

Unlocking the Diversification Potential of Bitcoin Forks in Crypto Portfolios

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ABSTRACT

Bitcoin forks have emerged as alternatives to mitigate Bitcoin's limitations or enhance its capabilities. Despite their common origin, there is a paucity of scholarly research investigating whether these forks facilitate diversification within cryptocurrency portfolios. This study evaluates the diversification potential of Bitcoin forks by scrutinizing their volatility and interrelationships with Bitcoin and among themselves. Employing a quantitative methodology, historical price data for Bitcoin and its ten forks from April 2020 to November 2024, obtained from CoinMarketCap.com, were analyzed. Advanced statistical methods, including Pearson correlation, Maximum Information Coefficient (MIC), Bayesian Information Criterion (BIC), and cluster analysis, were utilized to evaluate relationships and diversification advantages. The data reveal that most Bitcoin forks closely mimic Bitcoin's price patterns, demonstrating substantial positive correlations. However, certain forks, such as Bitcoin Gold, demonstrate unique patterns and reduced correlations, indicating possibilities for diversification. Certain forks offer special risk-adjusted return opportunities during times of high market volatility. Finding Bitcoin forks with distinctive characteristics can improve portfolio diversification, even though they typically mirror the price movements of the cryptocurrency. Analysis of these assets can help investors optimize risk-adjusted returns, particularly in volatile markets, highlighting the importance of strategic asset selection for a diversified cryptocurrency portfolio.

Keywords: Bitcoin forks, Portfolio diversification, Cryptocurrency markets, Risk and return analysis

1. Introduction

The reasons behind the establishment of cryptocurrencies were the weaknesses of the traditional systems of finance. Among them are centralization, the problem of high costs involved in executing a transaction, and insufficient transparency. With blockchain technology, peer-to-peer transactions have become safe, decentralized, and transparent. In 2009, a person or group otherwise known as Satoshi Nakamoto designed the first cryptocurrency called Bitcoin. Among these, its features are a fixed supply of 21 million coins that have helped place it as a revolutionary financial asset. The reasons behind the popularity of Bitcoin are due to its decentralized, transparent, and secure status, besides it also being a store of value. Known commonly as "digital gold," Bitcoin acts as an inflation and economic stability hedge, with its early adoption solidifying its position as the leading cryptocurrency (Bohr & Bashir, 2014; Nakamoto, n.d.).

Different types of Bitcoin forks, such as hard forks and soft forks, have emerged primarily to fix Bitcoin's weaknesses or to introduce new functionality (Narayanan et al., n.d.). A hard fork is a clear split in the blockchain, creating a new chain and requiring all users to use the new protocol. Examples of hard forks are Bitcoin Cash and Bitcoin SV, which were created to increase transaction capacity and scalability. A soft fork is a backward compatible upgrade, meaning that new features can be added without splitting the blockchain, such as Bitcoin's Segregated Witness (SegWit) upgrade. Issues of scalability, governance conflicts, new functionality, and competition in the marketplace are some of the primary reasons for the creation of forks (Corbet et al., 2019).

Bitcoin forks play a vital role in portfolio diversification in the cryptocurrency market. Even though most forks are highly positively correlated with Bitcoin, some of them, like Bitcoin Gold, exhibit different price actions and decreased correlation, hence providing diversification opportunities (Colombo et al., 2021). More importantly, the different levels of volatility combined with the unique market trajectories of these forks help investors diversify away some of the risks in Bitcoin's performance. These forks also consider specific use cases such as enhanced privacy or faster transaction processing thereby attracting various investor preferences. The inclusion of Bitcoin forks in a cryptocurrency portfolio tends to result in better risk-adjusted returns, especially during periods of market

volatility (Chen, 2023). Cryptocurrencies, particularly Bitcoin and its cousins, have turned into a hot asset class within the global financial ecosystem. There exist alternative cryptocurrencies which are simply called Bitcoin forks that are taken from the original Bitcoin blockchain and are developed to give new features, fix alleged flaws, or even create other governance structures (Kong et al., 2023). Bitcoin Cash, Bitcoin SV, Bitcoin Gold, Bitcoin Diamond, Bitcore, Bitcoin Atom, Bitcoin God, Super Bitcoin, and United Bitcoin are some of the more well-known ones (Bazan-Palomino, 2021). Every fork has unique traits and underlying value propositions that affect its market performance and potential usefulness for diversifying a portfolio (Kim et al., 2022).

Spreading investments across a variety of assets to lower risk and increase returns is known as portfolio diversification, and it is a fundamental component of contemporary investing theory (Markowitz, 1952). Diversification is especially important in this environment due to the extreme volatility of the cryptocurrency market and the strong correlation between different digital assets. Even though Bitcoin remains the largest cryptocurrency, owning more than 40% of the market capitalization as of early 2025 (CoinMarketCap, 2025), its forks offer investors wishing to diversify in this niche asset class both special opportunities and difficulties.

Bitcoin forks vary in their technical features, governance structures, and market behaviors, which can result in different levels of risk and reward. For example, Bitcoin Cash (BCH) was established in 2017 to tackle Bitcoin's scalability challenges, providing larger block sizes to facilitate quicker transactions (Briere et al., 2015). Bitcoin SV (BSV), another iteration of Bitcoin Cash, focuses on reinstating the original Bitcoin protocol while further increasing block sizes. Other forks, like Bitcoin Gold (BTG) and Bitcoin Diamond (BCD), aim to make mining easier by using algorithms that are not accessible to specialized mining equipment. Smaller-known forks, including Bitcoin God (GOD) and Super Bitcoin (SBTC), also research smart contracts and greater privacy features. Despite these improvements, market capitalization and adoption rates are very different among these forks, and Bitcoin Cash and Bitcoin SV are enjoying a relatively higher profile than their peers.

Bitcoin forks are an interesting case for diversification research since they are subgroups of the larger cryptocurrency market. Although the technological underpinnings of Bitcoin are transferred to these forks, their functionality, governance, and community support are different. For instance:

- Bitcoin Cash (BCH) increased block sizes to accelerate the transaction process.
- Bitcoin SV (BSV) was developed to scale the blockchain for business applications.
- Bitcoin Gold (BTG) has developed a mining algorithm that is resistant to ASIC gear in a bid to promote decentralization.

These distinguishing characteristics infer that, in theory, despite sharing a bloodline with Bitcoin, bitcoin forks may differ in their risk-return profile (Biais et al., 2019). In the theoretical framework for including bitcoin forks in a portfolio, it may be argued as justified since price movements in bitcoins will be regulated by different factors in the marketplace, thereby minimizing the overall risks of the diversified portfolio by minimizing the correlations.

The main aim of this study is to gauge the diversification of portfolios concerning Bitcoin forks. This research strives to highlight if these forks would help cryptocurrency investors reach better risk-adjusted returns by discussing past price behaviours, volatility responses, and correlation measures between them. It further explores whether the Bitcoin forks are distinct enough from both Bitcoin and each other for a diversified portfolio.

This research contributes to the growing stream of literature on cryptocurrency investing strategies by focusing on a niche set of digital assets often overlooked in studies of mainstream finance. Given the legal spotlight that Bitcoin has attracted and the recent technological ferment in blockchain technologies, it is crucial that institutional and individual investors develop an understanding of the behaviour of Bitcoin forks.

2. Literature Review

This literature review includes work related to portfolio diversification, the role of cryptocurrencies as a novel diversification option, Bitcoin's unique features and historical performance, and Bitcoin fork's potential to enhance portfolio efficiency through diversification.

2.1 Portfolio Diversification: Theoretical Foundations and Strategies

Portfolio diversification has long been a major element of the risk management strategy as per investment theory. The first framework illustrating how diversity could decrease the portfolio's risk without any loss in returns was found to be in Markowitz's Modern Portfolio Theory in the year 1952. Diversification into assets that have negative or low correlation will enable an investor to create the best trade-off between return and risk. Later researchers have tried to expand and diversify it further through portfolios in various asset classes like stocks, bonds, commodities, and real

estate scope (Elton et al., 2003); (Choueifaty, 2008). With the advent of new technologies in big data analytics and information technology, recent ones focus on dynamic portfolio strategies that adapt to market fluctuations. Now with the modern technologies regarding big data analytics and information technology, recent ones have tried focusing their interest on dynamic portfolio strategies built to adapt with the fluctuations within the marketplace (Ang et al., 2012); (Goetzmann et al., 2016).

2.2 Cryptocurrency as a Diversification Option

Because of the decentralized nature of cryptocurrencies, high volatility, and lack of usual market dependencies, they have enabled a new class of assets. There has been a lot of research on the use of cryptocurrencies as a diversification component in portfolios. For example, Bitcoin and other cryptocurrencies have recently been proven to have very small correlations with usual assets, therefore being a pretty good tool for diversification (Bouri, Lucey, et al., 2020). Similarly, (Chang et al., 2023) highlighted the safe-haven nature of cryptocurrencies during adverse financial conditions. Moreover, as they are decentralized, the traditional financial system is more resistant to systemic shocks (Yermack, 2015); (Corbet et al., 2019). The lack of study on the diversity of cryptocurrencies and Bitcoin splits is often excluded from the area. One exception is (Yermack, 2015), who contends that it is important to distinguish between large cryptocurrencies and smaller, less liquid ones when constructing portfolios but challenging to include them in traditional portfolios because of their extreme volatility and regulatory uncertainties (Koutmos, 2018).

2.3 Bitcoin: The Flagship Cryptocurrency

The most widely known and original cryptocurrency, Bitcoin, has been a subject of much research regarding its potential as a tool for diversification and investment. Decentralization, transparency, and a fixed supply cap are some of the characteristics of Bitcoin that add to its allure as "digital gold." Both institutional and ordinary investors have been drawn to it because of its track record as a high-risk, high-return asset. Scholarly research points out that Bitcoin has low or negative correlation with traditional assets, especially in times of turmoil, thus strengthening its diversification ability (Dyhrberg, 2016); (Bouri, Shahzad, et al., 2020). On the other hand, the argument is made that it is prone to speculative bubbles and environmental damage because of energy consumption in mining activities (de Vries, 2020). Bitcoin's place in portfolio diversification has been the focus of much recent financial research. There is empirical evidence that Bitcoin can enhance portfolio efficiency through returns that are uncorrelated or even negatively correlated with those of traditional asset classes. For instance, (Bossman et al., 2024) proved that Bitcoin acts as a hedge during economic downturns, thereby preserving value when traditional markets decline. (Shahzad et al., 2019) analysed dynamic linkages between Bitcoin and traditional assets, which shows that Bitcoin's diversification benefits are powerful in times of market stress. Also, it provides a higher opportunity for a great return but at a cost of higher risk. Further research has focused on Bitcoin's link to other altcoins. There is an implication that although most cryptocurrencies are seen moving with the leader, the bitcoin, specific altcoins move independently and expand on the available options of diversification. (Corbet et al., 2018); (Zaremba et al., 2021). Risk-averse investors have always worried about regulatory uncertainties and market immaturity.

2.4 Bitcoin Forks and Portfolio Diversification

Bitcoin forks include Bitcoin Cash (BCH), Bitcoin SV (BSV), Bitcoin Gold (BTG), Bitcoin Diamond (BCD), Bitcore (BTX), Bitcoin Atom (BCA), Bitcoin God (GOD), Super Bitcoin (SBTC), United Bitcoin (UBTC), and yet another fork-such as Bitcoin Private or another variant., all of which appeared in response to Bitcoin's perceived limitations or with a desire to test new features. Bitcoin forks share a common family tree with Bitcoin but tend to have distinct features, such as block size, transaction speed, and mining algorithms (Zaghloul et al., 2020). Bitcoin forks offer unique opportunities, given that they have different levels of correlation both with Bitcoin and with each other. For example, it has been reported that although most tend to track the price movements of Bitcoin closely, some, like Bitcoin Gold, tend to behave differently and exhibit decreased correlations, especially during periods of volatility (Kim et al., 2022). Such variations increase their diversification potential. The market for Bitcoin forks is relatively nascent, creating chances to exploit inefficiencies and attain superior risk-adjusted returns as averred by (Jalan et al., 2021). On the other hand, diversification based on Bitcoin forks faces various challenges in the form of market dynamics that are susceptible to lower liquidity, regulatory uncertainties, and technological adoption rates.

Another study by (Gkillas et al., 2021), examined the volatility clustering in Bitcoin forks and found that, during periods of market instability, some forks may provide higher risk-adjusted returns. The diversification benefits of Bitcoin forks are also more evident when combined with other cryptocurrencies and traditional assets, as they expose investors to different blockchain advancements (Yousaf et al., 2023) In reality, however, factors like lower liquidity, different adoption rates, and regulatory pressure would affect the use of forks in a portfolio (Yermack, 2015); (Corbet et al., 2018). However, using Bitcoin forks is considered a good diversification vehicle for investors who require diversification within the Bitcoin world since they can even complement the benefits of Bitcoin hedging by allowing for more avenues of growth and risk management.

There are two distinct types of Bitcoin forks: hard forks and soft forks. Since the hard forks are modifications of the Bitcoin protocol, these are incompatible with earlier versions and therefore create new coins (Schär, 2020). Soft forks are changes that are backward compatible without creating new coins. The most widely known hard fork is Bitcoin Cash (BCH), which was developed in 2017 in an attempt to solve the scalability problems with Bitcoin. Later forks, such as Bitcoin SV (BSV) and Bitcoin Gold (BTG), have included innovations like bigger block sizes and changed algorithms to fight mining centralization (Bazan-Palomino, 2021). Most of the basic characteristics of Bitcoin, including decentralization and the use of blockchain technology, are often transferred to Bitcoin forks. Their market capitalization, liquidity, and adoption rates, however, vary significantly (Conlon et al., 2024). While Bitcoin Gold and Super Bitcoin remain niche projects with little market activity, Bitcoin Cash and Bitcoin SV, for instance, have very strong ecosystems. These differences underscore the importance of evaluating the distinctive risk-return profile of each fork and how it might contribute to portfolio diversification.

Since Bitcoin is often used as a benchmark for the market, research has centred on the extreme volatility of cryptocurrencies. It was found that altcoins, being similar to Bitcoin forks, tend to be closely related to Bitcoin, particularly when the market is down (Corbet et al., 2019). Nevertheless, some of the forks exhibit unique price swings because of their special technological features and community support. As can be seen above, for instance, the democratised mining of Bitcoin Gold and the large-block strategy of Bitcoin SV, have produced niche user communities which may cause strange market activity. Despite these differences, the overall pattern of interlinkages between Bitcoin forks and between forks and Bitcoin remains somewhat robust, limiting their utility as diversification vehicles (Kim et al., 2022). The same market factors shaping the cryptocurrency sector, including investor sentiment and macroeconomic conditions, are often cited as factors behind this reality.

2.5 Major Events between the period of 2020 to 2024

Between the years 2020 and 2024, significant events in cryptocurrencies had shaped the role of Bitcoin forks in portfolio diversification. Some of the major events are Bitcoin halving, legal battles, regulatory changes, and market milestones, which had direct and indirect impacts on Bitcoin forks like Bitcoin Cash (BCH) Bitcoin Gold (BTG), and others.

Bitcoin Halving (May 2020 and April 2024): Bitcoin halving events often lead to an increase in the price and an increase in attention in the markets because they reduce the rate of new bitcoins in circulation (Kapar & Olmo, 2021). Bitcoin forks, which share similar mechanisms and often inherit Bitcoin's features, saw increased interest and price movements during these periods (Fosso Wamba et al., 2020). For investors, Bitcoin forks offered a chance to diversify portfolios with alternative cryptocurrencies that could profit from Bitcoin's price trends; for instance, during the 2020 halving, Bitcoin Cash and Bitcoin Gold saw speculative rallies (Yermack, 2020). The April 2024 halving had the same effects, with Bitcoin forks seeing price fluctuations aligned with the larger Bitcoin market (Sedlmeir et al., 2024). **Lawsuit SEC v. Ripple (December 2020):** Clear regulatory frameworks are necessary, as shown by the legal dispute between Ripple (XRP) and the U.S. Securities and Exchange Commission (SEC). Since they were derivatives of Bitcoin, Bitcoin splits often benefited from more regulatory clarity in this regard. Bitcoin forks like Bitcoin Cash and Bitcoin Gold remained stable throughout the litigation because they were widely thought to be more legally defensible than other altcoins like XRP. Bitcoin splits were a desirable alternative for diversification in times of regulatory uncertainty because of this regulatory clarity (Kim et al., 2022). **Approval of Bitcoin Spot ETF (January 2024):** An important turning point in the integration of Bitcoin into conventional financial markets was the adoption of Bitcoin spot ETFs in January 2024 (Mazur & Polyzos, 2024). As a result of this incident, institutional interest in Bitcoin and its forks grew, opening up additional diversification options. For institutional investors seeking alternative exposure in a regulated environment, Bitcoin forks—which share the core value proposition of Bitcoin—became attractive investment choices. Despite their correlation with Bitcoin, forks like Bitcoin Cash often displayed unique price swings, enabling investors to manage risk in their portfolios (Köchling et al., 2019).

Reaching \$100,000 in Pro-Crypto and Bitcoin Campaigns: As the Bitcoin price hit the threshold of \$100,000, along with government support that had begun increasing towards the cryptocurrency, exposure increased as well as speculation for a split of the Bitcoin, while forking mechanisms like Bitcoin Cash and Bitcoin Gold continued to rocket high at each and every pump by market speculators (Sedlmeir et al., 2024). However, these forks have also had serious negative effects, like the decline in Bitcoin Cash's market share following competition with Bitcoin's scaling solutions (Kim et al., 2022) However, these fluctuations offered investors the opportunity to diversify their holdings and make high-risk, high-reward acquisitions during Bitcoin's bull runs.

Increasing Institutional Interest and Regulation: As a result of regulatory developments and growing institutional interest, Bitcoin forks were accepted as respectable assets for portfolios. With their strong ecosystems, Bitcoin Cash and Bitcoin Gold in particular emerged as well-known substitutes for Bitcoin in institutional portfolios. In contrast to other cryptocurrencies, these forks saw considerable stability as the cryptocurrency ecosystem got more regulated

(Hasan et al., 2022) Regulating Cryptocurrencies: Assessing Market Reactions. These forks' position as diversification tools in the larger Bitcoin market was further cemented by institutional investors' heightened perception of their validity.

Notable Ups and Downs of Bitcoin Forks Bitcoin forks have experienced a number of relatively significant ups and downs. After the fork that occurred in 2017, acceptance as a peer-to-peer electronic currency system led to notable price spikes in Bitcoin (Ozisk & Levine, 2017). But as layer-two scaling solutions for Bitcoin became popular, Bitcoin Cash also ran into problems that led to its market dominance being eroded (Kim et al., 2022). Similarly, because of its extreme volatility and security flaws, the Bitcoin Gold, which was an alternative to Bitcoin offering a more decentralized version, saw both periods of value growth and decline (Corbet et al., 2019). In fact, despite the fluctuations, investors could take advantage of the unique technical features of each fork to diversify their risks, exploit unique market opportunities, or shield themselves from the volatility of Bitcoin.

Together, such events have altered how Bitcoin splits act as diversification instruments for the cryptocurrency portfolio. Unique pricing patterns, which echo Bitcoin's changes, made Bitcoin forks helpful instruments to balance risk against reward in any investor's portfolios. Changes in dynamics such as adoption and regulation do help institutional interest by making bitcoins such as bitcoin cash and bitcoin gold essential ingredients of diversified portfolios of cryptocurrencies. They reduced the risks associated with Bitcoin's performance and offered alternative exposure.

2.6 Theoretical Base

Introduction of Modern Portfolio Theory (MPT) and its later modifications in the context of cryptocurrency markets form the theoretical basis of this investigation. By using diversification to balance risk and return, MPT offers a framework for building the ideal portfolio. It highlights how crucial it is to choose assets with low or negative correlations to maximize expected returns and reduce overall portfolio risk (Markowitz, 1952). Historically, MPT has been applied to the more conventional financial markets of equities, bonds, and commodities. However, ideas are becoming ever more applicable to cryptocurrencies, an entirely new asset class that happens to be extreme in its variability. Due to their low correlations with traditional classes of assets, studies have established that cryptocurrencies could offer diversification benefits despite volatility (Bouri, Lucey, et al., 2020). More basically, to effectively use MPT in the cryptocurrency space, there is an immense need to understand the unique nature of these digital assets, including their technological basis, market dynamics, and investor sentiment (Chen, 2023).

One of the main concepts in MPT is the efficient frontier: the set of optimal portfolios offering the highest possible predicted return for a given level of risk. Building such an efficient frontier for Bitcoin forks involves examining the correlations, volatility, and past performance of different assets (DeMiguel et al., 2009). Some Bitcoin forks may shift the efficient frontier outwards, offering investors better risk-adjusted returns because of their distinct characteristics and market behavior.

2.7 Research Gaps and Objectives

Even though the previous research offers insightful information about the overall dynamics of cryptocurrency markets, there are still some gaps:

1. Bitcoin forks are paid less attention to as a class of assets in themselves.
2. The Bitcoin fork ecosystem's links and diversification potential are not relatively well explored.
3. Not enough empirical research has been conducted on the risk-adjusted performance of portfolios that contain Bitcoin forks.

The present study endeavors to close the above gaps and comprehensively evaluate their potential for diversification by methodically examining the price behavior, volatility, and correlation patterns of Bitcoin forks.

3. Data and Methodology

In order to perform deep research on Bitcoin forks and their use in portfolio diversification, a list of forks was fetched from ForkDrop.io, a specialist tracking platform for bitcoin forks. After examining each fork thoroughly, Forkdrop.io reported 75 overall splits. Among the most dominant were Bitcoin Cash (BCH), Bitcoin SV (BSV), Bitcoin Gold (BTG), and others. Collect data using CoinMarketCap.com, an aggregator of famous cryptocurrency data to gather historical prices and market information for these forks. CoinMarketCap provides so much information like historical price movements, market capitalization, and trade volumes, in order to gauge the market dynamic and diversification potential of the assets. Using information derived from these credible sources, the research guarantees a comprehensive assessment of the special value that Bitcoin forks bring to the strategies of a cryptocurrency portfolio. When information was drawn from CoinMarketCap, however, only ten Bitcoin splits have historical data that cover

the price and market movements sufficient for research. For example, some forks with adequate data include Bitcore (BTX), Bitcoin Atom (BCA), Bitcoin Cash (BCH), Bitcoin SV (BSV), Bitcoin Gold (BTG), Bitcoin Diamond (BCD), Bitcoin God (GOD), Super Bitcoin (SBTC), United Bitcoin (UBTC), and another fork—like Bitcoin Private or another variant. The restricted data availability in this list of examples emphasizes the fragmented and growing character of diverse cryptocurrency initiatives and highlights a common challenge in cryptocurrency research.

The time frame under this analysis is between April 10, 2020, and November 9, 2024. This timespan has been selected to reflect the evolution of the cryptocurrency landscape and the performance of Bitcoin splits since their inception in 2017. This time frame reflects multiple market cycles, which can offer a useful perspective on how the forks perform in different market scenarios.

A methodical approach based on well-established statistical and machine learning approaches guarantees reliable and significant outcomes when optimizing portfolio diversification using Bitcoin forks. To ensure data dependability, pre-processing starts with handling missing values using imputation techniques like mean or median replacement and handling outliers using strategies like winsorization or the interquartile range (IQR) rule (Gelman et al., 2004). The natural logarithm of price ratios is used in log return computation to normalize data, making it stable and appropriate for statistical analysis—a procedure that is generally advised for financial time series (Campbell et al., 1997).

A thorough understanding of asset interrelationships is provided by correlation analysis, which uses the Pearson correlation coefficient to measure linear relationships and the Maximal Information Coefficient (MIC) to identify both linear and non-linear dependencies (Reshef et al., 2011). The Bayesian Information Criterion (BIC) strikes a balance between model complexity and fit, as shown in model selection studies (Schwarz, 1978), effectively identifying important variables while excluding those that are unduly impacted by Bitcoin's dominance.

Lastly, a machine learning technique called hierarchical clustering organizes assets according to how similar their price movements are. By examining within-cluster variation, the elbow technique establishes the ideal number of clusters, and dendrograms provide a visual hierarchy of asset linkages that makes comprehension easier (Ward, 1963). Previous research, such as (Aste, 2019) which investigated the possibility of diversification in financial networks using hierarchical clustering, has verified these clustering methodologies.

The study expands on earlier research by using this structured methodology, including, which looked at the unique roles that Bitcoin forks play in portfolio optimization. By using this methodology, investors may create diversified cryptocurrency portfolios which bring down systemic risks by identifying Bitcoin forks with distinct risk-return profiles.

Having executed the correlation analysis of Bitcoin with its forks and forks, MPT optimized portfolios composed of Bitcoin and its forks are formed. Cases considered in the optimization of the portfolios were the equal-weighted portfolios, the risk-minimized portfolios, and the return-maximized portfolios. The Pearson correlation coefficients are determined. A smaller correlation has greater diversification ability, and larger correlations denote slighter benefits.

To evaluate the performances of these portfolios, risk-adjusted measures such as Sharpe Ratio, Sortino Ratio, and beta values were calculated. These metrics allowed for the comparison of the relative attractiveness of Bitcoin forks in a diversified portfolio. Analytics was executed using Python, with data manipulation done via Pandas and NumPy libraries along with Matplotlib and Seaborn for visualization, among these correlation matrices and efficient frontier charts. Preliminary data review and setup were completed using Microsoft Excel.

Specifically, the study encountered certain limitations that are concerned with the historical availability of data: only 10 forks gave a sufficient history for analysis. It is thereby prone to survivorship bias because less successful or dormant forks are excluded from the analysis. Lastly, the highly speculative and evolving nature of the cryptocurrency markets could introduce external effects from regulatory change or macroeconomic events that have impacted the conclusions of the research.

This research study aims to provide an enhanced understanding of strategies related to portfolio management for bitcoins through informative insights regarding the potential of Bitcoin forks to diversify by utilizing powerful statistical and portfolio optimization methods for a specified time horizon.

4. Results & Discussion

Table 1: The correlation relationship between BTC and its forked coins

Forked Coin	MIC	Pearson	T-Value	P-Value
Bitcoin Cash	0.4425	0.6779	30.8728	0
Bitcoin SV	0.3809	0.5256	20.6862	0
Bitcoin Gold	0.3954	0.6718	30.3655	0
Bitcoin Diamond	0.2272	0.5183	20.2927	0
BitcoinX	0.1609	0.1273	4.2984	0
Bitcore	0.1609	0.1273	4.2984	0
Bitcoin Atom	0.2252	0.0722	2.4227	0.0156
Bitcoin God	0.2258	0.0244	0.8169	0.4142
Super Bitcoin	0.1321	0.0551	1.8482	0.0648
United Bitcoin	0.6425	0.1018	3.4263	0.0006

In Table 1, statistical analysis of the relationship between Bitcoin and its forks is performed by using the MIC, Pearson correlation, T-value, and P-value. The high MIC values of 0.4425 and 0.3954 along with Pearson correlations of 0.6779 and 0.6718 in Bitcoin Cash and Bitcoin Gold show strong linkages with Bitcoin and indicate significant linear and non-linear dependencies. Their high T-values of 30.8728 and 30.3655, along with P-values of 0, further strengthen their substantial statistical significance. However, the MIC and Pearson correlations of BitcoinX, Bitcore, Bitcoin God, and Super Bitcoin are modest, indicating little reliance on Bitcoin's returns. United Bitcoin has a high MIC of 0.6425 but a low Pearson correlation of 0.1018, indicating possible non-linear interactions. There was no statistically significant connection between Super Bitcoin ($P = 0.0648$) and Bitcoin God ($P = 0.4142$). In all aspects, it is evident that while some of the forks are closely related to Bitcoin, including Bitcoin Cash and Bitcoin Gold, others have relatively weak or no connection at all, with the possibility of some non-linear effects in certain situations.

With the Pearson and MIC correlation being considered, A statistical technique for evaluating a time series' stationarity is the KPSS (Kwiatkowski-Phillips-Schmidt-Shin) test, which tests the null hypothesis that the series is stationary around a deterministic trend. Other tests, such as the Augmented Dickey-Fuller (ADF) test, which looks for a unit root and indicates non-stationarity, stand in contrast to this. When researchers need to verify that a time series is trend-stationary or stationery around a constant and does not include a stochastic trend, the KPSS test is very helpful. In the KPSS test, the alternative hypothesis proposes non-stationarity, whereas the null hypothesis asserts that the time series is stationary. This tests was carried out to filter off the non-stationary series and thereby bring down the influence of Bitcoin over all the series. The dataset was then refined for precise variable selection after the completion of the correlation study between Bitcoin and its offshoot cryptocurrencies using both Pearson correlation and Maximal Information Coefficient (MIC). While the correlation measurements gave insights into the linear and nonlinear correlations among the cryptocurrencies, the researchers found that Bitcoin's strong effect on its forks might affect the findings of later modeling.

Table 2. Result of KPSS test

Forked Coin	KPSS Test P-Value	Stationary	Observations
Bitcoin	0.1	TRUE	1121
Bitcoin Cash	0.1523	TRUE	1122
Bitcoin SV	0.0897	TRUE	1121
Bitcoin Gold	0.0815	TRUE	1121
Bitcoin Diamond	0.1342	TRUE	1122
BitcoinX	0.1194	TRUE	1121
Bitcore	0.0901	TRUE	1121
Bitcoin Atom	0.0783	TRUE	1122
Bitcoin God	0.1026	TRUE	1121
Super Bitcoin	0.0954	TRUE	1121
United Bitcoin	0.1215	TRUE	1121

In Table 2 The KPSS (Kwiatkowski-Phillips-Schmidt-Shin) test was used to exclude non-stationary series and make sure the dataset complied with the stationarity criterion for reliable time-series analysis in order to lessen this. Each cryptocurrency produced consistent results as the KPSS tests were conducted; the p-values for each cryptocurrency were higher than the conventional threshold (e.g., 0.05), indicating that their respective time series were stationary; this conclusion was further supported by the "Stationary" column, which marked all series as "TRUE." The lag order was determined automatically, with the "Auto" lag selection method guaranteeing that the ideal number of lags was

used for each test; the dataset was well-structured, with the majority of cryptocurrencies having 1121 or 1122 observations, making the analysis consistent and trustworthy. Having established stationarity, the authors then chose variables based on the BIC. The stationarity of the data rendered it easier to use BIC and ensured that the variables would render models that are accurate yet not too complicated. This method ensured a clean data set by eliminating potential noise from the non-stationary series, which reduced the overbearing effect of Bitcoin on the forks. Ultimately, it was this kind of attention to detail that enabled the team to uncover important insights into the dynamics of Bitcoin and its forks and laid the groundwork for rigorous modeling devoid of false correlations.

Figure 1: BIC value for each year

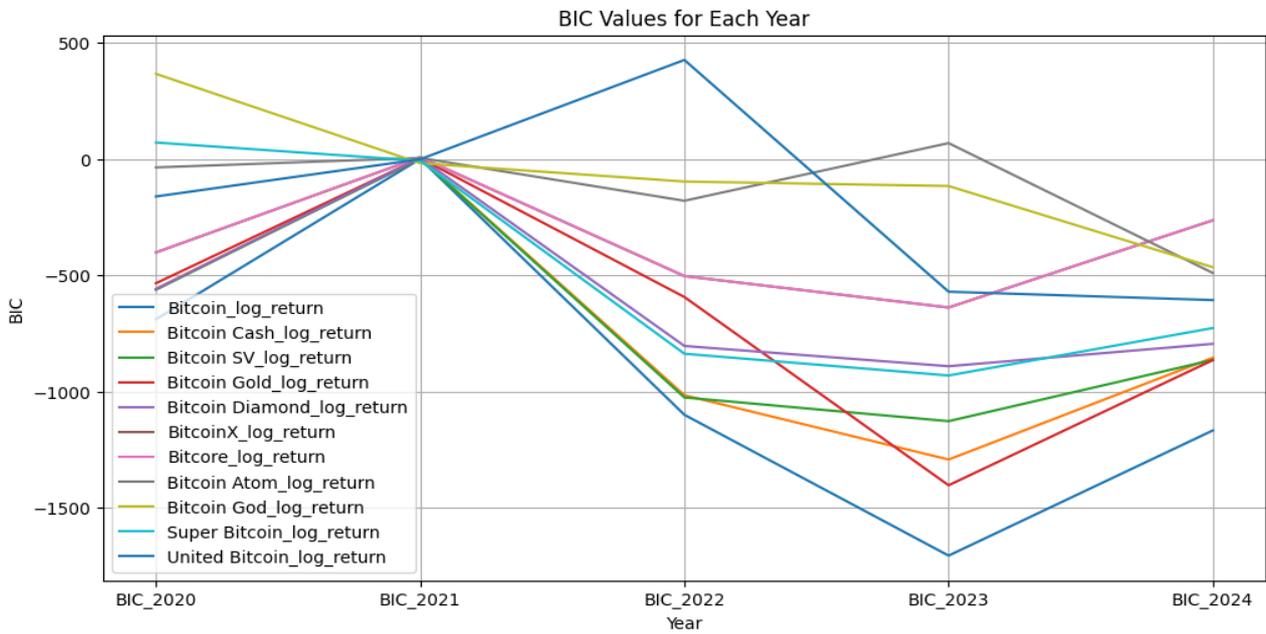


Figure 2: Correlation heatmap

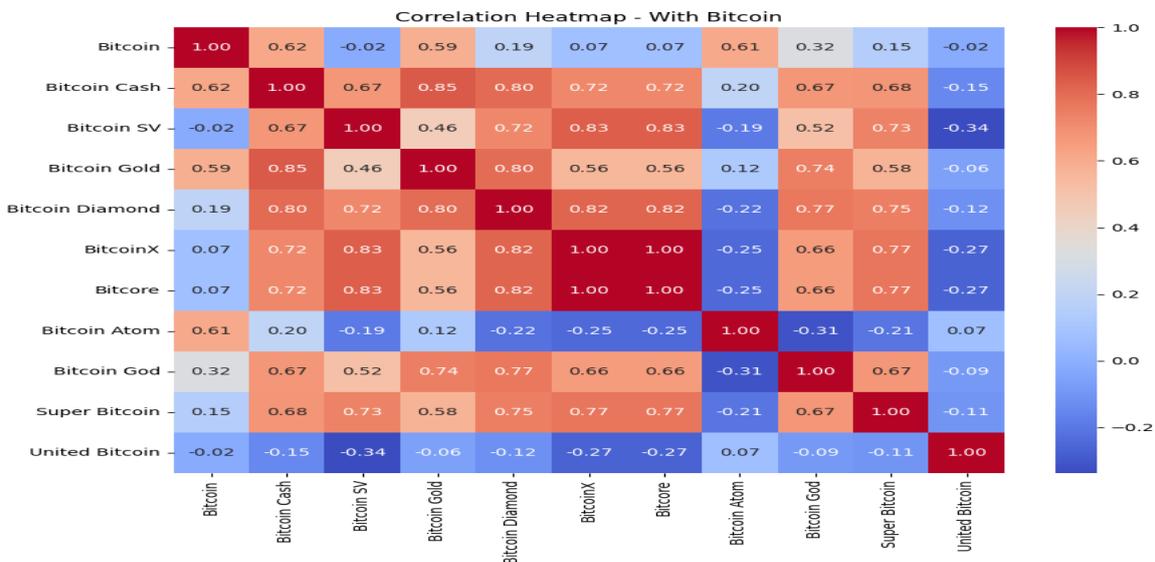
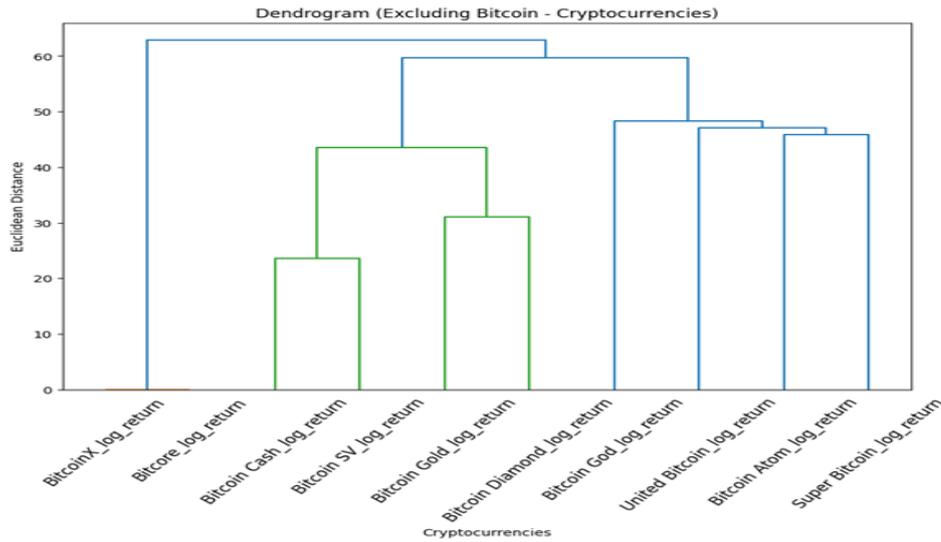


Figure 1. The trends reveal distinct patterns over time. For instance, Bitcoin (Bitcoin_log_return) shows a sharp improvement in model fit from 2021 to 2022, with a steep drop in BIC, but its fit weakens again in subsequent years. Cryptocurrencies like Bitcoin Gold_log_return maintain consistently lower BIC values, indicating better model performance, while others, such as Bitcoin God_log_return, struggle with persistently higher values. The figure highlights how market dynamics and structural differences influence the model's ability to explain log returns for each cryptocurrency over the years. The correlation heatmap in Figure 2 shows different degrees of association between

Figure 5: Cluster (Excluding Bitcoin)



After identifying the optimal clusters using the Elbow Method, the dendrogram- Figure 4 revealed how cryptocurrencies were grouped. Bitcoin and its major forks—Bitcoin Cash, Bitcoin SV, and Bitcoin Diamond—formed a tight cluster, showing similar return patterns. Bitcoin Gold, while somewhat distinct, remained loosely connected. Excluding Bitcoin in Figure 5, the forks stayed closely grouped, but cryptocurrencies like BitcoinX, Bitcore, and Bitcoin God appeared in separate, far-flung clusters, reflecting their unique behaviors. This analysis highlights how Bitcoin and its forks are strongly interconnected, while niche cryptocurrencies offer diversification opportunities due to their independence.

Table 3: Quantitative characterization of four different clusters.

Cluster No.	Bitcoin Fork Name	Mean	SD	Median	Trimmed	MAD	Min	Max	Range	Skew	Kurtosis	SE
1	Bitcoin Cash	0.00051	0.04777	-0.00062	-0.00025	0.03002	-0.33095	0.39494	0.72589	0.89685	17.41356	0.00144
1	Bitcoin SV	-0.00108	0.0496	-0.00219	-0.00136	0.03047	-0.40827	0.40982	0.81808	0.34077	19.22049	0.00149
1	Bitcoin Diamond	-0.00202	0.06489	-0.00258	-0.00264	0.03876	-0.45471	0.68829	1.14301	1.19305	24.49785	0.00195
2	Bitcoin	0.00219	0.03262	0.00076	0.00182	0.0205	-0.25284	0.3158	0.56864	0.54454	17.95915	0.00098
2	Bitcoin Gold	0.00094	0.06311	-0.00215	-0.0016	0.03138	-0.33936	1.30742	1.64678	8.7163	173.56029	0.0019
3	BitcoinX	-0.00041	0.12154	-0.00107	-0.00231	0.07562	-0.68285	0.70467	1.38752	0.11662	8.90436	0.00365
3	Bitcore	-0.00041	0.12154	-0.00107	-0.00231	0.07562	-0.68285	0.70467	1.38752	0.11662	8.90436	0.00365
4	Bitcoin God	-0.00027	0.32112	-0.00052	-0.00007	0.10758	-1.96216	2.64561	4.60776	0.5026	25.63576	0.00965
4	United Bitcoin	0.00029	0.26635	-0.00038	-0.00044	0.05763	-4.2518	4.32111	8.57291	3.29286	177.58769	0.00801
4	Bitcoin Atom	0.00309	0.20383	0.00084	-0.00277	0.09768	-0.80926	3.67112	4.48038	5.56802	100.20377	0.00613
4	Super Bitcoin	0.00031	0.14366	-0.0003	-0.00055	0.06987	-1.11398	1.08073	2.19471	0.07549	19.3257	0.00432

Table 3 presents an extensive statistical evaluation of Bitcoin forks, categorized into four separate clusters based on their traits. Cluster 1, which includes Bitcoin Cash, Bitcoin SV, and Bitcoin Diamond, shows a moderate level of risk and volatility, accompanied by low average returns and standard deviations. Among these, Bitcoin Diamond presents the highest spread, indicating a higher variability of its price change. The skewness and kurtosis value for this cluster indicates that there exist higher tail risks, and its distribution is found to indicate potential extreme price swings. Cluster 2 includes Bitcoin and Bitcoin Gold, in which Bitcoin presents the lowest standard deviation, showing how relatively stable Bitcoin is compared with other cryptocurrencies. On the other hand, Bitcoin Gold is more volatile and has a wider range, with a positive skew and more pronounced tails, which means that it is susceptible to extreme events. Cluster 3, which contains BitcoinX and Bitcore, is characterized by the highest standard deviations and ranges, making those assets quite volatile and suitable for high-risk, high-reward investment strategies. Last but not least, Cluster 4 is characterized by the extreme volatility of Bitcoin God, United Bitcoin, Bitcoin Atom, and Super Bitcoin, as United Bitcoin presents an unusually high range, skewness, and kurtosis, implying volatile price action. This cluster comprises the riskiest assets, which have the potential for extreme price movements. Summarizing, the analysis suggests the diversity of Bitcoin forks concerning their risk and return properties. Cluster 1 offers mediocre

diversification, Cluster 2 provides relatively stable and limited extreme returns, Cluster 3 attracts bold risk-takers, and Cluster 4 is volatile. Such results can give an investor the ability to build relevant portfolio strategies based on risk appetite and investment objectives.

Table 4: Technical characteristics among four different clusters.

Cluster No.	Bitcoin Fork Name	Consensus	Codebase	Bech32	SegWit	Height Forked	Forked Time	Projected Type
1	Bitcoin Cash	PoW	Bitcoin Core	Yes	Yes	478558	01-08-2017	Mainstream
1	Bitcoin SV	PoW	Bitcoin ABC (modified Bitcoin Core)	Yes	Yes	504032	15-11-2018	Mainstream
1	Bitcoin Diamond	Optimized X13	Bitcoin Core	No	No	495866	24-11-2017	Experimental
2	Bitcoin	PoW	Bitcoin Core	Yes	Yes	478558	01-08-2017	Mainstream
2	Bitcoin Gold	Equihash	Bitcoin Core	No	No	491407	24-10-2017	Mainstream
3	BitcoinX	PoW	Bitcoin Core	No	No	501118	25-01-2018	Experimental
3	Bitcore	ME GA-BTX	Bitcoin Core	No	No	501118	25-01-2018	Experimental
4	Bitcoin God	PoW	Bitcoin Core	No	No	501225	28-12-2017	Experimental
4	United Bitcoin	PoW	Bitcoin Core	No	No	498744	12-12-2017	Experimental
4	Bitcoin Atom	Hybrid (PoW/PoS)	Bitcoin Core with hybrid functionality	No	No	505888	23-12-2017	Experimental
4	Super Bitcoin	PoW	Bitcoin Core	No	No	498888	12-01-2018	Experimental

Table 4 This table displays a comparison in great detail between various Bitcoin forks, segregated into four groups depending upon the consensus method, codebases, functionalities, fork heights, and the type of application in which they are most likely to be used. Group 1 includes Bitcoin Cash and Bitcoin SV, both of which are based on the PoW consensus method and forked from the Bitcoin Core codebase but the latter has implemented an adapted version known as Bitcoin ABC. Both forks have adopted sophisticated features like Bech32 and SegWit, improving scalability and user experience. They diverged at levels 478558 (1 August 2017) and 504032 (15 November 2018) respectively and are classed as being in the mainstream, which demonstrates that their intentions are for mainstream adoption. Bitcoin Diamond and Bitcoin Gold are included in Group 2. Again these are forked from Bitcoin Core but implement other consensus mechanisms than Bitcoin: Bitcoin Diamond employs Optimized X13 and Bitcoin Gold uses Equihash. Neither of them have Bech32 or SegWit which would limit their usability. Forked in late 2017, Bitcoin Gold is considered mainstream while Bitcoin Diamond is considered experimental, showing different levels of acceptance and focus. Group 3 consists of BitcoinX and Bitcore, the latter of which uses the MEGA-BTX method, while the former applies the PoW method. These two are considered experimental forks with no support for Bech32 or SegWit since they were derived from height 501118 on January 25, 2018, and are not general-use-based but rather feature-focused. Group 4 includes Bitcoin God, United Bitcoin, Bitcoin Atom, and Super Bitcoin, all of which are based on Bitcoin Core, with Bitcoin Atom introducing a mixed PoW/PoS consensus mechanism. These experimental forks were forked between December 12, 2017, and December 23, 2017, and do not support Bech32 or SegWit, focusing on the exploration of new features. In summary, the chart emphasizes the variety among Bitcoin forks, with some aiming for mainstream acceptance through advanced scalability options, while others focus on experimental developments to tackle Bitcoin's challenges or investigate niche applications.

5. Conclusion and Policy Recommendations

This study analyzes the relationship between Bitcoin and its forks, stressing their stationarity, correlation, and potential for diversification in a cryptocurrency portfolio. The results show that Bitcoin Cash and Bitcoin Gold have strong linear and non-linear ties to Bitcoin, high MIC and Pearson correlations, low P-values, and significant T-values. These forks' strong statistical links to Bitcoin make them an excellent option for portfolio diversification. However, the correlations of other forks, such as BitcoinX, Bitcoin God, and Super Bitcoin, are smaller, indicating that they are less dependent on Bitcoin's earnings. The clustering analysis further highlighted the distinct risk-return profiles of these cryptocurrencies, with some, like Bitcoin Gold, maintaining consistent model fit and others, like Bitcoin God, displaying greater model instability, according to the BIC values for variable selection. The grouping of Bitcoin forks into clusters based on their return characteristics provides useful information for investors who want to tailor their portfolios to particular risk tolerances.

The future of Bitcoin forks and the larger cryptocurrency ecosystem is largely up to policymakers. To start, transparent regulatory frameworks are necessary to shield investors from the risks of speculative and volatile forks; regulators should keep an eye on how Bitcoin forks affect market stability and conduct stress tests to avoid the systemic risks; and educational campaigns are required to educate investors about the distinctions between Bitcoin and its forks so they can make well-informed decisions.

The key to implementing Bitcoin forks in a regular portfolio would be collaboration with financial institutions while maintaining strict regulatory standards. Research must be embraced by policymakers by encouraging the establishment of publicly accessible databases for the performance of cryptocurrencies and market dynamics. The environmental impacts of cryptocurrency mining must be dealt with either through sustainable practices or through alternative consensus mechanisms like Proof of Stake.

Moreover, the diversification of the cryptocurrency market necessitates standardization for easy regulation and avoiding the confusion of investors. A well-rounded approach with regulation, education, and cooperation is the way towards a stable, secure, and transparent development of Bitcoin and its derivatives for the investors and the wider financial system.

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