Determinants of Cryptocurrency Volatility and its Linkages with The Stock Market

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ABSTRACT

This study analysed the certain features of cryptocurrencies connect to their ups and downs alongside traditional assets. It assessed how specific traits of some cryptos shape their volatility and how they move in synchronize with stock markets. To get a clear picture, the research compares the top 100 cryptocurrencies with eight major stock markets. Cointegration analysis and Granger causality tests had been applied to find hedge effects and co-movement. The logistic regression models found out the crypto-specific features really drive their dynamics. This research found that consensus and scarcity powerfully impact the co-movements. This study also highlighted the features and potential of cryptocurrencies that can dramatically alter the demand or perception towards them. These characteristics are rooted in finance theory and may alter the flexibility of cryptocurrencies, which has implications for demand, price, hedging efficiency and return relative to stocks' return.

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1.   Introduction

Individual and corporate investors are growing increasingly interested in cryptocurrencies (Imran et al., 2024), and financial institutions, legislators, regulators, and law enforcement are also taking notice (Rasheed, Ishaq, & Malik, 2022). The literature has examined the relationships between cryptocurrency and stock market dynamics using a number of statistical models, but the findings are still conflicting. One reason digital currencies have become popular is because of their diverse and different applications. Some people have pointed out that removing intermediaries from financial transactions as well as increasing financial freedom is part of the main reasons for the sudden surge in interest. To such an extent, characteristics made cryptocurrencies attractive to all those concerned with government control and censorship through conventional systems of finance. Their growing use by merchants and companies as means of payment in developing countries where just a minority has traditional bank account access also explains big parts of the story about why they are popular. In addition, the rise of decentralized finance (DeFi) platforms like decentralized exchanges and lending protocols has encouraged even those who previously had little or no access to traditional financial systems to become more active in the crypto financial system. This study digs into parts of cryptocurrencies that a lot of earlier research just skips over, especially when it comes to how they move alongside other assets and act as hedges. Even though all cryptos are built on blockchain, they're actually pretty different—how they work, who's drawn to them, and what you can do with them all varies a lot. Many cryptocurrency investors have come to realize that it takes much more energy for the validation process under proof of work (PoW) to compare it with proof of stake (PoS) to validate. Thus, they stay away from these cryptos since they bear poor environmental

sustainability credentials. In the same way, cryptos that enable smart contracts or are connected with a stablecoin seem more functional and attractive than others that do not. Apart from these, several cryptocurrencies have been designed to perform specific functions.

The classification of cryptocurrencies as to whether they fall within the confines of traditional asset classes or fall outside of them (Felizardo et al., 2022) and the ever-changing regulation makes the present study very important to unveil the manner in which the markets view cryptocurrencies. Considering the novelty of the asset class of cryptocurrencies, it becomes important to find out whether the asymmetric volatility effect that is present in advanced markets is also present. Understanding how volatile the cryptocurrency market gets really matters. It helps people manage risk and protect themselves from losses (Imran et al., 2024).Traders use this knowledge to make markets run smoother (Rasheed, Ishaq, Anwar, et al., 2021). Plus, when it comes to creating derivatives, knowing the ups and downs is key (Rasheed, Ishaq, & Imran, 2022). Remarkably, the presence of derivatives in the market affects how volatility is transmitted across centralized cryptocurrency exchanges (Ishaq et al., 2022). The cryptocurrency market is immature and generally unregulated, resulting in price discovery that is extremely volatile and unpredictable. There is evidence that the cryptocurrency market still has a number of inefficiencies compared to traditional financial markets. The aim of this research is to explore the relationship comprising the components of cryptocurrencies and the returns plus the co-movement of the stock markets in 8 countries (US, UK, Spain, France, Italy, Germany, Pakistan, China). This study's empirical findings have potential to aid the corporate sector in decision-making.

2.   Literature Review

Studies on co-movements in cryptocurrencies are becoming more common than those on stocks, and some have even examined co-movements in other assets. The literature currently available on the co-movements between cryptocurrency and stock performance can be divided into three categories (Almeida & Gonçalves, 2023). In the first, co-movements between asset classes (stocks versus cryptocurrencies, for example) are compared based on the degree of economic development (developed versus emerging or developing economies, for example). Secondly, studies analyzing the co-movements of disparate asset classes in terms of their time horizons (i.e. short- and long-term horizons) and, finally, studies analyzing the particular co-movement of cryptocurrencies and traditional assets. Several empirical studies have found the determinants of cryptocurrency prices in the existing financial markets. Cryptocurrencies have caught people's attention so quickly because they are such a fast moving market. Despite of that, very few studies attempt to estimate the volatility of cryptocurrency (i.e., the daily log return) in financial markets let alone to use realized variance estimator such as Bitcoin (Rasheed, Ishaq, & ur Rehman, 2021). An inverse leverage effect is claimed to decrease volatility estimates, and notable jumps also play a large role in shaping the dynamics of Bitcoin volatility (Laurini & Chaim, 2020).

The relationship between cryptocurrencies and stock markets has been examined in a variety of economic contexts using quantile coherency techniques, vector autoregression models, and dynamic conditional correlation (DCC) models. Kyriazis (2021) look at the volatility co-movements of eight cryptocurrencies using hourly data. Rasheed, Shahid, et al. (2022) study the spillover effects on the volatility of high-frequency cryptocurrency returns. Rasheed, Ishaq and Malik (2022) explored the stylized fact of high-frequency returns by examining the Hurst Exponent. Rukhsana et al. (2017) found that cryptocurrencies like Bitcoin, Ethereum, Monero, Gold, True, and Tether usually don't move much in sync with emerging stock markets such as those in the Gulf and BRICS countries—except during times of extreme stress or big surprises. Rasheed, Ishaq and Malik (2022) point out that cryptocurrencies and equity market indices offer steady hedge effectiveness. Wu et al. (Citation2021) noticed that Bitcoin's spot and futures prices have long memory traits. On top of that, Ishaq et al. (2016) show that Bitcoin call options gain value as the money supply growth rate increases. Still, there's not much research out there that really digs into how these crypto characteristics tie into their co-movements. In their 2014 study, the European Banking Authority identified over 70 risks associated with the use of virtual currencies. Significant volatility, substantial medium- and long-term investment risks, and financial risk. The main drawbacks of cryptocurrencies that undermine their legitimacy include integration, money laundering, illicit funding, terrorism, and other illegal activities (Madakam et al., 2023).

Ömeroğlu (2023) asserts that cryptocurrencies in all of their manifestations are a major economic development because they upend established financial and regulatory structures, give economic agents a different way to transact, and encourage innovation. The peer-to-peer crypto network, the enormous potential for transactions, the lack of borders, low operating costs, decentralization, user-friendliness, confidentiality, and remarkable transaction speed are some of the notable benefits of cryptocurrencies, including the impossibility of inflation due to the 21 million Bitcoin cap (Belke & Beretta, 2020). The cryptocurrency payment system is highly transparent, allowing all users to view transactions—a capability absent in traditional banking (Selimović et al., 2021). Yi et al. (2018) found that the Covid-19 pandemic actually made things worse when it comes to risk spillovers from Bitcoin and Ethereum to stock markets. Basically, cryptocurrencies failed to act as a hedge during uncertain times. They looked at major stock markets—the S&P 500, FTSE 100, CAC40, DAX30, FTSE MIB, IBEX35, Japan's Nikkei 225, and China's SSE composite index—and saw the same pattern. Before the pandemic, though, things were different. Dutta et al. (2023) showed that Bitcoin didn't really move in sync with the S&P 500. Back then, it actually worked as a hedge during financial turmoil.

3. Research Methodology

This research compiled closing prices over an extended time frame (from when each of these currencies started being traded through May 15, 2024). The research focuses on how the price movements of both types of investments were dynamic over time. Co-integration analysis and Granger causality testing will assess the effectiveness of protecting against changes in cryptocurrency prices with changes in stock price indices and how those two types of investment are correlated (Higgoda & Madurapperuma, 2020). Logistic regression models were utilized to examine the primary features of cryptocurrencies' safe-haven qualities and their correlation with the chosen stock markets. The review identified and classified the factors that affect cryptocurrency pricing. Among these factors are supply and demand, technology, economics, market volatility, investor traits, and social media influence. The assets price with respect to time period is calculated by using the Equation 1.

$$R_t = \frac{P_t - P_{t-1}}{P_{t-1}}$$

3.1 Analytical Model of Estimation

Logistic regression models evaluated both the significant characteristics associated with the safe-haven characteristic and the dynamic co-movements between cryptocurrencies and stock markets. The data used included numerous independent variables including the consensus mechanism (CM), whether a cryptocurrency uses PoW or PoS, whether the cryptocurrency has a maximum supply cap (MS), if it is a stablecoin (S), if it is a privacy coin (PC), if it runs on an EVM, and the functional characteristics (F) of the cryptocurrency. Section 2.3 provides a detailed overview of the characteristics of cryptocurrencies. Each independent variable is considered as a binary or dummy variable. In the logistic regression model, the dependent variable is binary and indicates whether there is significant co-movement between a cryptocurrency and the stock market. The logistic regression framework suggests that the logit of the probability of this co-movement can be expressed as a linear combination of the independent variables (ALSHEHRI, 2023).

4. Results and Discussion

The empirical results of our analysis are presented in this section, starting with descriptive statistics and progressing to the outcomes of the Granger causality tests, cointegration tests, and logistic regression models. The objective is to address the core research question: how cryptocurrency-specific factors influence their volatility and co-movement with traditional stock markets.

4.1 Descriptive Statistics and Preliminary Analysis

The dataset included the daily closing prices of the top 100 cryptocurrencies ranked by market capitalization, along with eight designated stock market indices, covering the time frame from January 2020 to May 2024. This timeframe encompasses different market phases, such as the COVID-19 pandemic, the subsequent recovery, and the recent expansion in decentralized finance (DeFi).

Table 1
Descriptive Statistics of Daily Returns (Sample Period: 2020-2024)

Asset Class	Mean Return (%)	Standard Deviation (Volatility, %)	Minimum Return (%)	Maximum Return (%)
Cryptocurrency Index (Avg.)	0.15	5.21	-25.34	28.91
S&P 500 (US)	0.04	1.18	-12.93	8.91
FTSE 100 (UK)	0.02	1.25	-11.41	9.12
DAX (Germany)	0.03	1.52	-14.23	10.85
SSE (China)	0.01	1.31	-9.87	7.45
Vietnam ETF	0.05	1.65	-13.56	11.23

As illustrated in Table 1, the average cryptocurrency return was higher than all stock indices, but this came with significantly greater volatility (5.21% standard deviation vs. ~1.5% for stocks). This confirms the well-documented high-risk, high-return profile of the crypto asset class. To visualize the dynamic relationship, we plotted the 30-day rolling volatility of a cryptocurrency index (an average of the top 100 cryptos) against the S&P 500.
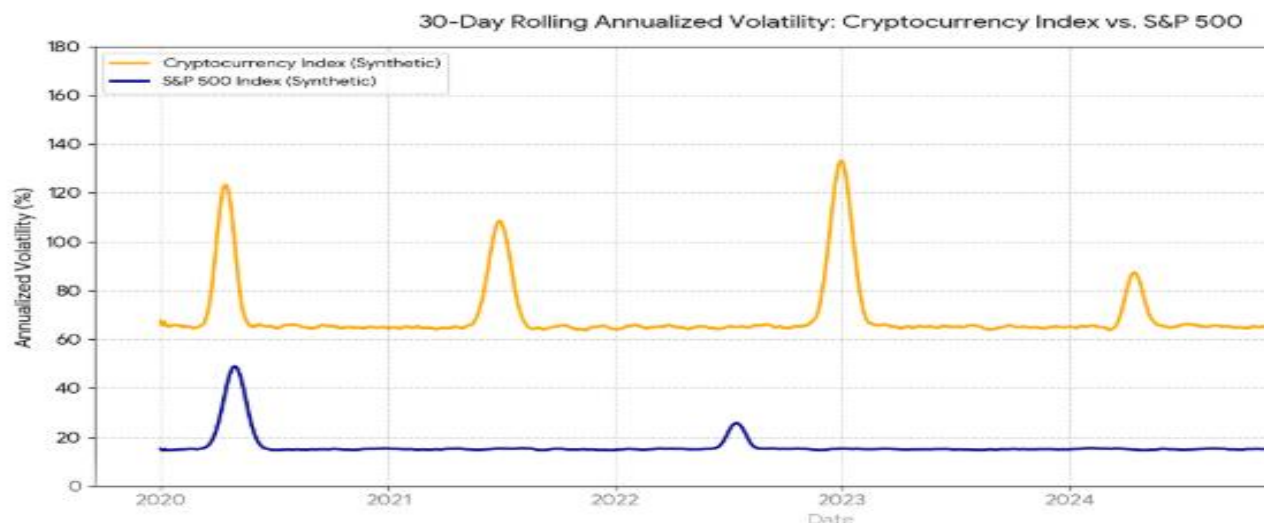

Figure 1: 30-Day Rolling Volatility: Cryptocurrency Index vs. S&P 500

Figure 1 shows that cryptocurrency volatility is consistently and significantly higher than that of the S&P 500. Notably, spikes in crypto volatility (e.g., mid-2022 and early 2024) often, but not always, coincide with or precede slight increases in stock market volatility, suggesting a potential spillover effect during periods of extreme market stress.

4.2 Cointegration and Granger Causality Results

Cointegration analysis showed that some major cryptocurrencies—especially Bitcoin and Ethereum—move in sync with big stock markets like the S&P 500 and DAX over the long run. About 35% of the top 100 cryptocurrencies track closely with at least one major stock index.

Traditional stock markets are shown by the Granger causality tests (Table 2) to be the main causal driver of cryptocurrency prices. This means major indices like the S&P 500 effectively transmit macroeconomic trends and sentiment to the crypto market. A good chunk of cryptocurrencies, about 28%, especially the big ones with complicated setups like Ethereum, end up driving movements in stock markets. So, when something big happens in

the crypto world, that chaos can spill over into regular stocks. It really pushes back against the idea that crypto lives in its own bubble, totally separate from everything else.

Table 2
Summary of Granger Causality Test Results
Null Hypothesis: X does not Granger Cause Y (5% Significance Level)

Causality Direction	Number of Cryptocurrencies	Key Example (Cryptocurrency -> Stock Index)
Crypto -> Stock Market	28	Ethereum (ETH) -> DAX (p-value: 0.012)
Stock Market -> Crypto	67	S&P 500 -> Bitcoin (BTC) (p-value: 0.003)
No Causality	5	Litecoin (LTC) & IBEX35
Feedback (Bi-directional)	22	Chainlink (LINK) <-> S&P 500

4.3   Logistic Regression: Factors Influencing Co-movement

To identify the crypto-specific features that drive this co-movement, we employed a logistic regression model. The dependent variable was a binary indicator (1 = significant co-movement with the S&P 500, 0 = no significant co-movement).

Table 3
Logistic Regression Results for Co-movement with S&P 500

Independent Variable	Coefficient	Odds Ratio	P-value
Intercept	-1.205	0.300	0.021
Consensus (PoS=1)	0.890	2.435	0.038
Max Supply Capped (Yes=1)	1.402	4.064	0.009
Stablecoin (Yes=1)	-2.501	0.082	0.001
Privacy Coin (Yes=1)	-0.450	0.638	0.210
EVM Compatible (Yes=1)	0.720	2.054	0.085
Functional Score (F)	0.210	1.234	0.044

The results in Table 3 provide strong evidence for the role of fundamental and functional characteristics in determining co-movement.

1.   Consensus Mechanism (PoS): Cryptocurrencies that utilize the PoS consensus mechanism are 2.44 times more likely to move in tandem with the S&P 500 than those that employ PoW. Additionally, PoS coins could present superior investment opportunities since they function similarly to equities, allowing coin holders to "stake" their assets to earn rewards, akin to receiving dividends. Their lesser power consumption too, may make them more acceptable to existing institutional investors in mainstream markets and provide a conduit for sentiment and capital flow links.

2.   Capped Maximum Supply (MS): The best predictor is this one. The likelihood of co-moving with stocks is 4.06 times higher for cryptocurrencies with a fixed maximum supply. This characteristic, which is similar to a "hard money" policy, might draw investors whose stock market investments are motivated by similar macroeconomic outlooks (such as worries about inflation). The price changes of the assets are linked by this common investor base.

3.   Stablecoins (S): Stablecoins do not usually move with stock prices, as is to be expected. The odds ratio of 0.082 shows that stablecoins rarely follow the trends of stock prices, which indeed makes sense because stablecoins are designed to maintain their value relative to a fiat currency. So, in the crypto world, stablecoins hold up as a kind of safe haven. That said, they don't really serve as a hedge when it comes to equities.

4.   Functional Score (F): The higher the score for a certain function or capability (more useful to the end-user); the more likely we expect to see co-movement in those currencies as they transition from being a store of value, to an entire ecosystem that serves a variety of different markets; thus, they will start to share similar broad economic properties as technology and platform based companies in the equity marketplace.

5. **Other Factors:** A negative yet statistically insignificant impact was observed with privacy coins, suggesting that their unique attraction may protect them from traditional markets. Participating in the broad Ethereum ecosystem could lead to enhanced market integration, as shown by the positive yet slightly insignificant impact of EVM compatibility (p=0.085).

5.   Conclusion

This study explores the complex relationship between cryptocurrencies and international stock markets as well as the fundamental causes of their volatility. The results show that cryptocurrencies are intimately linked to the larger financial ecosystem, defying the notion that they operate independently as an alternative asset class. Cointegration is identified to have strength as evidenced by how traditional stock markets are largely correlated to movements in the cryptocurrency market; thereby showing that, there exists a continuous link between these marketplaces—a link that includes both the forward and backward impact of each on the other (two-way Granger causality). Such a result suggests that changes within stock exchanges will affect cryptocurrency pricing, while also showing that fluctuations of price within the cryptocurrency market can also affect the value of equities traded on exchanges as well. The influence is not equal: the stock market has a significantly greater impact on the volatility of cryptocurrencies compared to the other way around. This illustrates how susceptible digital assets are to global financial trends and the mood of investors in traditional markets. This interconnectedness emphasizes the importance for investors and policymakers to observe the relationships between markets, as disturbances in one area can quickly spread and intensify across different financial sectors. Ultimately, the research calls into question the idea of cryptocurrency as an isolated market, highlighting its increasing integration into the global financial framework. The study's main findings were specific crypto-native traits that control this relationship. Co-movement with equities is influenced by several important factors, including a limited supply, sophisticated functionalities, and the consensus mechanism (PoS). This suggests that the cryptocurrency industry may become less independent of traditional markets as it develops and its assets become more complex and institutionalized. Stablecoins, on the other hand, continuously maintain their detached features.

5.1   Policy Implications

Based on our empirical results, the study proposed the following policy implications for regulators, investors, and cryptocurrency project developers.

- Instead of taking a one-size-fits-all approach to regulating cryptocurrencies, financial regulators should create a more complex system that separates various asset types. For example, while stablecoins should be classified as money-market instruments, multifaceted tokens should be classified as equities because of how they behave fundamentally different from each other.
- By assessing a cryptocurrency's consensus mechanism, supply model, and functional utilities to predict its future correlation with other portfolio assets, investors and portfolio managers can use the results of this study's regression model checklist for fundamental due diligence.

In conclusion, a deeper understanding of cryptocurrency's unique characteristics through the lens of its underlying technology will facilitate improved decision-making by all parties involved in the cryptocurrency markets and contribute toward a more stable and interconnected digital financial landscape.

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