Journal of Applied Economic Sciences
Volume XX, Spring, Issue 1(87), 2025

Cryptocurrency Market Dynamics: Interconnectedness and Interdependence with Global Uncertainties

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Article's history:

Received 5th of January, 2025; Received in revised form 31st of January; Accepted 11th of February, 2025; Available online: 16th of February, 2025. Published as article in the Volume XX, Spring, Issue 1(87), 2025.

Suggested citation:

Chittineni, J., & Jeet, D. (2025). Cryptocurrency market dynamics: interconnectedness and interdependence with global uncertainties. *Journal of Applied Economic Sciences,* Volume XX, Spring, 1(87), 123 – 134 https://doi.org/10.57017/jaes.v20.1(87).08

Abstract

The study aims to understand the interconnectedness and interdependence of cryptocurrency with global uncertainties. The study employs quantile regression and Markov regime-switching models to understand the time-varying connectedness between the cryptocurrency market and uncertainties. The study findings reveal that geopolitical risk positively influences cryptocurrency returns at all quantiles, highlighting the significance of understanding geopolitical risk before considering the investments in cryptocurrency market. On the other hand, economic policy uncertainty negatively affects with the returns during economic expansions and at higher quantiles. Cryptocurrency market is independent of gold price volatility and oil price volatility significantly reduces cryptocurrency returns. The results suggest that cryptocurrency investments are attractive during geopolitical uncertainties, they are unfavourably affected by economic policy uncertainty and oil price volatility, reflecting complex investor behaviours.

Keywords: cryptocurrency economic policy, geopolitical risk, Markov regime switching model.

JEL Classification: G11, G18, G32.

Introduction

In the interconnected world, events like economic, political and policy uncertainties are playing a major role in driving the financial markets. An empirical analysis by Husain et al. (2024) summarizes the impact of economic policy uncertainty (EPU) and geopolitical risks (GPR) on the financial markets. Both EPU and GPR bring volatility, unpredictability, and systemic risk into financial markets, affecting investor emotions, market prices, and overall market stability (Bossman et al., 2023; Chiang, 2021; Hong, et al., 2020). This study explores into the impact of economic policy uncertainty, geopolitical risks on the cryptocurrency market. Understanding how these uncertainties influence cryptocurrency market returns volatility is important for portfolio managers, investors and policy makers.

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Economic policy uncertainty refers to the impulsiveness or uncertainty regarding a country's economic policies including policy rate changes, fiscal policies, tax guidelines, and other policy decision that the government authorities make. On the other hand, geopolitical risks include political uncertainties, wars, conflicts and any geopolitical actions that can disturb the economic status quo. Both EPU and GPR play an important role in investor investment decisions, market conditions, and, eventually the financial assets stability including cryptocurrencies (Almeida et al., 2024, Hu & Borjigin, 2024).

Cryptocurrency, a relatively new digital currency introduced in 2009, was initially seen as an asset detached from traditional financial systems and geopolitical tensions. However, as the cryptocurrency market matured, it became evident that the cryptocurrency market was not immune to global economic and political upheavals. Bitcoin returns volatility often reflects the broader uncertainties present in the international financial landscape (Wüstenfeld et al., 2022, Wu et al., 2022, Umar et al., 2021, Antonakakis, et al., 2019).

The geopolitical risk impacts the financial markets in many ways, hence during the geopolitical uncertainty investors prefer to shift their investment strategies from the risky assets to less risky safe assets (McGee, 2009). Geopolitical risks not only impact the financial markets it also influences the commodity markets like oil and gas. Geopolitical unrest causes price volatility or supply shortages of these commodities (El-Gamal et al., 2018, Wang, et al., 2021).

The interaction between economic policy uncertainty and geopolitical risks creates a feedback affect that increases market volatility and uncertainty (Chiang et al., 2021). Geopolitical unrest causes economic policy uncertainty as policymakers tries address the geopolitical challenges while framing the domestic policy priorities. On the other hand, EPU can worsen geopolitical risk by disturbing the diplomatic political relations, impairing trade disputes, and fuelling nationalist sentiments (Anser et al., 2021). The combined impact of EPU and GPR on financial markets is deeply shaping the investors sentiments, asset returns volatility and the investors risk perceptions (Albaity, et al., 2023; Thaw, 2023). Financial market participants closely observe the geopolitical developments and policy changes to adjust their investment strategies in line with them (Fang et al., 2023). Risk management is very important when investors are diversifying their portfolios, hedging against risks, and incorporating geopolitical risk calculations into their decision-making processes (Bai et al., 2023).

The association among EPU, GPR, and the cryptocurrency market is complex. During the high levels of economic policy uncertainty investors searching for safe-haven assets often try to invest in cryptocurrency investments. This surge in demand can cause cryptocurrency price volatility. Likewise, geopolitical risks can cause rapid shifts in investor sentiments, leading to unexpected and sharp movements in cryptocurrency prices (Su et al., 2020).

Recently, academic literature focusing on measuring the impact of EPU and GPR on the volatility of Bitcoin returns. For example, an analysis by Yen et al. (2021), Al-Yahyaee et al. (2019), Wang, et al. (2020), Wu et al. (2022) shows a positive correlation between EPU index and Bitcoin volatility, suggesting that higher economic policy uncertainties are associated with more significant Bitcoin price fluctuations. Conversely, during periods of relative geopolitical stability, Bitcoin might exhibit lower volatility, reflecting a decreased demand for it as a safe haven. For investors, understanding the dynamics between EPU, GPR, and the cryptocurrency market is essential for confidently navigating the cryptocurrency market. Investors can make more informed decisions by closely monitoring economic policy announcements and geopolitical events. Furthermore, diversifying investment portfolios can help minimise the risks associated with high volatility in the cryptocurrency market. As the global financial landscape evolves, the interplay between these factors will continue to influence the cryptocurrency market. For stakeholders in the digital currency ecosystem, staying informed about international economic and political trends while adopting prudent risk management strategies will be vital to navigating the uncertainties of the digital currency world.

This study is motivated by two key considerations. Firstly, the growing importance of cryptocurrency in the portfolio diversification strategy. Secondly, its highly volatile nature. The primary objective of this study is to understand its interconnectedness and independence from economic, political, and policy uncertainties.

1. Literature Review

Numerous studies have indicated that Bitcoin's volatility has a positive correlation with economic policy uncertainty and geopolitical uncertainty (Fang et al., 2019; Mokni, 2021; Wu, Ho & Wu, 2022; Umar et al., 2021; Wüstenfeld & Geldner, 2022; Al Mamun et al., 2020); Nouir & Hamida, 2023; Kyriazis, 2020), while others found no significant connection (Aysan et al., 2019; Singh et al., 2022). As a result of uncertain economic conditions, demand for Bitcoin increases, leading to greater volatility in Bitcoin prices. However, some researchers contend that the correlation between Bitcoin's volatility and EPU and GPR is insignificant Aysan et al., 2019, Singh et al., 2022; Yen & Cheng, 2021; Shaikh, 2020; Mokni, 2021 or negative (Fang et al., 2019; Hazgui et al., 2022, Nouir, et al. 2023; Nouir & Hamida, 2023). These contradicting and mixed results suggest that beyond EPU and GPR, some other traditional economic indicators also impact the cryptocurrency market returns. Therefore, it is evident that other variables like market sentiment uncertainty in the commodities market could also contribute to fluctuations in Bitcoin's value (Hazgui et al., 2022; Das, et al., 2020; Ozturk, 2020; Kyriazis, 2020).

Using Bitcoin as a hedging tool during uncertain economic and geopolitical times has been a topic of interest among researchers, with various studies exploring its potential role and effectiveness. Earlier research studies indicating Bitcoin has the potential as a safe haven asset (Umar et al., 2021; Shahzad et al., 2019; Stensås, 2019; Baur & Hoang, 2021; Kliber et al., 2019; Wu et al., 2019; Gbolahan, 2023). During uncertain economic times, investors may turn to Bitcoin as a store of value and a hedge against currency depreciation. As a result, during increased geopolitical tensions or regulatory changes, investors may seek refuge in Bitcoin as a safe haven asset, driving up its price and volatility. However, the effectiveness of Bitcoin as a hedge during economic uncertainty remains a topic of debate, with other research indicating that its price movements are due to speculative trading than fundamental economic factors (Li et al., 2017; Zhu et al., 2017, Wang, et al., 2023). A study conducted by Colon, et al. (2021) concludes that uncertainty significantly affects cryptocurrency returns.

This article investigated the impact of policy and political uncertainty on the cryptocurrency market, focusing on the top 25 cryptocurrencies. It finds that the cryptocurrency market can be a robust hedge against geopolitical risks but less so against economic policy uncertainty during bull markets. Most of the available literature focused on understanding the effect of policy uncertainty and geopolitical risk on Bitcoin volatility or a set of cryptocurrencies.

The present study aims to explore two objectives. Firstly, we examine the effects of policy uncertainty (EPU), geopolitical risks (GPR), and macroeconomic variables like oil and gold price volatility on the cryptocurrency market index. We also investigate whether there is any difference in the effects at different quantiles of cryptocurrency market returns. In the literature, many studies focused on Bitcoin or a couple of cryptocurrencies as a proxy for cryptocurrency market volatility, but this study considers the CMC 200 index, which captures the price movements of 200 cryptocurrencies by its market capitalization. The second objective is to understand the regime-switching probabilities of the cryptocurrency market index and its time-varying conditional correlations with policy uncertainty, geopolitical risk and implied volatility indices of gold and oil. This part is our contribution to the literature.

2. Data and Research Methodology

Data

Davis (2016) proposed the EPU index in 2016, and Caldara & Iacoviello (2022) proposed the GPR index; the EPU and GPR data available on https://www.policyuncertainty.com/ website. The study uses Crypto 200 market index data, created based on the 200 largest cryptocurrencies by their market capitalization. The data is available at https://www.solactive.com/ website. Collecting monthly prices from January 2019 to April 2024. Data points are decided based on the availability of the data for the cryptocurrency index. This study uses monthly logarithmic

transformed returns for cryptocurrency i in month n (Ln CCMR) as a dependent variable. The Geopolitical risk (GPR) and Economic Policy Uncertainty (EPU) are independent variables. The study also uses a few control variables. The study includes implied volatility of oil (VOX) and implied volatility of gold price (GVZ) to capture the volatility of macroeconomic factors.

Model specification

Monthly crypto currency market returns are estimated as $R_t = \ln(p_t/p_{t-1})$. All other variables are calculated as a change in the level. Crypto currency market returns are regressed over uncertainty indices values and control variable indices values. The following OLS model is estimated:

$$R_t = \beta_0 + \beta_i(uncertanity\ variables_{it}) + \beta_j\ (control\ variable_{it}) + \vartheta R_{t-1} + \varepsilon_t \quad (1)$$

where: R_t is cryptocurrency returns; $(uncertanity_{it})$ represents vector of uncertainty indices values expressed as a change in level; $(control\ variable_{it})$ represents the vector of macroeconomic variables such as crude oil volatility, and gold volatility.

We also employ the quantile regression (QR) approach (Koenker & Basset, 1978) to analyse the different responses in the cryptocurrency market to changes in uncertainty over different cryptocurrency return quantiles (0.1, 0.25, 0.5, 0.75, and 0.9). Note that the quantile regressions estimate each quantile of the dependent variable (cryptocurrency returns), conditional on the value of the explanatory variables. Additional controls variables are included in all specifications to identify the effect of unobservable characteristics embedded in our data.

Quantile regression method:

The impact of uncertainties can vary across different quantiles of crypto currency returns. Thus, quantile regression is used to estimate the heterogeneous effect of uncertainties on the crypto currency market returns. This model overcomes the restrictive assumption of the identical distribution of error terms. The model equation proposed by Koenker & Basset (1978) is as follows:

$$Q_\theta\{\tau|uncertinity_{it}, \beta(\tau)\} = uncertìnity_{it}\beta(\tau) \quad (2)$$

where: $\beta(\tau)$ represents the vector of coefficient for the given quantile.

The quantile parameters are estimated by using the following equation:

$$\widehat{\beta_n}(\tau) = min_{\beta\tau}\{\sum_i \gamma_t(R_t - uncertinity_{it}\beta(\tau)\} \quad (3)$$

The OLS regression model does not include the non-linearity of the estimates that manifest due to regime changes. Hence, the regime switching regression model is as follows:

$$R_t = \beta_{st} + \beta_{ist}(uncertanity\ variables_{it}) + \beta_{jst}\ (control\ variable_{it}) + \vartheta_{st}R_{t-1} + \varepsilon_t \quad (4)$$

where: R cryptocurrency market returns. *St* specified the state specific regimes.

This study assumes two state Markov process (1,2) and $\varepsilon_t \sim N(0, \sigma_{st}^2)$.

3. Analysis and Results

The Table 1 presents the summary statistics of all the variables used in this study.

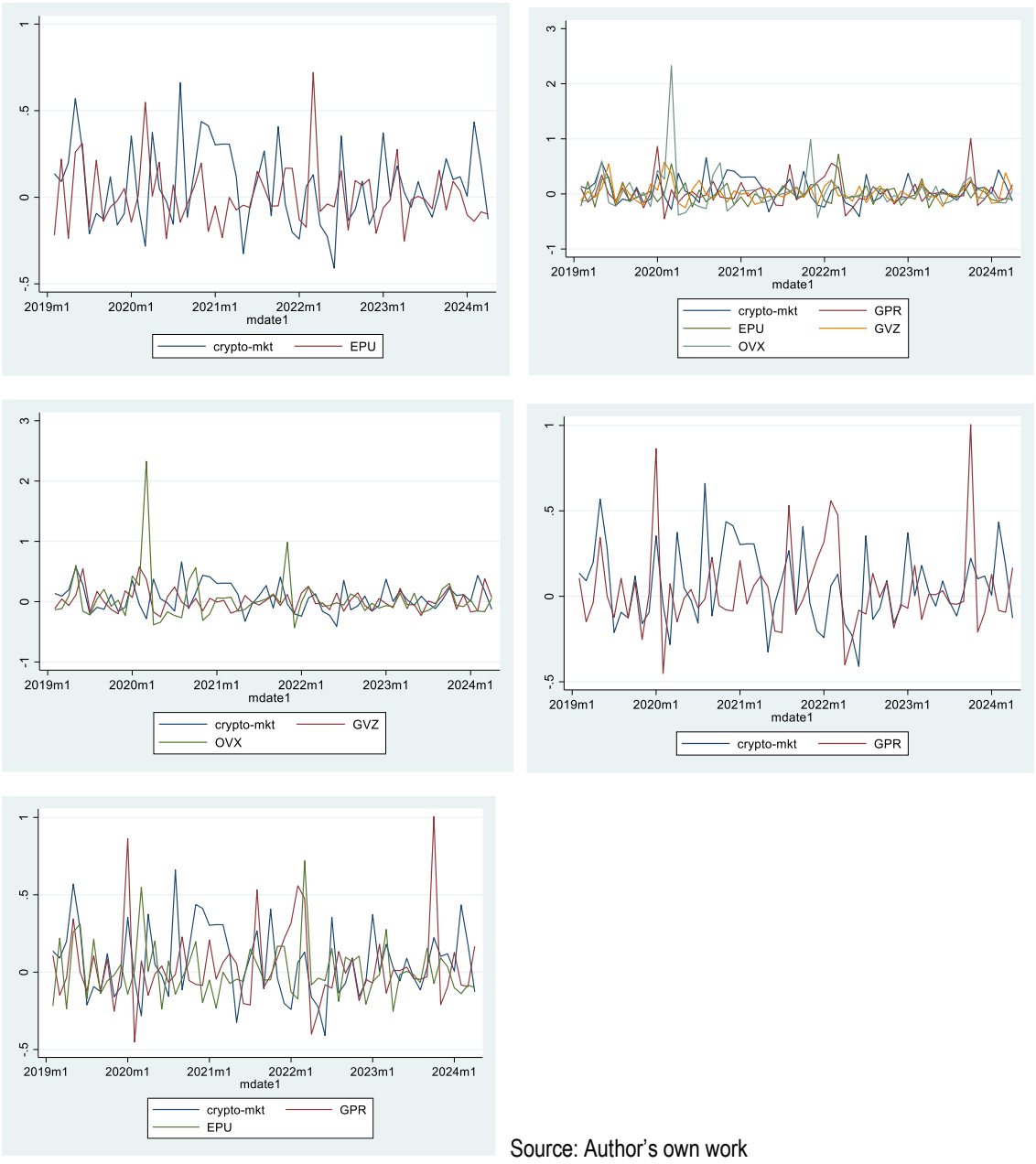
Table1: Summary statistics for all the variables

Variable	Mean	Std.dev	Variance	Skewness	Kurtosis
ln(CCMR)	0.067198	0.228302	0.052122	0.37613	2.636698
ΔGPR	0.034815	0.249901	0.062451	1.632093	7.045601
ΔGEPU	0.006838	0.181098	0.032796	1.385824	6.091917
ΔGVZ	0.020467	0.174628	0.030495	1.041327	4.302035
Δ OVX	0.039102	0.377598	0.14258	3.871302	23.07016

Source: Author's own work

The oil prices, cryptocurrency market and geopolitical risk indices are volatile compared to policy and gold uncertainty indices. The skewness of the variables is less than 2, indicating the normality of the variables except oil price volatility. Figure 1 presents the graphical representation of the same.

Figure1: Time series plots for crypto currency market index, GPR, GEPU, OVX and GVZ



Source: Author's own work

Table 2 summarizes the OLS regression results; from the results, it is evident that Geopolitical risk and global economic policy uncertainty are positively related to the cryptocurrency market returns, and macroeconomic uncertainty negatively impacts cryptocurrency market returns. Geopolitical risk impacting the cryptocurrency market returns positively and significantly. Global policy uncertainty does not have any significant impact on the cryptocurrency market. The results show that Oil price volatility is negatively but significantly contributing to the changes in the cryptocurrency market. However, gold market uncertainty does not significantly impact the cryptocurrency market returns; these results align with Liu et al. (2023) findings.

Table 2: The OLS results

	OLS	
	Coefficient	P value
GPR	0.211818	0.078
GEPU	0.091813	0.592
GVZ	-0.09597	0.593
OVX	-0.11612	0.016
Intercept	0.0657	0.027

Source: Author's own work

The simultaneous quantile regression equation is estimated to be 0.10 to 0.90 quartiles for robustness in the analysis. Table 3 shows the simultaneous quantile regression results, showing that the cryptocurrency market returns are not asymmetric across all quantiles. Geopolitical risk is positive and significantly impacts the cryptocurrency returns during the normal and higher quantiles. Global economic uncertainty is positive but not significant at lower and normal quantiles but negatively impacting at higher quantiles. Macroeconomic uncertainty is negatively impacting the returns of the cryptocurrency market. Oil price volatility is negative and significantly impacts the cryptocurrency market returns in almost all quantiles except for the extremely low (10%) and extremely high quantiles (90%). Cryptocurrency market returns are independent of gold price volatility. Intercept is positive and significant at higher and normal quantiles, negative and significant at lower quantiles. Cryptocurrency market returns are not asymmetric across all quantiles. The quantile regression results present an asymmetric relationship between the cryptocurrency market returns and uncertainty indices. Linear quantile regression cannot address these time-varying asymmetric relationships among the variables. The Markov regime model is estimated to address the time-varying parameters (Table 4).

Table 3: Simultaneous quantile regression results

	GPR	GEPU	OVX	GVZ	Intercept
0.1	0.2299173	0.2778791	-0.1105912	-0.0617836	-0.170918
P-value	0.199	0.375	0.252	0.891	0.0000
0.2	0.2401518	0.1889557	-0.1080193	-0.1033163	-0.113446
P-value	0.212	0.536	0.095	0.799	0.023
0.3	0.3120134	0.0530105	-0.104195	-0.1106509	-0.05038
P-value	0.076	0.826	0.072	0.702	0.052
0.4	0.3035201	0.0958403	-0.1215007	-0.1010052	-0.036540
P-value	0.043	0.701	0.132	0.696	0.094
0.5	0.2371593	0.2442811	-0.2238863	0.1486615	0.0323357
P-value	0.006	0.339	0.019	0.604	0.045
0.6	0.1867431	0.0468136	-0.1564538	-0.021356	0.0914417

	GPR	GEPU	OVX	GVZ	Intercept
P-value	0.000	0.878	0.033	0.942	0.025
0.7	0.2453219	0.1612684	-0.2416707	0.1008488	0.1364428
P-value	0.000	0.602	0.001	0.752	0.062
0.8	0.278349	-0.2280609	-0.2665618	-0.2199667	0.2747998
P-value	0.000	0.047	0.016	0.342	0
0.9	0.1199432	-0.0528364	-0.2371662	-0.1765204	0.3558221
P-value	0.043	0.006	0.322	0.468	0

Source: Author's own work

The results show the state-dependent mean and error variance. The results show that state 1 is a recession state because the mean crypto market return in this state is -0.4%. In state-1, Geopolitical risk (GPR) is the only significant variable, and its relationship is positive. The second state is the expansion state because, from Table 4, it is evident that the mean value of state 2 is 36.5%. In the expansion state except GVZ, all other variables significantly impact the cryptocurrency market returns. The geopolitical risk impacts the cryptocurrency returns positively and significantly in both recession and expansion states. Global Economic uncertainty is negatively and significantly impacting only in higher returns state. Oil price volatility is negatively and significantly impacting the expansion state. Cryptocurrency market is independent of gold price volatility in both the states. It implied that gold is the safe haven tool for investors during an adverse situation.

Table 4 summarizes the estimated transition probabilities; P11 indicates the probability of 80% to change its current state from state 1 to state 1 in the next period by assuming that the current process is in state 1. P21 represents that the transition probability from state 2 to state 1 is 1.00 -0.47 = 0.53. The estimated transition probabilities indicate that state 1 is more persistent than state 2. Investors are more interested in knowing the duration of the state. Table 4 shows the estimated duration for each state. State 1 is a recession state, which continues for approximately 5 months, and state 2, which is an expansion state, continues for approximately 2 months.

Table 4: Markov regime switching model estimated results

Crypto currency returns (CCMR)	Variable	Coefficient	P value
state-1	GVZ	-0.2282155	0.344
	OVX	0.0871774	0.446
	GPR	0.2786973	0.007
	GEPU	0.1221538	0.375
	Const	-0.040513	0.043
state-2	GVZ	-.1670588	0.211
	OVX	-.2741851	0.000
	GPR	.7154177	0.002
	GEPU	-.0133052	0.080
	Const	.3651221	0.000
Sigma1	0.134391		
Sigma2	0.100678		
Transition probabilities	p11	0.8013124	

Crypto currency returns (CCMR)	Variable	Coefficient	P value
state-1	GVZ	-0.2282155	0.344
	OVX	0.0871774	0.446
	GPR	0.2786973	0.007
	GEPU	0.1221538	0.375
	Const	-0.040513	0.043
	p12	0.1986876	
	p21	0.4793534	
	p22	0.5206466	
Expected duration	State1	5.033027	
	State2	2.086143	

Source: Author's own work

4. Discussions

The study results posted two interesting facts. Firstly, geopolitical risk is positively associated with the cryptocurrency market returns in all quantiles and all states (recession and expansion). Economic Policy Uncertainty is negatively associated with the cryptocurrency market only during the expansion state and higher quantiles (0.8 and0.9). These finding are in line with the studies conducted by Long et al. (2022) and Kyriazis (2020). The results indicate that the cryptocurrency market is not independent of geopolitical risk or policy uncertainty. Factors like geopolitical risk or policy uncertainty influence investors' behaviour and market dynamics differently. A positive and significant association between cryptocurrency market returns and geopolitical risk is that during geopolitical tensions, investors seek to protect their wealth from potential losses in traditional markets, leading to increased demand for cryptocurrency. Geopolitical events often underscore the value of decentralized financial systems.

The appeal of cryptocurrencies, which operate outside government control, increases during such times, boosting market performance. During economic policy uncertainty, investor sentiment can go negative. Cryptocurrencies, which are highly sentiment-driven, can see significant price drops as negative sentiment spreads in the market. Investors prefer to sell the riskier assets, including cryptocurrencies and move towards more stable investments like government bonds or established blue-chip company stocks. The study result shows negative and significant association between cryptocurrency market returns and global economic policy uncertainty reinforces this validation. The study results supporting the study conducted by Sharma (2023).

In summary, while geopolitical uncertainties highlight the appearance of cryptocurrencies as a decentralized, safe-haven assets leading to positive market returns, and economic policy uncertainty tends to create a risk-averse environment that negatively impacts all risky assets including cryptocurrencies. This twofold dynamic elucidates the conflicting relationship of these two types of uncertainty with cryptocurrency market returns. The results also show oil price volatility is significantly and negatively impacting the cryptocurrency market returns. High oil price volatility can reduce overall market liquidity as investors move away from the riskier markets. Cryptocurrencies as a part of these riskier markets often suffer from reduced liquidity, leading to price drops, particularly visible at higher quantiles where more institutional investors operate. Institutional investors, who are significant players at higher quantiles, might rebalance their portfolios to hedge against oil price volatility. This rebalancing typically involves decreasing cryptocurrency investments. The significant negative effect of oil price volatility on cryptocurrencies at higher quantiles reveals that investors are more sensitive to macroeconomic events.

The study findings also suggest that the cryptocurrency market operates independently of traditional safe assets like gold. It shows that investors follow different decision-making processes in these two markets. Investors in the cryptocurrency market might not view gold price volatility as a relevant factor as they prioritize for high returns; this could be the reason for not having a significant impact of gold price volatility on cryptocurrency market returns.

Conclusion and Implications

In conclusion, the study explores the association between cryptocurrency market returns and various external factors such as geopolitical risk, economic policy uncertainty, and macroeconomic factors such as gold and oil price volatility. It establishes a positive and significant association between geopolitical risk and the cryptocurrency market as investors perceive crypto currency as a decentralized, safer alternative to traditional financial assets during geopolitical tension. On the contrary, the study results reveal that economic policy uncertainty and oil price volatility negatively impact the cryptocurrency market. This negative association could be a shift in investor sentiment towards risk aversion, leading to a preference for more stable investment options and causing a decline in cryptocurrency values. The study also highlights cryptocurrencies are independence from traditional assets like gold and suggesting a different investor decision-making process that prioritizes the higher returns from cryptocurrencies. Policy decisions should consider the role of cryptocurrencies in the financial system as an asset class and provide clear and consistent regulatory frameworks. To reduce the extreme reaction in the investment community the policymakers must communicate their decisions' long-term goals and potential economic impacts of their policy decisions.

Apart from various macro, micro, economic and geopolitical, uncertainties technological innovations influence on cryptocurrencies remains significant. Hence, investors should closely monitor market sentiment, technological innovations and macroeconomic indicators to make informed investment decisions regarding cryptocurrencies.

Credit Authorship Contribution Statement

Both authors have contributed significantly to the completion of this work – including conceptualization, methodology, writing the original draft, data curation, formal analysis, and the revision. Both authors have also reviewed and approved the final version of the paper.

Acknowledgments/Funding

The authors do not receive any type of funding to undertake this research.

Conflict of Interest Statement

The authors declare that there is no potential conflict of interest in conducting and completing the research.

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