highs. While bitcoin's strong price action pre-halving could be viewed as the market

frontrunning the hype stage we typically see post halving, the driving forces driving bitcoin price this cycle are new developments not existent in the previous halving cycles – specifically the launch of spot-based Bitcoin ETFs in the U.S. in January 2023.

Bitcoin's fourth halving will occur amidst a significant paradigm shift for the asset following the introduction of spot Bitcoin ETFs. Since the launch of the ETFs on January 10, 2024, BTC spot ETFs have accumulated over $1.25bn in net inflows. Bitcoin has reemerged at the forefront of macro investors' discussions, now mentioned in the same breath as gold and treasuries as a pivotal macro hedge asset. The advent of the Bitcoin ETFs in the United States represents a monumental shift poised to disrupt conventional notions about Bitcoin price cycles, the evaluation of holder behavior, and the dynamics of intra-crypto rotations.

BTCUSD 5 Days Before Halvings
Source: Galaxy Research

Halving	Halving Date	5 Days Prior	BTCUSD 5d Prior	Prior ATH Date	Prior ATH Price	% Down from ATH
2nd	9-Jul-16	4-Jul-16	$652	4-Dec-13	$1,134	-42.5%
3rd	11-May-20	6-May-20	$9,266	16-Dec-17	$19,640	-52.8%
4th	20-Apr-24*	15-Apr-24	$63,442	8-Nov-21	$67,541	-6.0%

Data: Coin Metrics
*Expected halving date based on average block times of 10min as of Apr. 15, 2024

Halving Block Activity

Block number 840,000, also known as the halving block, will be a highly demanded block for transaction inclusion due to its historical significance and rarity. Halving blocks only occur every 210,000 blocks and there will only be 34 halving blocks in Bitcoin's existence, and there is likely to be significant competition by both users and miners to transact within or mine the block.

The core factors that will drive transaction fee spikes at the halving include the launch of a new fungible token standard called Runes, and rare sat hunting. Runes is a new fungible token standard on Bitcoin that is more efficient than the BRC-20 token standard. Runes will launch on the halving block and numerous Rune token collections are expected to pay high transaction fee rates to ensure they are included in that block. To read more about Runes, we go into greater detail on the new fungible token standard in our Galaxy Research newsletter. For reference, a sat is the smallest unit of a Bitcoin – one bitcoin is divisible by 100m sats. Rare sats is a new collectable asset on Bitcoin that was created when Ordinals emerged in December 2023. Rare sat collecting entails purchasing sats that were mined in blocks with historical significance such as halving blocks, or blocks that were mined by Satoshi Nakamoto (Block 9). Every sat in block 840,000 will hold significant historical value, therefore, rare sat hunters will attach high fees to their transactions to ensure block inclusion.

Another potential factor that will drive up transaction fees at the halving is if a mining pool attempts to reorganize (re-org) Bitcoin's historical blockchain state. A re-org occurs when an alternative version of the blockchain gains consensus among nodes, effectively rewriting a part of the blockchain's transaction history. While the chances of a successful re-org are slim, mining pools might attempt to re-org the chain to successfully capture blocks with high fees. Notably, mining pools that attempt to re-org the chain and are unsuccessful will still drive-up transaction fees as the hashrate that is devoted to reorganizing the chain is being diverted away from the longest chain tip. This would slow block times and lead to a natural increase in fees as there is more time for mempool pressure to build up.

Why the Halving Matters

The halving is the effectuation of Bitcoin's transparent, predictable, and deflationary monetary policy. The halving event reinforces Bitcoin's fundamental value proposition encompassing its open peer-to-peer network, competitive mining sector, decentralized network of nodes, and active open-source development community. The halving itself is the mechanism that distinguishes Bitcoin's scarcity from that of other assets.

Bitcoin's immutable monetary policy coupled with its hard cap 21m supply is revolutionary concept for a macro asset. The transparency of Bitcoin's daily issuance schedule enables anyone in the world with a computer to verify themselves that Bitcoin's issuance is occurring as planned without having to rely on or trust an intermediary. Additionally, every node in the Bitcoin network can confirm that the 21m hard cap supply remains intact.

The predictability and transparency of Bitcoin's fixed supply positions the emerging asset as a viable alternative store of value to fiat currencies. Unlike Bitcoin's fixed supply, fiat currencies are subject to the discretionary actions of central banks, which have the authority to adjust the money supply to manage econoic stability or stimulate growth. This discretion results in an uncapped total supply and an unpredictable issuance schedule for all fiat currencies. The implications of this unpredictability are evident when evaluating the behavior of central banks. In response to global economic turmoil resulting from the COVID-19 pandemic, the Federal Reserve printed $5tn of dollars out of thin air, more than doubling the central banks balance sheet. This money printing, along with fiscal spending by the U.S. government, trickled through the U.S. economy to help blunt the negative impact of lockdowns and COVID-19 measures, and stimulate the economy, but eventually led to the largest inflation in decades. Even gold, renowned as the oldest scarce monetary asset, lacks a definitive total supply, and its production, while influenced by market dynamics rather than central bank policy decisions, remains unpredictable.

Bitcoin's resilience across numerous bear markets underscores the broader market's reignition of its value as a decentralized macro asset characterize by transparency, predictability, and scarcity. Bitcoin's monetary policy is fixed, and every halving that occurs proves its longevity yet again. Halvings will continue to occur, stakeholders will never be bailed out by the system. The upcoming halving, expected to occur on April 20, 2024, reinforces these truths and will remind the market of Bitcoin's unique properties.

"If you don't believe me or don't get it, I don't have time to try to convince you, sorry."   – **Satoshi Nakamoto**, Jul. 29, 2010

Contact Us

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