Navigating Uncertainty: The Role of Digital Assets

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Abstract: This research studies the dynamic connectedness among digital assets proxied by non-fungible tokens (NFTs), Islamic cryptocurrencies, and conventional cryptocurrencies with the US Economic Policy Uncertainty (EPU) and Geopolitical Risk (GPR) indices. We also examine the hedge and safe haven properties of the aforementioned digital assets against the uncertainties. Using wavelet coherence analysis from 19 January 2018 to 31 October 2023, we show that NFTs react heterogeneously to changes in uncertainties while cryptocurrency reacts inversely. NFTs and conventional cryptocurrencies can only act as diversifiers, but neither as a hedge nor a safe haven against uncertainties. However, Islamic cryptocurrencies have the potential to act as both a hedge and a safe haven against uncertainties. Our findings shed light on the role of emerging digital assets in formulating investment strategies and ensuring stability in the financial markets.

Originality/Value: Given the immense potential of digital assets, a remaining research gap concerns their interplay with uncertainty. In other words, given the presence of extreme market turmoil over recent years, no consensus is present in terms of highlighting the dynamic co-movement between digital assets such as NFT, Islamic cryptocurrencies, and global uncertainty factors. In addition to that, the lead-lag relationship among digital assets and uncertainties are also unknown till date. The current study fills this gap by providing robust evidence.

Introduction

Fundamentally, uncertainties play a mentionable role in influencing investors on their investment decision and asset selection wavering investor's pessimistic consideration about future returns (Li et al., 2016). Induced by the related environment, policymakers often bring changes in their policy. Over the last decades, several events (i.e., GFC, Eurozone crisis, China-US trade war, Brexit, US presidential election, Covid-19, and the ongoing Russian war) triggered policy-related uncertainties. Since the Global Financial Crisis in 2008-09, alternative investments and especially digital financial instruments have attracted significant attention. In particular, Bitcoin has been found to act as a safe haven for investors (Dyhrberg, 2016, Wang et al., 2019). The cryptocurrency market has experienced exponential growth during the COVID-19 pandemic (Dowling, 2022a), where Bitcoin and Ethereum have grown by more than 538% and 2684%, respectively.[1] Similarly, Islamic cryptocurrency managed to garner substantial attention all around. Consequentially, the NFT market also grew notably after the start of

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[1] Derived from coinmarketcap.com on October 11, 2023.

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the COVID-19 pandemic with total market capitalization rising by around USD 25 billion between January 2021 and July 2022 (NonFungible, 2022). Additionally proving their beneficial capabilities in the financial market (Aharon & Demir, 2022; Ante, 2022a; Dowling, 2022b; Karim et al., 2022). Thus, motivated by the growing capital flow into NFT markets, growing digital financial markets and turbulent global financial markets, this study therefore investigates the dynamic connectedness among non-fungible tokens (NFTs), cryptocurrencies and the US Economic Policy Uncertainty (EPU) index amidst recent global economic downturns.

The digital finance market is growing substantially, which contributes to global economic growth (Banna & Alam, 2021; Liu et al., 2021). As an emerging component, NFTs distinguish themselves from most other digital financial assets such as cryptocurrency.[2] Prior studies document dynamic relationships between NFTs and other exogenous factors and economic indicators.[3] However, it remains unclear whether and how NFTs are associated with EPU despite the far-reaching implications of EPU in recent shocks to global financial markets, such as COVID-19, the China and US trade war, as well as the Russia and Ukraine war (Xia et al., 2022). Effective management of EPU is useful in mitigating portfolio drawdown associated with financial instruments such as bonds (Fang et al., 2017), stocks (Badshah et al., 2019), and cryptocurrencies (Matkovskyy et al., 2020).

Even though some studies on NFTs are all related to financial instruments such as understanding their nexus with stock, commodity, cryptocurrency, etc. However, given the significance of policy uncertainty within financial markets (Liu & Zhang, 2015; Yuan et al., 2022), the interplay between EPU and NFTs and the associated implications on risk management remain largely unexplored. In particular, we explore by comparing NFTs and mainstream cryptocurrencies their resistance and protection ability against policy uncertainty.

Karim et al., (2022) examine the correlations among cryptocurrency, NFTs, and Decentralized Finance (DeFi) tokens. They find that NFTs are potential diversifiers for investment portfolios, as they have the capacity to withstand sudden shocks such as COVID-19. Similar findings are noted in Dowling (2022b) and Aharon and Demir (2022). Price bubbles among cryptocurrencies including NFT and DeFi during COVID-19 and their future outlooks are highlighted in (Maouchi et al., 2022). The impact of COVID-19 on the correlations between NFTs and major asset returns is analyzed by Umar et al. (2022c).

Further, Yousaf and Yarovaya (2022c) study the relationship among NFT, DeFi, and traditional assets such as gold, WTI, and S&P 500, whereby digital assets are found to be disconnected from traditional assets. Umar et al. (2022a) examine the return and volatility connectedness of NFT segments with media coverage, highlighting the heterogeneity among the return and volatility of different NFT segments. Similar findings are revealed when segment-wise return and volatility connectedness are considered (Umar et al., 2022b). With regards to the lead-lag relationship among NFTs and other assets, Ante (2022a) and Ante (2022b) note a positive (negative) connectedness between shocks in bitcoin (Ethereum) and NFT sales.

In terms of cryptocurrency, the market is growing exponentially from its date of inception. Particularly, given the uncertainty and extreme market turbulence over the past few years, investors are consistently in search of assets with safety features. To this end, studies relating to conventional and Islamic cryptocurrencies gained momentum. Recent evidence highlights the growing potential of these cryptocurrencies acting as beneficial for investors. For instance, Mnif and Jarboui (2022) and Wasiuzzaman et al. (2023) provided evidence of risk resilient capabilities of Islamic cryptocurrencies during the recent pandemic. Aloui et al. (2021) argued on the difference between Islamic cryptocurrencies and conventional cryptocurrencies. Thus, this in turn potentially makes them a safe haven for conventional stock market investors (Ali et al., 2022; Mnif et al., 2022).

Given the immense potential of these digital assets, a remaining research gap concerns their interplay with uncertainty. In other words, given the presence of extreme market turmoil over recent years, no consensus is present in terms of highlighting the dynamic co-movement between digital assets and global uncertainty factors. In addition to that, the lead-lag relationship among digital assets and uncertainties are also unknown till date.

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[2] Digital financial assets include cryptocurrency, tokens, web domain, and websites.
[3] Some examples include satellite data on rainfall, tax aggressiveness and firm's market value, and green technology advancements.

This study explores the relationship among NFTs, cryptocurrencies (Conventional cryptocurrencies and Islamic cryptocurrencies), and uncertainties, particularly, the US Economic Policy Uncertainty Index (EPU) and the Global Geopolitical Risk Index (GPR). As such, our study aims to answer the following three research questions. First, what is the degree of connectedness among NFTs, cryptocurrencies, and the uncertainty indices? Second, what is the lead-lag relationship between the returns of NFTs and cryptocurrencies in relation to the uncertainty indices? Lastly, do NFTs differ from other cryptocurrencies in their ability to navigate the uncertainty present in the US EPU and GPR? Using the wavelet coherence analysis, we find that NFTs react heterogeneously to changes in the uncertainties. In particular, ENJ and MANA have a relatively lower correlation against the US EPU among NFTs. Similarly, we find that cryptocurrencies react inversely against the US EPU. When uncertainty heightens, EPU leads both NFTs and cryptocurrencies. Furthermore, we find that both NFTs and cryptocurrencies can act as diversifiers, but not as hedges or safe havens, against EPU. Conversely, we find evidence of time-dependent hedge and safe haven capabilities of Islamic cryptocurrencies against both uncertainties.

Our study brings meaningful contributions to the literature in the following manner. First, acknowledging a maturing digital financial market alongside NFT's material presence in the digital financial ecosystem, even though, the influence of uncertainty over investment has been widely explored, from a digital instrument's perspective, most studies explore the relationship between conventional cryptocurrency and EPU (Wu et al., 2021; Yen & Cheng, 2021), the extant research is mostly concentrated on Bitcoin (Mokni, 2021; Wang et al., 2022), and Ethereum (Mokni et al., 2022; Papadamou et al., 2021). This study illuminates this line of research by exploring dynamic co-movement among NFTs, and conventional and Islamic cryptocurrencies against EPU and GPR. Second, we examine the lead-lag relationship among NFT, cryptocurrencies, and the US EPU and GPR. This facilitates the identification of the direction and strength of the impact of EPU and GPR on NFTs and cryptocurrencies which can help investors to make informed decisions, especially during periods of heightened uncertainty. Further, we compare the roles of NFTs and cryptocurrencies as hedge and safe haven assets against uncertainties. While previous studies suggest that conventional cryptocurrencies can act as a hedge or safe haven, our findings indicate that they can only serve as portfolio diversifiers during periods of extreme uncertainty. Additionally, our results strongly reiterate existing findings on the hedge and safe haven role of Islamic cryptocurrencies. Overall, our study provides two important new insights into the relationship between NFTs, cryptocurrencies, and uncertainties, which have important implications for investors and policymakers. First, unlike existing studies claiming NFTs different than most digital instruments, we here showed the opposite with respect to uncertainty. We show, both cryptocurrencies and NFTs displaying similarities in reacting towards uncertainties (negatively) with various global environment such as sanctions, covid, invasion etc. Second, we add to the understanding of digital assets and uncertainty through providing insights on lead-lag relationship at time of heightened uncertainty. We show both EPU and GPR leading NFT during high uncertainty and a time-varying nature with respect to cryptocurrencies.

The remainder of this paper includes data and methodology in Section 2, results and discussions in Section 3, and conclusion in Section 4.

Methods

In our study, we examine the relationship among NFTs and cryptocurrencies with EPU and GPR over the sample period from January 19, 2018, to October 31, 2023. Our study includes two important global uncertainties: COVID-19 and the ongoing Russia-Ukraine war. The significant downturn in digital financial asset markets coincides with the start of the war, creating tensions among investors. Our sample selection of NFT focused on the largest five categories based on market capitalization, namely Theta (THETA), Tezos (XTZ), Enjin Coin (ENJ), Decentraland (MANA), and Digibyte (DGB) which are in line with previous studies such as Dowling (2022b), Karim et al. (2022), Maouchi et al. (2022), Yousaf and Yarovaya (2022a), and Yousaf and Yarovaya (2022b) considering similar variables as ours. Our variable selections were based on two notions. First, most NFTs are created or issued through several platforms acting as indexes such as the S&P 500 reflecting the overall movement of individual tokens. And, due to the unavailability of historical data for individual NFTs, therefore, following Karim et al., (2022), some NFT platforms were proxied to reflect segmented NFTs. We also examine two

leading conventional cryptocurrencies, namely Bitcoin (BTC) and Ethereum (ETH) due to their connectedness with NFTs. Most NFTs are transacted/priced in Bitcoin or Ethereum terms (Ante, 2022a; Ante, 2022b). Moreover, as Islamic investments are presumably considered safe due to their ethical alignment, we considered four mostly traded Islamic cryptocurrencies. In line with existing literature, for example, Ali et al. (2022), Aloui et al. (2021), Mnif and Jarboui (2022), Mnif et al. (2022), Wasiuzzaman et al. (2023), we considered GoldCoin (GCOIN), Gold Mint (MNTP), Xaurum (XAUR) and X8X (X8X) to represent the digital Islamic market. Data for NFTs and cryptocurrencies are sourced from Coinmarketcap. We also collect the US Economic policy uncertainty index and Global Geopolitical Risk index (Baker et al., 2016) from policy uncertainty[4]. While EPU for other countries or regions is also available, we choose the US EPU index for the following two reasons. First, it is the only policy uncertainty series available at the daily intervals, which is compatible with the daily returns described in Section 2.2. Second, as the largest capital market, events in the US significantly influence other international markets (Chiah & Zhong, 2021).

We compute the daily returns of assets in this study as follows:

$$R_t = \ln(P_t/P_{t-1}) \tag{1}$$

To study the co-movement among NFTs, Cryptocurrency, the US EPU, and GPR, this study employs the wavelet coherence analysis. This method has been widely employed in previous studies to ascertain co-movements among variables (Goodell & Goutte, 2021; Kang et al., 2019). This method captures the time and frequency of the co-movement among variables. In addition, we include time-varying phase differences within the wavelet diagrams, which identifies the causal impact and allows for better interpretation (Goodell & Goutte, 2021).

The wavelet for two distinguished time series, *x* and *y* under continuous wavelet transform is described as:

$$W_{xy}(u,s) = W_x(u,s)W_y(u,s) \tag{2}$$

Where $u \ and \ s$ are defined as position and scale respectively.

The wavelet coherence of time series between pairs over time and frequency estimators (Torrence & Webster, 1999) can be defined as:

$$R^2(u,s) = \frac{|S(s^{-1} W^{xy}(u,s)|^2}{S(s^{-1}|W^x(u,s)|^2 S(s^{-1}|W^y(u,s)|^2} \tag{3}$$

Where S acts as the smoothing operator across time and frequency (scale) given that $0 \le R^2(u,s) \le 1$ (Rua & Nunes, 2009). $R^2(u,s)$ refers to the wavelet squared coherence. The coherence values define the magnitude of strength among two variables where 0 is the least, indicating no correlation while 1 is the highest, indicating perfect correlation. Different from the normal correlation matrix ranging between +1 and -1, wavelet coherence is squared. Therefore, any negative numbers are reflected as positive. The presence of negative correlations is identified through phase differentials and is represented through the direction of arrows (Torrence & Compo, 1998).

Wavelet coherence phase differential is computed as follows:

$$\Phi_{xy}(u,s) = \tan^{-1}\left(\frac{Im\{S(s^{-1}W^{xy}(u,s))\}}{R_e\{S(s^{-1}W^{xy}(u,s))\}}\right) \tag{4}$$

Where, $I_m \ and \ R_e$ are defined as the imaginary and real components for smoothed cross-wavelet transform, respectively. The arrows within the wavelet diagrams show the phase patterns used as a basis to describe the positive (negative) correlations and the lea-lag nature among variables.

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[4] Derived from policy uncertainty website, https://www.policyuncertainty.com.

Results and Discussion

Descriptive Statistics

The descriptive statistics for returns of financial assets in this study are presented in Table 1, which highlights the average, median, minimum, maximum, standard deviation, skewness, and kurtosis. Overall, both conventional cryptocurrencies and two among five NFTs (MANA and THETA) have average positive returns. In particular, Bitcoin and THETA jointly share the highest average returns. With respect to Islamic cryptocurrencies, all four generated negative average returns. Besides being substantially greater in numeric values, the average returns for the aforementioned cryptocurrencies are the least of the whole sample, MNTP and GCOIN (-0.18% and -0.16% respectively). These cryptocurrencies are not only among the leaders for the least returns, but they also represent the most risky ones among the whole sample. The lowest standard deviation of Islamic cryptocurrency is almost double of the riskiest NFTs (i.e., XAUR 11.52% compared to ENJ 8.40%). Among the NFTs, MANA and THETA have the highest mean returns. The standard deviations of NFTs are nearly twice of Bitcoin and Ethereum (i.e., the Standard Deviation for ENJ and MANA are 8.40% and 8.04% respectively, vs BTC's 4.35%), reflecting a positive risk and return trade-off.

Table 1. Descriptive Statistics for Returns of NFTs, Cryptocurrencies, and Uncertainties

		Mean	St.Dev.	Skewness	Kurtosis	Jarque-Bera	n
NFT	XTZ	-0.14%	7.21%	-0.6	7.16	91.92	1501
	MANA	0.03%	8.04%	0.68	12.25	120.09	
	ENJ	-0.03%	8.40%	0.74	12.97	140.97	
	DGB	-0.17%	7.35%	-0.16	5.88	6.73	
	THETA	0.06%	8.04%	-0.17	6.8	7.9	
Islamic Cryptocurrency	GCOIN	-0.16%	17.99%	0.81	13.64	170.74	
	MNTP	-0.18%	21.86%	-0.03	38.42	52.47	
	XAUR	-0.11%	11.52%	-0.1	6.77	3.32	
	X8X	-0.19%	26.89%	0.14	469.9	9088.21	
Conventional Cryptocurrency	BTC	0.06%	4.35%	-1.03	11.86	268.87	
	ETH	0.03%	5.69%	-0.79	9.81	158.27	
Uncertainty	US EPU	0.01%	49.60%	0.2	0.92	9.73	
	GPR	-0.01%	47.65%	-0.15	1.79	5.33	

This table presents the summary statistics for the returns of five NFTs, four Islamic cryptocurrencies, the two leading cryptocurrencies, and the two uncertainty factors considered in this study. The sample period is from January 19, 2018, to October 31, 2023.

This study uses wavelet coherence to analyze the relationship among NFTs, cryptocurrencies, the US EPU, and GPR. Figures 1 to 4 display the co-movement with color coding, which is bounded (with grey borders) using a 95% confidence level. Any region beyond the cone is ignored. In all graphs, the blue (red) color indicates a lower (higher) correlation. We use arrows to identify the lead-lag relationship. An arrow pointing to the right (left) indicates a positive (negative) correlation. The arrow pointing left-upwards (left-downwards) indicates that the first (second) variable is leading the second (first) variable and vice-versa. Due to the default use of the 2^n sequence for the wavelet coherence analysis, we assume 2-16 days as short-term, 16-64 days, and 64-256 days as medium and long-term periods, respectively (Baruník & Křehlík, 2018).

NFT and Uncertainty

The wavelet coherence analysis provides valuable insights into the relationship between NFTs, US Economic Policy Uncertainty (EPU), and Geopolitical Risk (GPR) over different periods. The co-movement between EPU and NFTs and, GPR and NFTs are illustrated in Figure 1 and Figure 2

respectively. Before 2020, there was a positive co-movement between NFTs with the US EPU and GPR, indicating that they tended to move in the same direction. This suggests that during relatively stable economic times, NFTs were influenced by broader economic policy conditions and geopolitical events. However, after 2020, this co-movement turned negative, suggesting a divergence in their movements. This shift may be attributed to the unique challenges posed by the COVID-19 pandemic.
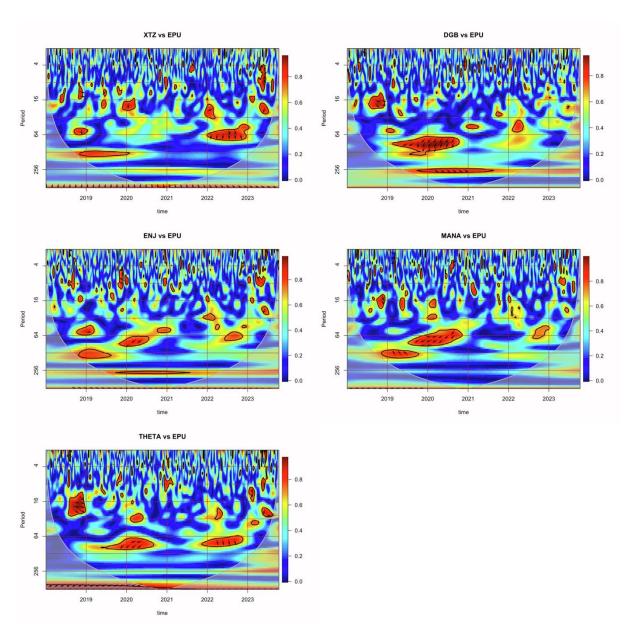

Figure 1. Wavelet Coherence among NFTs and the US EPU
Note: Figure 1 displays the wavelet coherence analysis among XTZ, DGB, ENJ, Mana, and Theta in relation to the US EPU and GPR from January 19, 2018, to October 31, 2023. The diagrams are derived following Equations 2, 3, and 4.

The analysis also highlights varying correlations among different types of NFTs (such as THETA, DGB, ENJ, MANA, and XTZ) and both uncertainties over different time horizons. For instance, THETA exhibited stronger potential for diversification before the pandemic, especially over periods of 16-64 days and 128 days and beyond. This indicates that THETA may have been a more effective asset for hedging and diversification strategies prior to the pandemic. During the COVID-19 outbreak in 2020, low correlations were observed for DGB and ENJ over shorter periods, suggesting that they offered some degree of diversification benefits in times of heightened uncertainty. On the other hand,

MANA showed promise as a long-term portfolio hedge against uncertainties due to its consistently low correlation over long horizons.
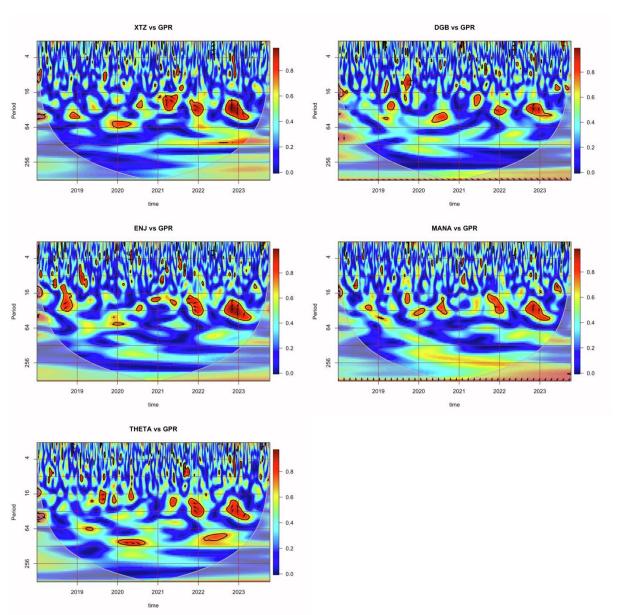

Figure 2. Wavelet Coherence among NFTs and GPR
Note: Figure 2 displays the wavelet coherence analysis among XTZ, DGB, ENJ, Mana, and Theta in relation to the US EPU and GPR from January 19, 2018, to October 31, 2023. The diagrams are derived following Equations 2, 3, and 4.

With the onset of the Russian invasion in early 2022, all NFTs exhibited negative co-movements with the US EPU over longer timeframes. This indicates that NFTs may not have served as effective hedges or safe havens during this geopolitical crisis. However, they still demonstrated value as short- and medium-term diversifiers, with low correlations to EPU.

From an economic standpoint, the observed wavelet coherence between NFTs and the uncertainty indices implied that during stable economic periods, NFTs mirrored the sentiments and fluctuations of the uncertainty indices, signifying a reliance on global economic stability. However, the stark shift post-2020, marked by a negative co-movement, signifies a departure from this synchrony. The divergence hints at a detachment of NFTs from these traditional economic indicators, suggesting a newfound independence or a response pattern distinct from broader economic policies. The emergence

of the COVID-19 pandemic during this period serves as a crucial catalyst for this divergence, likely prompting unique challenges and shifts in consumer behavior, investment patterns, and market dynamics. This separation between NFTs and the previously correlated indices might signify an evolution in the factors influencing NFT markets, potentially driven by specific sectoral trends, technological advancements, or altered investor perceptions. The economic interpretation of this divergence suggests a maturation or redefinition of NFT markets, implying a need to reconsider traditional economic models to comprehend and forecast the dynamics of these digital assets in contemporary economic landscapes. To this end, these findings suggest that economic and geopolitical events significantly influence the relationship between NFTs and broader market conditions. Investors should consider these factors when incorporating NFTs into their portfolios, tailoring their strategies based on the prevailing economic and geopolitical landscape.

The lead-lag analysis of Non-Fungible Tokens (NFTs) in relation to the US Economic Policy Uncertainty (EPU) and the Global Geopolitical Risk (GPR) index uncovers nuanced insights into their interplay within the economic landscape. Over an extended timeframe encompassing 2019 to the present, both the EPU and GPR indices consistently lead most NFTs, indicating a predictive relationship where changes in these economic and geopolitical uncertainties precede fluctuations in NFT prices, albeit with a few exceptions. For instance, specific NFTs like DGB and XTZ exhibit instances of leading the EPU and GPR in shorter windows, suggesting moments of isolated anticipation or responsiveness to immediate uncertainties in economic policies and global geopolitics. Interestingly, ENJ demonstrates an even shorter leading time, implying swift responsiveness to these external factors. However, MANA stands out due to its notably low correlation with EPU over longer horizons, hinting at its potential as a portfolio hedge against US economic uncertainties for long-term investors.

Conversely, concerning the GPR, all NFTs exhibit weaker coherence compared to their relationship with the EPU, indicating a less pronounced connection with global geopolitical risks. Furthermore, the onset of Russia's invasion of Ukraine in early 2022 triggers a notable shift in the correlation dynamics, leading to negative correlations between NFTs and the US EPU over longer horizons. This shift complicates the perception of NFTs as reliable hedging instruments against prolonged economic uncertainties, diminishing their long-term safe haven potential. However, in the short to medium term, these NFTs prove valuable as diversifiers due to their lower correlations with uncertainty, aligning with prior research findings (Karim et al., 2022; Yousaf & Yarovaya, 2022c).

This economic interpretation underscores the intricate relationship between NFTs and external uncertainties, highlighting their nuanced roles as predictive assets and diversifiers in investment portfolios. The findings accentuate the temporal sensitivity of NFTs to economic and geopolitical events, emphasizing their potential as short-to-medium-term diversifiers while raising questions about their long-term hedging capabilities amidst prolonged uncertainties. The alignment of these outcomes with existing literature reaffirms the evolving and complex nature of NFTs within the broader economic and geopolitical landscape.

Cryptocurrency and Uncertainty

We next proceed to the wavelet coherence analysis for the cryptocurrencies with EPU and GPR. Figure 3 plots the wavelet coherence diagrams of Bitcoin and Ethereum with EPU and GPR. The findings highlight distinct patterns in the correlation dynamics of Bitcoin and Ethereum with these uncertainties. Until 2018, both cryptocurrencies exhibited positive correlations with EPU and GPR, followed by a shift to negative correlations in subsequent periods. Notably, Bitcoin displayed weaker correlations compared to Ethereum, implying a lower sensitivity to these uncertainties. However, during the tumultuous period of 2020, both cryptocurrencies demonstrated heightened correlations with uncertainties, suggesting a shared response during sudden shocks such as the COVID-19 pandemic. Interestingly, this analysis suggests Bitcoin's potential suitability over Ethereum for long-term investors amid such abrupt upheavals, indicating Bitcoin's perceived resilience during these challenging times.

A notable shift in the correlation dynamics emerges from 2022 onward, revealing that Bitcoin becomes less connected to uncertainty indices compared to Ethereum. This divergence suggests a stronger sign of resilience for Bitcoin against escalated uncertainties, indicating a potential evolution in its role as a store of value or a hedge in volatile economic climates.

Regarding the lead-lag relationship, the analysis indicates that uncertainties consistently lead both Bitcoin and Ethereum, implying their predictive influence on the behaviors of these cryptocurrencies. However, the conclusion drawn from this analysis challenges the conventional perception of cryptocurrencies as reliable hedges or safe havens against EPU risks. Despite their responsiveness to uncertainties, neither Bitcoin nor Ethereum emerges as an effective hedge against economic policy uncertainties.
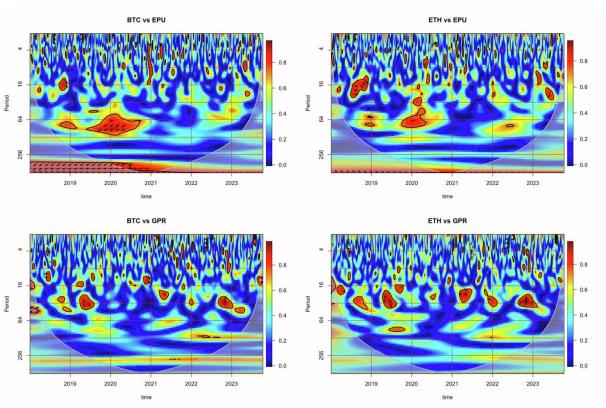

Figure 3. Wavelet Coherence among Conventional Cryptocurrency with the US EPU and GPR
Note: Figure 3 displays the wavelet coherence analysis among Bitcoin and Ethereum in relation to the US EPU from January 19, 2018, to October 31, 2023. The diagrams are derived following Equations 2, 3, and 4.

Figure 4 plots the wavelet coherence analysis of Islamic cryptocurrencies in relation to the US Economic Policy Uncertainty (EPU) and the Global Geopolitical Risk (GPR) index unveils intriguing nuances in their relationship with uncertainties. Unlike Non-Fungible Tokens (NFTs) and conventional cryptocurrencies, Islamic cryptocurrencies exhibit distinct patterns in their co-movement with these uncertainties. With the exception of X8X, which displays a relatively stronger correlation with EPU compared to GPR, the remaining Islamic cryptocurrencies—GCOIN, MNTP, and XAUR—exhibit stronger co-movements with GPR than with EPU, particularly over longer periods. Notably, during crisis periods such as the COVID-19 pandemic and the Russian invasion, a negative co-movement between all Islamic cryptocurrencies and EPU is identified. Conversely, partial positive co-movement is evident for certain cryptocurrencies, notably GCOIN and XAUR, suggesting their potential as hedges and safe havens against geopolitical uncertainty. However, this hedge and safe haven nature seems conditional on long-term investments.

Regarding the lead-lag relationship, the analysis reveals time-dependent outcomes among Islamic cryptocurrencies and uncertainty indices. Prior to the COVID-19 pandemic, distinct lead-lag patterns were observed, with EPU leading GCOIN and MNTP, while XAUR leads the EPU. However, a bi-directional lead-lag relationship is noted for X8X. In the subsequent periods following the pandemic, the dominance of EPU in influencing Islamic cryptocurrencies becomes pronounced, with minimal evidence of lagging, particularly with XAUR over short-term horizons in late 2022.
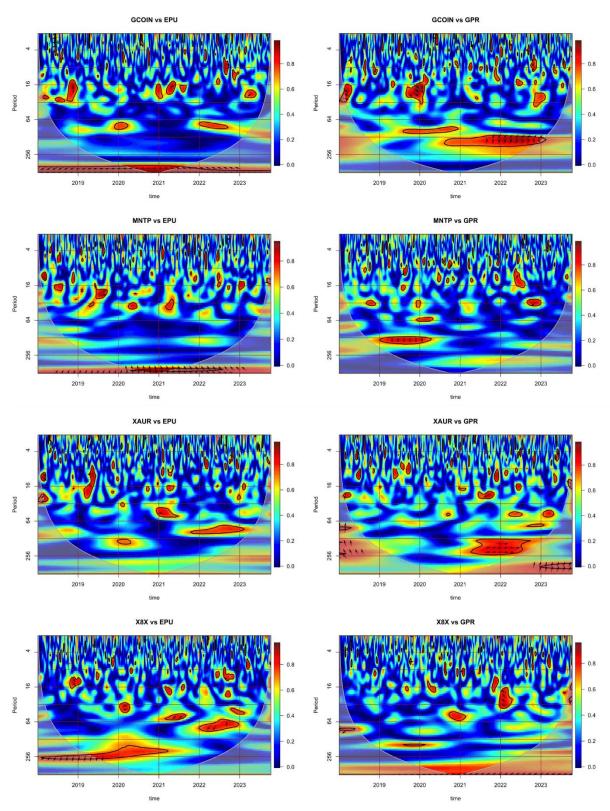
Figure 4. Wavelet Coherence among Islamic Cryptocurrency with the US EPU and GPR
Note: Figure 4 shows the wavelet coherence analysis for four Islamic cryptocurrencies with the US EPU and GPR from January 19, 2018, to October 31, 2023. The coherence diagrams are derived from Equations 2, 3, and 4. The acronyms GCOIN, MNTP, XAUR, and X8X indicate the international tickers for GoldCoin, GoldMint, Xaurum, and X8X respectively.

From an economic standpoint, the evolving nature of Bitcoin and Ethereum in response to economic uncertainties is underscored by these findings. Bitcoin's resilience and reduced correlation with uncertainties since 2022 suggest a potential shift in its role within investment portfolios, potentially enhancing its appeal as a long-term store of value amid economic uncertainty. Conversely, Ethereum's heightened sensitivity to uncertainties highlights its unique susceptibility to external economic factors. However, the inability of both cryptocurrencies to serve as dependable hedges against Economic Policy Uncertainty (EPU) risks underscores the complexities of relying solely on them for risk mitigation in investment strategies, emphasizing the need for comprehensive portfolio diversification and risk management approaches.

In contrast, the unique dynamics of Islamic cryptocurrencies in response to economic uncertainties diverge from traditional patterns observed in NFTs and conventional cryptocurrencies. This suggests a distinct sensitivity to geopolitical risks over economic policy uncertainties. The negative co-movement with EPU during crises indicates a possible aversion to economic policy uncertainties within Islamic cryptocurrency markets. Conversely, certain cryptocurrencies show partial positive co-movement with the Global Geopolitical Risk (GPR), hinting at their potential role as hedges and safe havens against geopolitical uncertainty, contingent on longer investment horizons.

Furthermore, the time-dependent lead-lag relationships highlight the evolving influences shaping Islamic cryptocurrencies. Post-pandemic, the dominance of EPU's influence on these cryptocurrencies signals a shift in their responsiveness to economic uncertainties. These findings stress the need for a nuanced understanding of Islamic cryptocurrencies' behaviors, offering opportunities for investors seeking to navigate geopolitical risks while integrating these assets into their portfolios.

Conclusion

Considering the ongoing interest among digital investments, particularly NFTs and cryptocurrencies, their growing market shares, and global political conditions, we examine the dynamic relationships among NFTs and cryptocurrencies with two major uncertainty measures, the US economic policy uncertainty (EPU) and the Global Geopolitical Risk (GPR). To this, we show, that not all uncertainties are alike. That is, NFTs do not respond similarly to uncertainties. Although their reaction can be generally described as symmetric, further investigation shows that MANA is weakly correlated with uncertainties over longer horizons. For cryptocurrencies, we find that all of them are positively (negatively) correlated with uncertainties in the absence (presence) of major global events such as COVID-19 or the global tension induced by the ongoing Russian invasion. We also show that NFTs and cryptocurrencies behave similarly in reacting against the uncertainties. As such, they can only act as a diversifier but not as a hedge or safe haven against the examined uncertainties. However, when Islamic cryptocurrencies are considered, they do demonstrate some hedging and safe haven potential against uncertainties.

With the rapid evolution of digital assets, we show that investing in NFTs has diversification benefits, and during times of high uncertainty, both EPU and GPR lead NFTs and cryptocurrencies. Our findings shed light on the properties of NFTs and cryptocurrencies for investors and fund managers in portfolio constructions, as these assets have varying relationships with EPU over different timeframes suggesting investors and managers for close monitoring of digital instruments at times of uncertainty and possible reallocating funds to safe haven assets such as Gold. In converse, based on our findings, we contend that Islamic cryptocurrencies are relatively better than their conventional counterparts as well as the emerging digital assets, i.e., NFTs.

For policymakers, our study adds to the understanding of the susceptibility of these digital assets showing attachments to heightened uncertainty, which is key to ensuring stability in financial markets. Thus, in addition to acknowledging uncertainty measures as predictors for negative return, policymakers may advise investors on fund allocation range at times of heightened uncertainties and may suggest other possible assets to combat uncertainty. In particular, policymakers should strongly direct investors and fund managers to closely monitor the US EPU rather than GPR.

With growing cross-border integration and higher dependency among financial instruments, as our study only looked at the US EPU and GPR and their connectedness with NFTs and cryptocurrencies, this study can be extended through examining other macro policy instruments such as federal funds rate, and TED spread for better insight into digital instruments. Further, given the rise of many

alternative instruments such as stocks, commodities, metals, etc. Relating to clean energy, another direction of studies could focus on a detailed investigation of portfolio analysis that may be conducted focusing on alternative financial instruments and crisis periods. Additionally, with recent concern over post-COVID and Russian invasions induced another global financial crisis, investigating the predictive interplay among alternative financial instruments and traditional assets such as stocks, bonds, and commodities might help towards better risk mitigation.

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