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Bitcoin Ordinals and Inscriptions: An Analysis of Bitcoin's Evolving Network Dynamics

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Abstract

Bitcoin Ordinals and inscriptions facilitate the on-chain storage of arbitrary data on the Bitcoin blockchain. In this study, we analyse the impact of inscriptions on the Bitcoin network. We find that inscriptions have significantly increased network activity, created additional demand for blockspace, and influenced Bitcoin's fee market dynamics. Furthermore, we find that the rise of inscriptions coincided with an increased utilisation of Taproot, a notable increase in block size, and the longest sustained period of high blockspace utilisation in Bitcoin's history. Our study shows that inscriptions have reshaped how Bitcoin's blockchain is utilised and underscores the growing number of use cases beyond its original function as a peer-to-peer financial network.

Keywords: *Bitcoin, Blockchain, Ordinals, Inscriptions, Digital Assets, Network Dynamics*

JEL Classifications: *D85, O33*

1. Introduction

Bitcoin Ordinals and inscriptions represent a milestone in the evolution of Bitcoin, as they facilitate the storage of arbitrary data directly on the blockchain. By leveraging protocol upgrades like Segregated Witness (SegWit) and Taproot, it is possible to create non-fungible and fungible digital assets directly on Bitcoin's base layer, thus expanding the network's use cases beyond traditional peer-to-peer payments. Unlike earlier approaches, such as Colored Coins [1], inscriptions quickly emerged as the first widely adopted mechanism to introduce new functionality without altering Bitcoin's core protocol. The launch of the Ordinals protocol in January 2023 triggered a surge in network activity. This development raises a central question: "What is the impact of inscriptions on the Bitcoin blockchain?"

In this paper, we present a comprehensive analysis of how inscriptions reshaped Bitcoin's network dynamics. We use transaction- and block-level data to assess the extent to which inscriptions influenced on-chain activity, blockspace demand, fee market dynamics, and Taproot adoption.

While existing studies offer valuable insights, they typically focus on specific aspects of inscriptions. To the best of our knowledge, we are the first to present a comprehensive analysis of the impact of inscriptions on the Bitcoin network across multiple dimensions:

- We conduct a holistic, network-level assessment of how inscriptions have influenced Bitcoin's network dynamics.
- We quantify the impact of inscriptions on the Bitcoin network based on a set of key metrics.
- We leverage a novel, large-scale dataset covering a period when inscriptions were the only significant metaprotocol-based asset on Bitcoin, allowing us to isolate their effects more clearly.

The remainder of this paper is structured as follows. Section 2 discusses related work. Section 3 examines the theoretical and technical foundations of Bitcoin Ordinals and inscriptions. Section 4 describes the data and methodology. Sections 5 and 6 present our descriptive and econometric analyses. Section 7 highlights broader debates and outlines research limitations. Section 8 concludes.

2. Related Work

This paper contributes to a growing body of literature on Ordinals and inscriptions. Bertucci [2] finds that inscriptions carry lower fee rates but contribute to a higher overall fee volume. Li et al. [3] provide a technical report on the foundations, operational mechanisms, use cases, as well as potential challenges and opportunities associated with inscriptions. Liao et al. [4] also delve into the technicalities of inscriptions and assess their potential to enhance the programming functionality on the Bitcoin blockchain. Zhu et al. [5] investigate concerns over inappropriate inscription content by developing a monitoring system to address this issue.

Another strand of literature focuses on BRC-20 inscriptions, an inscription-based fungible token standard. Wang et al. [6] examine user sentiment and market performance surrounding BRC-20 tokens, and Qi et al. [7] analyse potential attack vectors related to the transfer mechanism of this fungible token standard.

Some studies extend inscription-related research beyond Bitcoin. Messias et al. [8] examine how inscriptions affect scalability and gas fees on EVM-compatible blockchains, while Wang et al. [9] propose a cross-chain bridge between Bitcoin and Ethereum using BRC-20 inscriptions.

3. Foundations of Ordinals and Inscriptions

3.1 Bitcoin Ordinals

Bitcoin Ordinals, introduced by Casey Rodarmor in 2022, represent a concept for numbering, ordering, and tracking individual satoshis, the smallest unit of Bitcoin. According to Ordinal theory, each satoshi is assigned a distinct ordinal number based on the order in which the satoshi was mined. This makes it possible to recognise and transfer each individual satoshi as a distinct digital unit on the Bitcoin blockchain. The technical implementation of Ordinal theory is realised through the Ordinals protocol, which runs as a metaprotocol on top of Bitcoin without altering the consensus rules of the network [10].

3.2 Inscriptions

Among the various applications emerging from the Ordinals protocol, inscriptions became the most prominent use case. Inscriptions are used to embed arbitrary data – such as text, images, music, or code – onto individual satoshis, thereby storing the data directly on the Bitcoin blockchain. In more technical terms, an inscription represents a link between a particular satoshi, identified through Ordinal theory, and specific on-chain data, which is the inscription content inscribed on that satoshi [10].

An inscription is created through a two-step commit-reveal transaction process. In the commit transaction, a Taproot output is generated that commits to a hash of a script containing the inscription content by embedding the hash in the output's locking script (ScriptPubKey). The subsequent reveal transaction spends this Taproot output and discloses the inscription content by embedding it in the witness field of the transaction. Once the commit and reveal transactions are confirmed, the inscription content is permanently stored on the Bitcoin blockchain [10].

Although Bitcoin Ordinals and inscriptions are closely related, it is important to highlight that the numbering scheme used by Ordinals can function independently of inscriptions. In contrast, inscriptions depend on Ordinals for identifying, tracking, and transferring the specific satoshi carrying the embedded data [10].

Another distinction must be made between inscriptions and Ethereum non-fungible tokens (NFTs). While both enable similar use cases, their designs are fundamentally different. Ethereum NFTs typically store their content off-chain and reference it via a token ID [11], which raises concerns about the immutability and availability of the content [12]. Since inscriptions store the content directly on the Bitcoin blockchain, they offer a higher level of permanence, accessibility, and decentralisation.

3.3 SegWit and Taproot

Although the Ordinals protocol defines how satoshis can be uniquely identified and tracked, the ability to inscribe data onto satoshis relies on two foundational protocol upgrades: SegWit and Taproot. These upgrades introduced critical changes to Bitcoin that made inscriptions technically and economically feasible.

SegWit, introduced in 2017, changed the structure of Bitcoin transactions by separating the witness data from the rest of the transaction data. It also introduced weight units, a new unit of measurement for transaction size. Under SegWit, each byte of non-witness data counts as 4 weight units, while each byte of witness data counts as only 1 weight unit. This 75% discount for witness data reduced the cost of embedding data in the witness field of a transaction and increased the effective capacity of Bitcoin blocks [13].

Taproot, activated in 2021, expanded Bitcoin's scripting capabilities and lifted prior constraints on witness data size [14–16]. This made it possible to include large, complex data files in the witness field of a transaction, enabling the storage of extensive data structures on the Bitcoin blockchain.

While earlier approaches, such as OP_RETURN, also support on-chain data storage [17], they were limited in both capacity and cost-efficiency. In contrast, inscriptions utilise the enhancements introduced by SegWit and Taproot, making them a more scalable and economically viable method for storing arbitrary data on Bitcoin.

4. Data and Methodology

4.1 Data

For our study, we source all data from the blockchain analytics platform Dune (dune.com) using custom SQL queries. Our dataset spans July 2022 to March 2024 and contains more than 67 million inscriptions and 237 million Bitcoin transactions.

To analyse block-level dynamics and Taproot adoption, we collect data for over 355,000 Bitcoin blocks (August 2017 to March 2024) and more than 880 million transaction outputs (November 2021 to March 2024). In addition, we gather daily Bitcoin price data to contextualise market dynamics.

4.2 Inscription Identification and Classification

We identify inscription transactions by scanning the hexadecimal structure of Bitcoin transactions for the inscription envelope ("0063036f7264"). For transactions containing this envelope, we further classify inscriptions by detecting the hexadecimal representation of their MIME type, which indicates the file format of the inscription content. In practice, this involves detecting the patterns shown in Table 1.

Table 1. Hexadecimal Identifiers Used for Inscription Classification

Inscription Category	Hexadecimal Identifier
BRC-20	2270223a226272632d323022
Text	74657874
Image	696d616765
Application	6170706c69636174696f6e
Video	766964656f
Audio	617564696f

To ensure accuracy, we validated our methodology in two ways: (i) by comparing our SQL queries against alternative approaches available on Dune and (ii) by manually inspecting a random sample of inscription transactions and their associated content using Ordinals explorers. Both checks confirmed the correctness and reliability of our classification procedure.

4.3 Descriptive Analytics Framework

For our descriptive analysis of Bitcoin's network dynamics (Section 5), we employ distinct observation windows to address different analytical needs. To analyse individual inscription patterns, we consider the period from the first inscription on 14 December 2022 (block 767,430) through 31 March 2024 (block 837,164). To examine inscription transaction patterns, we focus on the period from the launch of the Ordinals protocol on 20 January 2023 (block 772,739) through 31 March 2024. To assess broader structural shifts – such as changes in block size, blockspace utilisation, and Taproot adoption – we extend the observation window further back in time to capture pre-Ordinals dynamics. All dates are based on Coordinated Universal Time (UTC). We conclude our study period at the end of March 2024, which is prior to the Bitcoin halving and the launch of the Runes metaprotocol on 20 April 2024, to avoid potential confounding effects from these events.

We classify any transaction containing at least one inscription as an "inscription transaction," while all other transactions are classified as "regular transactions." In some cases, transactions contain multiple inscriptions (batch inscriptions). We split these batch inscriptions into their individual inscriptions and allocate transaction size, blockspace consumption, and transaction fees proportionally across all inscriptions included in the batch. Although this approach may introduce some imprecision, particularly for batch inscriptions containing inscriptions of different categories, it provides a practical and consistent framework for category-level analysis.

To capture inscription activity and its direct impact on the Bitcoin network, we define three primary inscription-specific metrics:

- **Transaction Share**: The proportion of all Bitcoin transactions that contain at least one inscription.
- **Blockspace Share**: The share of blockspace consumed by inscription transactions.
- **Fee Share**: The proportion of total transaction fees paid by inscription transactions.

To assess broader network dynamics potentially influenced by inscriptions, we analyse three additional metrics:

- **Blockspace Utilisation**: The share of available blockspace that is consumed by all transactions.
- **Block Size**: The size of Bitcoin blocks measured in megabytes (MB).
- **Taproot Utilisation**: The share of Taproot transaction outputs.

All metrics are aggregated at the daily level.

4.4 Regression Methodology

To formally assess the impact of inscriptions on Bitcoin's network dynamics, we complement our descriptive analysis with regression models. The regression analysis covers the period from 1 July 2022 to 31 March 2024. This window allows us to capture both the pre-Ordinals baseline and the post-launch adoption phase, while avoiding potential confounding effects from events outside this window.

We employ ordinary least squares (OLS) regressions with heteroskedasticity- and autocorrelation-robust (HAC) standard errors to account for serial correlation in daily blockchain data. To improve model fit and interpretability, variables exhibiting strong skewness were log-transformed (natural logarithm) prior to estimation.

The general regression specification is given by:

$$Y_t = \alpha + \sum_{i=1}^{k} \beta_i X_{i,t} + \epsilon_t$$

where Y_t denotes the dependent variable, α the constant, β_i the coefficient estimates of the independent variables, $X_{i,t}$ the independent variables, and ϵ_t the error term.

The selection of dependent variables is motivated by the analysis in Section 5, where we identify inscription-related shifts in transaction activity, Taproot adoption, blockspace dynamics, and transaction fees. From these findings, we derive hypotheses that are tested econometrically in Section 6. The dependent variables include:

- Total Transactions (log)
- Regular Transactions (log)
- Taproot Utilisation (%)
- Average Block Size (MB)
- Blockspace Utilisation (%)
- Inscription Transaction Share (%)
- Total Transaction Fees (log)
- Regular Transaction Fees (log)

The independent variables are chosen to capture the impact of inscriptions and to control for price dynamics, which may also influence the dependent variables. These include:

- Inscription Transaction Share (%)
- Inscription Blockspace Share (%)
- Daily Bitcoin Log Returns
- 7-Day Price Volatility of Bitcoin

We use inscription-related metrics in relative terms (share values) rather than absolute values to account for the unique characteristics of inscriptions and to better capture their impact on overall network dynamics. For instance, a single inscription transaction may fill almost an entire block, which is clearly reflected in the share value but less so in absolute terms. We include daily Bitcoin log returns to control for short-term price fluctuations and 7-day price volatility to control for the effect of short- to medium-term market uncertainty on on-chain activity. Price volatility is calculated as 7-day standard deviation of daily log returns.

All variables used in the regression analysis are calculated at the daily level for our 640-day observation period. The summary statistics for these variables are reported in Table 2.

5. Exploration of Bitcoin's Network Dynamics

5.1 Composition and Evolution of Inscriptions

Between December 2022 and March 2024, 67.3 million inscriptions were recorded on the Bitcoin blockchain. As shown in Table 3, BRC-20 inscriptions were the dominant category, accounting for 77.7% of all inscriptions, followed by text (16.2%) and image (3.5%) inscriptions.

As illustrated in Figure 1, early inscription activity following the launch of the Ordinals protocol in January 2023 was primarily driven by text and image inscriptions. This pattern changed significantly with the introduction of the BRC-20 token standard in March 2023, which triggered the first major wave of inscription activity in the following months. Inscription volume surged until late September, with BRC-20 accounting for the vast majority of inscriptions. Overall, the evolution of inscriptions shows a dynamic and rapidly shifting ecosystem. The data in Figure 1 indicate that the timing of inscription waves appears to be more closely linked to protocol innovations – such as the introduction of BRC-20 – than to Bitcoin price fluctuations. This motivates our first hypothesis:

Table 2. Summary Statistics for Variables Used in Regression Analysis (Daily data, 1 July 2022 – 31 March 2024)

Variable	Observations	Mean	Std. Dev.	Min	Median	Max
Total Transactions (log)	640	12.773	0.315	12.142	12.710	13.503
Regular Transactions (log)	640	12.499	0.145	11.885	12.500	13.185
Taproot Utilisation (%)	640	17.80	16.78	0.14	13.93	65.24
Average Block Size (MB)	640	1.563	0.312	0.825	1.654	2.518
Blockspace Utilisation (%)	640	92.31	11.83	54.58	99.20	99.85
Total Transaction Fees (log)	640	3.418	0.878	1.780	3.196	6.454
Regular Transaction Fees (log)	640	3.304	0.788	1.780	3.133	5.934
Inscription Transaction Share (%)	640	20.38	21.67	0.00	12.60	75.50
Inscription Blockspace Share (%)	640	15.22	13.61	0.00	15.85	55.26
Daily Bitcoin Log Returns	640	0.002	0.021	−0.110	0.001	0.107
7-Day Price Volatility	640	0.017	0.009	0.003	0.016	0.061

H1: Short-term Bitcoin price dynamics have only a limited direct influence on inscription activity.

Table 3. Inscriptions per Category

Inscription Category	Count	Share (%)
BRC-20	52,287,206	77.68
Text	10,929,318	16.24
Image	2,358,488	3.50
Other	956,205	1.42
Application	699,332	1.04
Video	78,316	0.12
Audio	1,299	0.00
Total	67,310,164	100.00

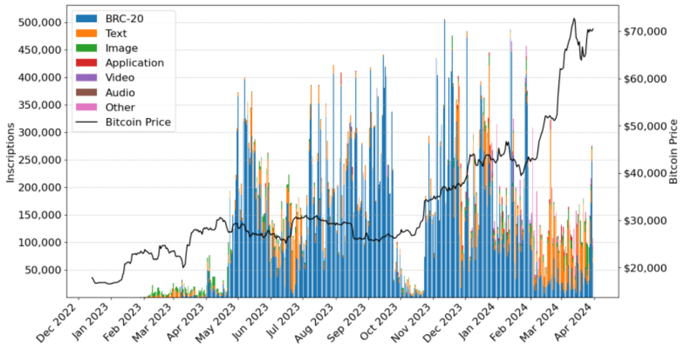

Figure 1. Inscriptions and Bitcoin Price.

5.2 Transaction Analysis

5.2.1 Transaction Dynamics

To assess the impact of inscriptions on Bitcoin's on-chain activity, we examine the transaction share of inscription transactions and analyse how this metric interacts with overall network activity. As shown in Table 4, Bitcoin recorded nearly 64 million inscription transactions between 20 January 2023 and 31 March 2024, representing 34.6% of all transactions during this period. Figure 2 shows that the number of regular transactions remained relatively stable, implying that inscription transactions added to overall network activity rather than replacing existing transaction flows. As shown in Panel A of Table 5, BRC-20 inscriptions accounted for the vast majority of inscription transactions, followed by text and image inscriptions.

Table 4. Transactions Distribution

Transaction Type	Count	Transaction Share (%)
Regular Transactions	121,121,535	65.44
Inscription Transactions	63,959,185	34.56
Total	185,080,720	100.00

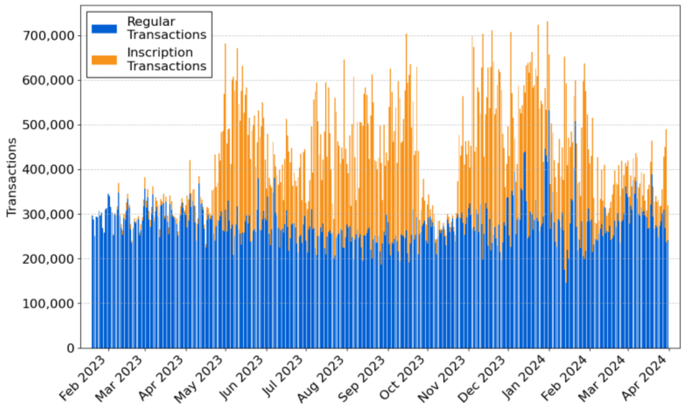

Figure 2. Transactions Distribution.

Figures 1, 2, and 3 indicate that inscription transaction volumes closely mirrored the number of individual inscriptions created. Since each inscription must be recorded in a transaction, the number of new inscriptions directly drives inscription-related transaction volume. The fact that there is no perfect correlation between these two metrics can be attributed to batch inscriptions, which allow multiple inscriptions to be created in a single transaction. As shown in Table 6, approximately 3.7 million inscriptions were created in 344,287 batch inscriptions, reducing inscription-related transaction volume by approximately 3.36 million and explaining the imperfect correlation between the number of individual inscriptions and inscription transactions.

Table 5. Main Metrics per Inscription Category

Panel A: Share Relative to All Inscription Transactions

Inscription Category	Transaction Share (%)	Blockspace Share (%)	Fee Share (%)
BRC-20	81.54	56.70	73.47
Text	13.46	15.78	13.86
Image	3.05	24.90	8.84
Other	1.95	2.62	3.83
All Insc. Transactions	100.00	100.00	100.00

Panel B: Share Relative to All Bitcoin Transactions

Inscription Category	Transaction Share (%)	Blockspace Share (%)	Fee Share (%)
BRC-20	28.18	12.86	16.24
Text	4.65	3.58	3.06
Image	1.05	5.65	1.95
Other	0.67	0.59	0.85
All Insc. Transactions	34.56	22.68	22.10

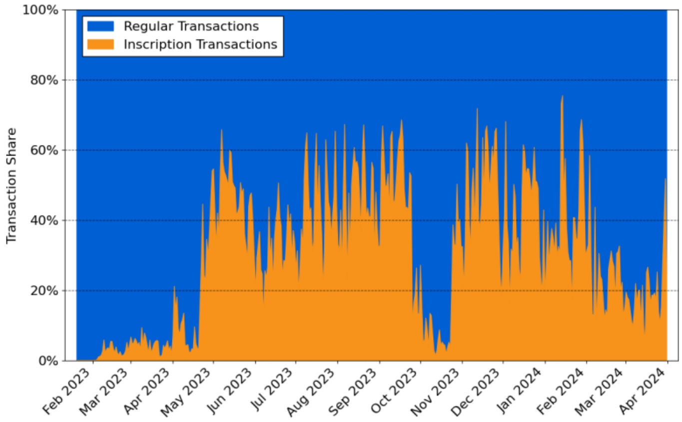

Figure 3. Transaction Share.

The transaction share metric highlights that inscriptions introduced a novel use case that significantly increased on-chain activity on Bitcoin's base layer. At the same time, regular transaction volume remained largely unaffected. Taken together, these findings motivate the following hypotheses:

H2.1: Higher levels of inscription activity are associated with an increase in the total number of Bitcoin transactions.

H2.2: Higher levels of inscription activity are not associated with a substantial reduction in the number of regular transactions.

Table 6. Batch Inscriptions

Batch Size	Batch Inscriptions	Share (%)
≥ 10,000	6	0.00
5,000–9,999	1	0.00
1,000–4,999	776	0.23
500–999	714	0.21
100–499	4,934	1.43
50–99	4,114	1.19
10–49	24,451	7.10
3–9	35,185	10.22
2	274,106	79.62
Total	344,287	100.00

5.2.2 Taproot Utilisation

As outlined in Section 3.2, the creation of an inscription requires the generation of a Taproot output. This link between Taproot outputs and inscriptions motivates us to investigate whether the rise in inscription transactions corresponded with an increase in Taproot utilisation. We define Taproot utilisation as the share of Taproot outputs relative to all transaction outputs.

Figures 4 and 5 show that prior to 2023, Taproot use was minimal. Following the launch of the Ordinals protocol, both the number of Taproot outputs and Taproot utilisation increased sharply. We can further observe that Taproot utilisation exhibited a strong co-movement with the share of inscription transactions. This pattern suggests that Taproot adoption was driven less by general demand for its technical features and more by the emergence of inscriptions as a new use case that is dependent on this protocol upgrade. We thus derive the following hypothesis:

H3: Higher levels of inscription activity are associated with increased Taproot utilisation.

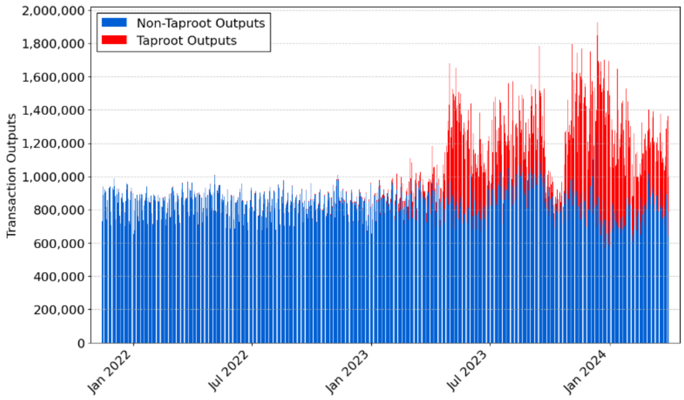

Figure 4. Transaction Outputs Distribution.

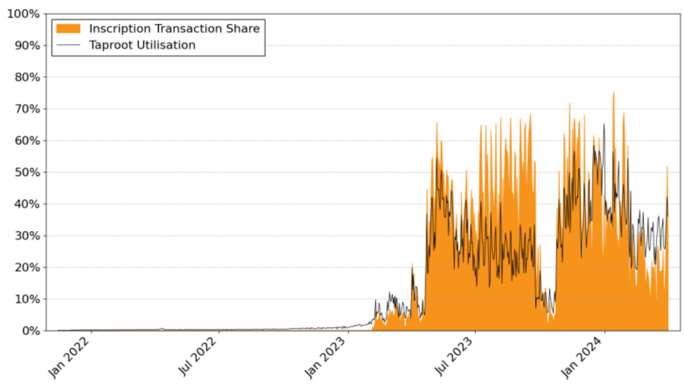

Figure 5. Inscription Transaction Share and Taproot Utilisation.

5.3 Blockspace Analysis

5.3.1 Blockspace Dynamics

Bitcoin's base layer operates under a strict block size limit, which caps the amount of data and thus the number of transactions that can be included in each block. As a result, transactions compete for limited blockspace. The emergence of inscriptions intensified this competition. We use the blockspace share metric to assess the impact of inscriptions on one of the network's most constrained resources.

Panel B of Table 5 shows that between January 2023 and March 2024, inscription transactions consumed 22.7% of the network's total blockspace, which is notably lower than their 34.6% share of total transactions. Figures 3 and 6 illustrate that this divergence between transaction share and blockspace share persisted throughout the sample period. This can be explained by the variability in size and frequency of transactions across different inscription categories. As shown in Panel A of Table 5, BRC-20 and text inscriptions, which together comprised 95% of inscription transactions, accounted for only 72.5% of inscription-related blockspace consumption. By contrast, image inscriptions represented just 3% of inscription transactions but consumed nearly 25% of inscription-related blockspace. Transaction size data in Table 7 corroborates this pattern. On average, BRC-20 and text transactions were 61% and 49% smaller than regular transactions, respectively, while image inscription transactions were 276% larger. This dynamic underscores that blockspace consumption is shaped not only by aggregate inscription volume but also by the characteristics and composition of inscription categories.

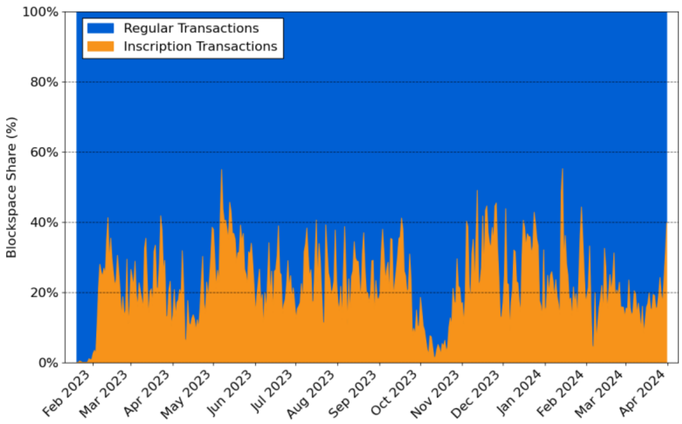

Figure 6. Blockspace Share.

Table 7. Transaction Size Comparison

Transaction Type	Size (virtual bytes)		Delta to Regular (%)	
	Median	Avg.	Median	Avg.
Regular	163	406	–	–
BRC-20	143	157	−12	−61
Text	147	208	−10	−49
Image	328	1,525	+101	+276
Other	155	218	−5	−46

5.3.2 Blockspace Utilisation and Block Size

The analysis of blockspace dynamics associated with inscriptions reveals two additional insights. First, the rise of inscriptions had a substantial impact on blockspace utilisation. Figure 7 shows that as the blockspace share of inscriptions rose in February 2023, Bitcoin blocks began to reach full capacity more frequently, and overall blockspace utilisation increased. With the first major wave of BRC-20 inscriptions in April 2023, the network entered the longest sustained period of persistently high blockspace utilisation in Bitcoin's history. Prior to 2023, such periods typically lasted only for a few months. These dynamics suggest an association between inscription activity and the degree to which available blockspace is utilised. Accordingly, we derive the following hypothesis:

H4: Higher inscription blockspace shares are associated with higher levels of blockspace utilisation.

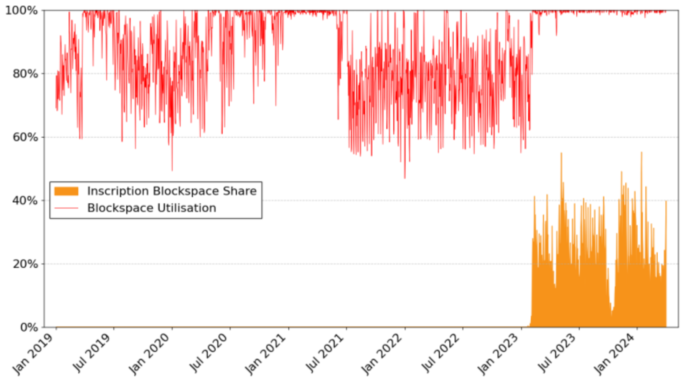

Figure 7. Inscription Blockspace Share and Blockspace Utilisation.

The second notable observation concerns block size. As shown in Figure 8, the average daily block size remained relatively stable after the SegWit upgrade, even though this upgrade enabled individual blocks to reach a capacity of up to 4 MB. Following the launch of the Ordinals protocol, average block size rose sharply, frequently exceeding 2 MB during the early phase of inscriptions. Throughout the remainder of the sample period, the daily average block size remained at an elevated level.

To further assess the impact of inscriptions, we compare block size metrics between two equally long 437-day periods before and after the launch of the Ordinals protocol. Table 8 shows that the average block size increased from 1.18 MB to 1.74 MB, a 47% rise, while the median increased by 20%. Stripped block size – which excludes witness data and therefore inscription content – experienced only modest changes over the same period. In fact, the median value decreased slightly. This suggests that the observed growth in block size was largely attributable to witness data, which is also driven by inscriptions. Based on these findings, we formulate the following hypothesis:

H5: Higher inscription blockspace shares are associated with an increase in the average size of Bitcoin blocks.

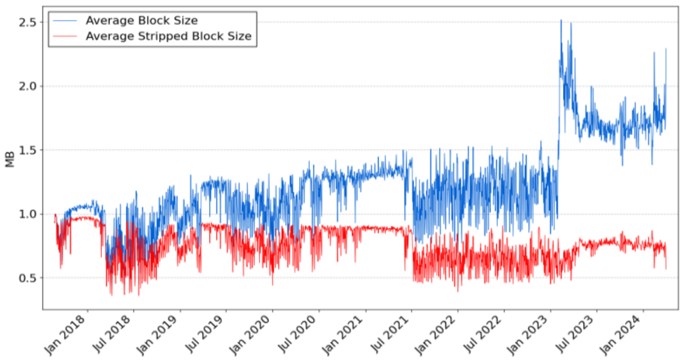

Figure 8. Block Size Comparison.

Table 8. Bitcoin Block Size Changes

	Pre-Ordinals (MB)	Post-Ordinals (MB)	Change (%)
Average Size	1.182	1.737	+47
Median Size	1.394	1.673	+20
Average Stripped Size	0.648	0.737	+14
Median Stripped Size	0.794	0.770	−3

5.4 Fee Analysis

Bitcoin's fee market allocates blockspace through a competitive bidding process, with miners prioritising transactions based on their fee rates, expressed in satoshis per virtual byte (sat/vB). Given our findings about inscription activity in Sections 5.2 and 5.3, it is relevant to assess how inscriptions affected fee market dynamics.

As shown in Table 9, total transaction fees on the Bitcoin network amounted to 29,060 Bitcoin between January 2023 and March 2024, of which inscription transactions contributed 6,423 Bitcoin, or 22.1%. This value is lower than their 22.7% blockspace share, indicating that inscription transactions, on average, paid slightly lower fees per unit of blockspace than regular transactions. This pattern also holds over time. As illustrated in Figures 6 and 9, the fee share of inscriptions generally mirrored their blockspace share throughout the sample period, albeit at a lower magnitude. The near parity between inscriptions' total fee share and blockspace share can be explained by inscriptions contributing disproportionately more fees during periods of heightened network fee rates (Figures 10 and 11).

Table 9. Transaction Fees Distribution

Transaction Type	Fees (BTC)	Share (%)
Regular TXs	22,637	77.90
Inscription TXs	6,423	22.10
Total	29,060	100.00

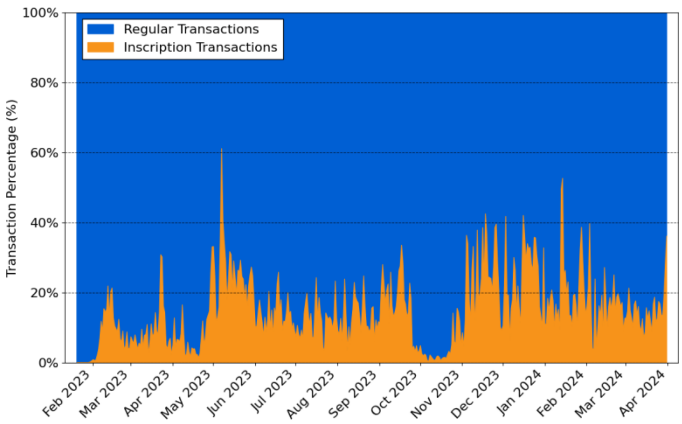

Figure 9. Transaction Fee Share.

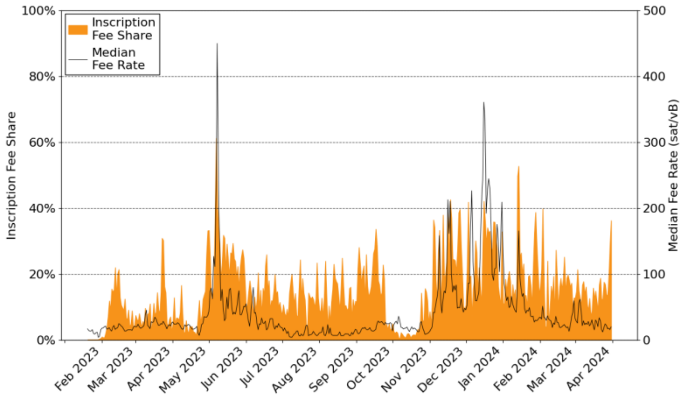

Figure 10. Transaction Fee Share and Median Fee Rate.

At the category level, Panel A of Table 5 shows that BRC-20 inscriptions were the only major category whose fee share (73.5%) exceeded their blockspace share (56.7%). In contrast, image inscriptions accounted for 24.9% of blockspace consumed by inscriptions but contributed only 8.8% of transaction fees paid by inscriptions. Consistent with this observation, Table 10 shows that image inscription transactions exhibited the lowest fee rate of all categories. It also shows that inscription transactions, on average, paid a lower fee rate than regular transactions. These findings are consistent with the results of Bertucci [2].

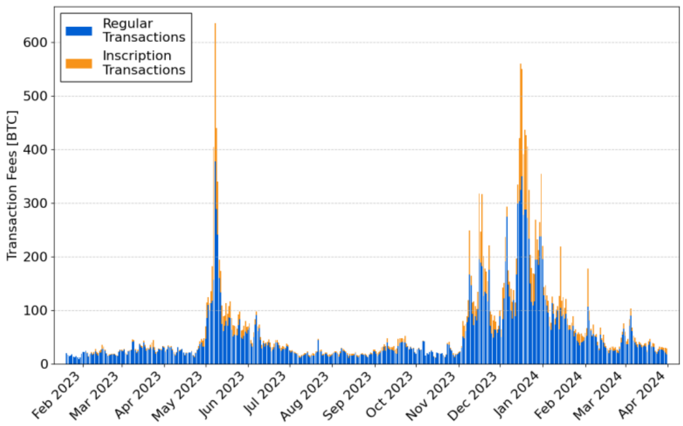

Figure 11. Transaction Fees Distribution.

Table 10. Transaction Fee Rates

Transaction Type	Median Fee Rate(sat/vB)
All Transactions	27.51
Regular	28.98
All Inscriptions	23.92
BRC-20	22.68
Text	24.91
Image	20.57
Other	45.91

Bitcoin's fee market dynamics reflect the interplay between on-chain activity, blockspace scarcity, and user bidding behaviour. Although inscriptions paid, on average, lower fees per unit of blockspace than regular transactions, they created additional network activity and increased competition for limited blockspace. These dynamics suggest that inscriptions may have contributed to higher total fee revenue and may have also influenced regular transactions to bid more aggressively for block inclusion. We therefore derive the following hypotheses:

H6.1: Higher inscription blockspace shares are associated with an increase in total transaction fees.

H6.2: Higher inscription blockspace shares are associated with an increase in regular transaction fees.

While fee rates represent an important dimension of Bitcoin's network dynamics, we do not econometrically assess them in our study, as this topic requires a dedicated analysis beyond the scope of this paper (see [2] for a detailed assessment).

6. Impact of Inscriptions on Bitcoin's Network Dynamics

Building on the descriptive evidence in Section 5, we now turn to a formal econometric analysis of how inscriptions have affected Bitcoin's network dynamics. We use OLS regression analysis to quantify this effect and test the hypotheses derived in the previous section, using inscription-related metrics as the key explanatory variables (except for H1) while controlling for Bitcoin price dynamics. The regression results are summarised in Table 11.

H1: Short-term Bitcoin price dynamics have only a limited direct influence on inscription activity.

The regression results show that daily log returns are statistically insignificant, while 7-day price volatility has a negative and significant effect. This suggests that higher volatility may dampen inscription activity, whereas short-term price changes exert no measurable influence. However, the explanatory power of the model is very low, indicating that price dynamics explain only a small fraction of variation in inscription activity. Broader market cycles, however, may still affect inscription activity.

H2.1: Higher levels of inscription activity are associated with an increase in the total number of Bitcoin transactions.

The regression for total transactions shows a strong and highly significant positive association between the share of inscription transactions and overall transaction volume on Bitcoin, with the model explaining a substantial share of the variation. The results indicate that a 1 percentage point increase in the inscription transaction share is associated with a 1.3% increase in total transactions, confirming our assumption that inscriptions add additional on-chain activity.

Daily log returns also enter positively and significantly, suggesting that short-term price changes stimulate higher transaction activity, for instance, when users adjust their Bitcoin holdings in response to price swings. In contrast, 7-day price volatility remains statistically insignificant. Therefore, both inscription activity and short-term price changes contribute to transaction growth.

H2.2: Higher levels of inscription activity are not associated with a substantial reduction in the number of regular transactions.

The regression for regular transactions indicates a small but statistically significant negative effect of inscription activity, suggesting that a 1 percentage point increase in the inscription transaction share is associated with a 0.1% decline in regular transactions. Log returns again enter positively and significantly, consistent with the assumption that price movements spur regular transaction volume, while 7-day volatility remains insignificant.

Although the results suggest a limited substitution effect, we interpret this with caution. Our findings from H2.1 indicate that the net effect of inscription activity is positive for overall transaction volume. Given the limited explanatory power of the model used to test H2.2, we regard the substitution effect as modest in magnitude and insufficient to offset the broader increase in network activity.

H3: Higher levels of inscription activity are associated with increased Taproot utilisation.

The regression results support our hypothesis. The share of inscription transactions is positively and significantly associated with Taproot utilisation. An increase of 1 percentage point in the share of inscription transactions corresponds to a 0.69 percentage point increase in Taproot utilisation. The fact that the effect is smaller than unity most likely reflects that not all inscription transactions consist exclusively of Taproot outputs and that Taproot is not exclusively used for inscriptions. Given the high explanatory power of our model and the lack of significant effects from price dynamics, the evidence suggests that the adoption and utilisation of Taproot is largely associated with inscription activity.

H4: Higher inscription blockspace shares are associated with higher levels of blockspace utilisation.

The regression results support our hypothesis. The coefficient estimate of the inscription blockspace share is positive and highly significant. An increase of 1 percentage point in the share of blockspace consumed by inscriptions is associated with a 0.58 percentage point increase in overall blockspace utilisation. This indicates that inscriptions substantially contributed to Bitcoin blocks becoming fuller.

A possible explanation for this effect lies in the heterogeneity of transaction sizes across inscription categories. As shown in

Tables 5 and 7, BRC-20 and text inscriptions are considerably smaller than image inscriptions but occur in much higher numbers. A few large image inscriptions can easily consume the space of an entire block, whereas the smaller yet more numerous BRC-20 and text inscriptions can also drive blockspace consumption and efficiently fill residual space when blocks are nearly full. In both cases, the outcome is similar: inscriptions create additional demand for blockspace and thereby contribute to higher blockspace utilisation.

Log returns also exhibit a positive and significant effect, consistent with the notion that short-term price changes may stimulate transaction activity and thereby increase demand for blockspace. By contrast, price volatility shows no discernible impact. With an adjusted R-squared value of 0.46, the model accounts for a considerable share of variation in blockspace utilisation, though substantial unexplained dynamics remain.

H5: Higher inscription blockspace shares are associated with an increase in the average size of Bitcoin blocks.

The results provide evidence consistent with our hypothesis. The coefficient estimate of the inscription blockspace share is positive and highly significant. An increase of 1 percentage point in the share of blockspace consumed by inscription transactions corresponds to an increase in the average block size of approximately 0.017 MB. While this absolute value may appear modest, its cumulative effect is substantial given the block size limit of 4 MB. These regression results are consistent with our findings in Section 5.3, which show that the average block size rose sharply after the launch of the Ordinals protocol.

Because inscriptions store their content in the witness part of transactions, they can individually or collectively add substantial amounts of data, sometimes inflating block size to nearly 4 MB. Evidence from Table 8 also indicates that the increase in block size between the pre- and post-Ordinals periods was primarily driven by witness data. Although our model leaves a considerable share of variation unexplained, the combined evidence from our regression and descriptive analysis suggests that inscriptions were a major factor associated with the observed growth in block size.

H6.1: Higher inscription blockspace shares are associated with an increase in total transaction fees.

The results support our hypothesis. The coefficient estimate of the inscription blockspace share is positive and highly significant, indicating that a 1 percentage point increase in the inscription blockspace share is associated with roughly a 4% increase in total transaction fees. This suggests that inscriptions, by competing for scarce blockspace, contributed to higher fee revenue. By contrast, log returns and price volatility show no significant effects. However, our model only explains a moderate share of total fee revenue variation.

H6.2: Higher inscription blockspace shares are associated with an increase in regular transaction fees.

The coefficient estimate of the inscription blockspace share is positive and highly significant, implying that a 1 percentage point increase in the inscription blockspace share corresponds to approximately a 3.2% increase in regular transaction fees. This indicates that inscriptions, while paying lower average fee rates themselves, raised competitive pressure on regular transactions, pushing their fees higher. Price dynamics remain statistically insignificant. Although this model also only has moderate explanatory power, the results are consistent with our

Table 11. OLS Regression Results (1 July 2022 – 31 March 2024)

	(1) H1 Inscription Transaction Share (%)	(2) H2.1 Total Transactions (log)	(3) H2.2 Regular Transactions (log)	(4) H3 Taproot Utilisation (%)	(5) H4 Blockspace Utilisation (%)	(6) H5 Average Block Size (MB)	(7) H6.1 Total Transaction Fees (log)	(8) H6.2 Regular Transaction Fees (log)
Inscription Transaction Share (%)		0.013*** (0.000)	−0.001*** (0.000)	0.69*** (0.04)				
Inscription Blockspace Share (%)					0.58*** (0.05)	0.017*** (0.002)	4.071*** (0.476)	3.200*** (0.446)
Daily Bitcoin Log Returns	−5.20 (37.88)	0.742*** (0.243)	0.845*** (0.266)	20.01 (15.53)	40.75** (17.11)	0.887** (0.395)	1.984 (1.329)	2.034 (1.262)
7-Day Price Volatility	−568.82*** (159.85)	1.072 (0.763)	0.658 (0.914)	73.59 (60.30)	−57.45 (56.56)	2.045 (1.760)	2.646 (4.645)	2.506 (4.309)
Observations	640	640	640	640	640	640	640	640
Adjusted R-Squared	0.059	0.839	0.051	0.779	0.457	0.564	0.394	0.302

Note: Standard errors in parentheses. The significance levels are: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

hypothesis that inscriptions increase fee pressure on regular transactions.

7. Discussion

7.1 Broader Debates on Inscriptions

The impact of inscriptions on Bitcoin has been highly controversial, with critics warning of negative externalities and proponents emphasising potential benefits.

Critics argue that inscriptions contribute to network congestion and fee spikes, thereby reducing usability for regular payment transactions. Some even dismiss inscriptions as "spam" that exploits protocol features and undermines Bitcoin's original role as a peer-to-peer financial network [18].

By contrast, proponents argue that additional transaction volume from inscriptions increases miner revenue and thus strengthens the network's long-term security budget. They also emphasise that inscriptions introduced new use cases and spurred further innovation within the Bitcoin ecosystem. Proponents further highlight that inscriptions operate within Bitcoin's consensus rules and therefore did not alter the protocol's fundamental design [19].

7.2 Research Limitations and Future Research

Our study offers relevant perspectives on the impact of inscriptions on the Bitcoin network, yet it is not without limitations. By focusing on a period when inscriptions were the only significant metaprotocol-based asset on Bitcoin, we are able to isolate their effects more clearly. However, as Bitcoin's ecosystem continues to evolve, future research should explore how multiple metaprotocols and other emerging technologies interact and collectively influence Bitcoin's network dynamics.

Our regression analysis relies on daily data. While this level of granularity is sufficient for our purposes, block-level data could provide additional insights and help assess the robustness of our results.

Finally, our regression analysis focuses on the impact of inscriptions at the aggregate level. Future research could investigate the effects of individual inscription categories in greater detail.

8. Conclusion

Bitcoin inscriptions facilitate the on-chain storage of arbitrary data on the Bitcoin blockchain. This capability has unlocked new use cases within the Bitcoin ecosystem. In this study, we analysed the impact of inscriptions on Bitcoin's network dynamics across multiple dimensions. Our results show that inscriptions increased on-chain activity, intensified competition for blockspace, and influenced Bitcoin's fee market dynamics. We also find that the rise of inscriptions coincided with an increased utilisation of Taproot, an increase in average block size, and the longest sustained period of high blockspace utilisation in Bitcoin's history. Overall, these findings demonstrate that inscriptions have reshaped how the Bitcoin blockchain is used and underscore the growing diversification of its applications beyond its role as a peer-to-peer financial network.

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