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Gold and Bitcoin as Hedging Instruments for Equity Markets under Crisis

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ABSTRACT

Gold has been traditionally well recognized as a safe heaven for financial markets. Lately, Bitcoin has been gradually considered as a popular alternative. Since the outbreak of COVID-19 in early 2020, it has become even more necessary and critical to examine the diversification capability of them to hedge financial risks associated with an unexpected crisis comparable to the pandemic. This paper hence employs the wavelet analysis, complemented by the multivariate DCC-GARCH approach, to measure the coherence of the gold and Bitcoin prices with six representative stock market indices, three for developed economies and three for emerging economies, all of which are heavily affected by the pandemic. To have a more balanced and comprehensive analysis, two-year data are used, spanning from 12th April 2019 to 15th April 2021, which covers approximately one year before and one year after the announcement of the COVID-19 pandemic. The results suggest that the returns of both gold and Bitcoin are generally not strongly correlated with the market returns of all six indices, particularly for short-term investment horizons. That is, investors in all six indices can benefit through gold, as well as Bitcoin, in terms of hedging. Meanwhile, compared with Bitcoin, gold shows to be less correlated with the indices, particularly for long-term investment horizons. The findings hence suggest that gold and Bitcoin offer diversification benefits to investors in the market indices during a crisis such as the COVID-19 pandemic, especially for short-term investment horizons. The study also reminds policymakers thinking beyond the pandemic about the future of the earth, including air pollution and health, for sustainable development of the whole world.

KEYWORDS

Gold; Bitcoin; Wavelet Coherence; DCC-GARCH; Hedging; COVID-19

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1. Introduction

The global financial crisis (GFC) has heavily affected the financial markets around the world, including both emerging and developed economies such as Brazil, India, Japan, Malaysia, the UK, and the USA. The crisis reminds further investors globally on looking into safe heavens to protect and safeguard their investments (Baur and McDermott, 2016; Mensi et al., 2016).

1.1. Hedge

Different from a diversifier, which may have positive but not perfect correlation with other assets or a portfolio, a hedge or a safe haven usually has zero or negative correlation (Baur and Lucey, 2010). While the former features negative or zero correlation with other assets within a portfolio, the latter is expected to exhibit its negative or zero correlation characteristics during a period under a crisis. More specifically, a strong hedge has negative correlation and a weak hedge has no correlation with other assets or a portfolio (Baur and McDermott, 2010). Accordingly, the strength of a safe haven can be interpreted in a similar way particularly during a crisis.

The subtle difference between a hedge and a safe haven can hence be interpreted as that a hedge holds in all circumstances and a safe haven is more for the time period under a crisis.

1.2. Gold as Hedge

Historically, traditional assets such as gold are on the front-line to hedge against fluctuations in the prices of other assets (Shiva and Sethi, 2015). It is found that precious metals including gold, silver, and platinum exhibit hedging capability, especially at times with abnormal stock market volatility (Hillier et al., 2006). In particular, gold is widely recognized as a long-established safe haven (Agyei-Ampomah et al., 2014; Gürgün and Ünalmi¸s, 2014; McCown and Zimmerman, 2006; Miyazaki and Hamori, 2016; Reboredo, 2013b), with the power to absorb, for example, the inflationary risk (Balcilar et al., 2017b; Beckmann and Czudaj, 2013; Blose, 2010).

In one of the very first studies to examine the hedge and safe haven properties of gold against the stock and bond markets in Germany, the UK, and the US, gold is claimed as a hedge for the equity and a safe haven during market turmoil (Baur and Lucey, 2010). From a multi-economy analysis, it is further shown that gold is both a hedge and a strong safe haven for developed markets, but not necessary for emerging markets such as the BRIC (Baur and McDermott, 2010).

Mixed findings are additionally reported (Ghazali et al., 2013). While gold fits in as both a hedge and a diversifier, it is conditional more for certain markets (Beckmann et al., 2015). Particularly, gold is not found to act as a hedge or a safe haven for the Thai investors (Pasutasarayut and Chintrakarn, 2012). Concerning the oil risk, the hedging power of gold is not evidenced as well (Ciner et al., 2013; Reboredo, 25 2013a).

1.3. Bitcoin as Hedge

Recently, the revolution in e-commerce and the introduction of virtual currencies have created new arenas in investment behaviour in general. For instance, following its debut after the GFC, Bitcoin has brought notable changes in finance in terms of issuing, storing, and transferring money. It is claimed either as a speculative asset (Baek and Elbeck, 2015) or a digital form of gold (Popper, 2015; Samah, 2020).

As an alternative replacement for gold in terms of safe haven properties, lately Bitcoin has increasingly become a more impactful factor in finance and investment, despite its controversies and hurdles in relation to policy making, economic issues, and other users, as well as a critical concern about the volatility (Balcilar et al., 2017a; Baur et al., 2015; Brandvold et al., 2015; Chaim and Laurini, 2018; Cheah and Fry, 2015; Dwyer, 2015; Gandal et al., 2018; Glaser et al., 2014; Katsiampa, 2017; Vandezande, 2017). This is due to its unique features such as independence of third-party manipulation, medium of exchange, easy means of transaction or reduced transaction cost, as well as the steadily increasing number of its users (Gajardo et al., 2018; Harvey, 2014; Kim, 2017; Urquhart, 2016).

Bitcoin hence gains more and more attention from investors as a hedging instrument (Aysan et al., 2019; Corbet et al., 2018; Guesmi et al., 2019; Hussain Shahzad et al., 2019; Kliber et al., 2019), to diversify risks associated with, for instance, the exchange rate (Dyhrberg, 2016a), inflation (Kub´at, 2015), money market (Bouoiyour and Selmi, 2017), and energy commodity (Bouri et al., 2017b).

For example, it is noted from examining the hedging properties of Bitcoin with respect to currencies that Bitcoin acts as a hedge for certain currencies and a diversifier for others (Urquhart and Zhang, 2019). Similar results are obtained concerning the hedging capabilities of gold and Bitcoin for oil price movement (Selmi et al., 2018). In addition, sufficient evidence is revealed to claim Bitcoin as an effective hedge against global uncertainty (Bouri et al., 2017a).

Analogous findings are reported in terms of hedging stock indices, for instance, the FTSE 100 index (Dyhrberg, 2016b). Consistent evidence is shown from using the GARCH model that Bitcoin acts as a strong candidate for hedge against the Euro STOXX, Nikkei, Shanghai A-Share, S&P 500, and the TSX Index (Chan et al., 2019).

Meanwhile, studies also suggest that the hedging properties of Bitcoin should be cautiously looked into further. For example, it is found from using the BEKK-GARCH model that the hedging capacity of Bitcoin, compared with gold, varies with portfolio and time (Klein et al., 2018). Postulated as an immature market, Bitcoin is not recommended as an appropriate choice to be considered for protecting the downside of investments (Smales, 2019). Similar concerns are raised on the effectiveness of Bitcoin as a hedge, rather than a diversifier (Bouri et al., 2017c; Charfeddine et al., 2020; Yermack, 2015).

1.4. COVID-19

Due to its direct or indirect effect (Sun et al., 2020), the pandemic is considered as one of the causes of fear for investors in financial market worldwide since the outbreak of COVID-19 (Ji et al., 2020; Zhang et al., 2020). During the pandemic, even gold fails to display its safe properties (Cheema et al., 2020). It is hence worth testing further the implication beyond the usual capacity pertaining to, e.g., digital currency (Alfaro et al., 2020; Corbet et al., 2020a,b; Jabotinsky and Sarel, 2020; Jana and Das, 2020), in terms of diversification as well as volatility (Platanakis and Urquhart, 2020; Shen et al., 2019).

At this extraordinary time point, it then becomes critically essential and worthwhile to investigate the hedging properties of gold and Bitcoin against both emerging and developed market indices under the crisis circumstance, which may have not be completely covered in the literature. In particular, even though the relationship between Bitcoin and gold has been intensively explored (Baur et al., 2018; Bouoiyour et al., 2019; Hussain Shahzad et al., 2020; Jareño et al., 2020; Naeem et al., 2020; Wu et al., 2019; Zhang and Wang, 2021), the present study contributes to the literature by looking into the hedging ability of Bitcoin to select their investment asset classes as well as to better construct their investment portfolio.

More specifically, the contributions are threefold. Firstly, most existing analysis concerning the hedging ability foregoes the inclusion of emerging economies such as Brazil and Malaysia, which are incorporated into the current analysis. Secondly, this study estimates the time-varying correlation and volatility of the assessed pairs and hedging effectiveness, for which portfolio managers can have a better understanding of the pre and during COVID-19 market structure. Thirdly, the hedging properties of gold and Bitcoin are explored for six representative markets, three of developed economies and three of emerging economies, including Brazil, India, Japan, Malaysia, the UK, and the USA. All of them are heavily affected by the pandemic as well.

COVID-19 has significantly greater adverse impact on the stock markets than any preceding infectious disease outbreaks such as the 1918 Spanish Flu (Baker et al., 2020). More specifically, the circuit breaker of the US stock market, only been triggered once in 1997 since its commencement in 1987, was triggered four times within a short period of ten days in March 2020 (Zhang et al., 2020). To examine the effects of COVID-19 on the six representative stock market indices, pre- and post-pandemic periods are included, approximately one year before and one year after the announcement of pandemic by the World Health Organization on 11 March 2020. The two-year sample data are hence relatively comprehensive and balanced, compared with existing studies. The study is expected to help potential investors to identify hedges for their investments and protect the downside at times of before and after the outbreak of a crisis.

To examine the correspondence of gold and Bitcoin with the six representative market indices, namely, Bovespa, NIFTY, NIKKEI, FTSE Bursa Malaysia KLCI as FTSEMY, FTSE 100, and S&P 500, this paper employs the wavelet and multivariate GARCH methods. Specifically, a notable inclusion to examine the time-varying and time-scale dependent market returns co-movements between the time series, the continuous wavelet transform (CWT) has recently been gradually demonstrated to be a powerful tool in the field of economics and finance (Ahmad Alrazni Alshammari, 2020; Bhuiyan et al., 2019; Bouri et al., 2020; Dai et al., 2020; Kang et al., 2019; Lim and Masih, 2017; Madaleno and Pinho, 2012). Particularly, while most traditional econometrics techniques may not be applied directly, the wavelet method readily steps in to deal with stylized facts such as nonstationary or nonlinear lead-lag interactions commonly observed in financial time series, partially due to heterogeneous expectations and risk perceptions of investors across varying investment horizons.

In the following Section 2, the CWT and multivariate GARCH are described. The data used and the results are presented in Section 3. Section 4 concludes the study with possible future directions.

2. Methodology

The CWT projects the original time series, a function of one variable, time, into a function of two separate variables, time and frequency. The series correlation displayed in a two-dimensional diagram then helps to identify and interpret the pattern or hidden information. The analysis of correlation between two time series is generally known as the wavelet coherence, which specifies the degree of correlation between two variables with the varying time and frequency.

To measure the dynamic conditional correlation (DCC) of a portfolio, the multivariate DCC-GARCH approach is applied. In particular, for risk assessment concerning the tail properties of returns to identify diversification benefits, the DCC model with a multivariate t-distribution captures the fat-tailed nature of asset returns.

2.1. Continuous Wavelet Transform

In terms of selecting the wavelet filter, it is revealed by studies on high-frequency data that a moderate-length filter is suitable to deal with the characteristics or features of time series data (Gen¸cay et al., 2001, 2002). It is also claimed that an LA (8) filter, a least asymmetric wavelet filter of length L=8 based on eight nonzero coefficients (Antonini et al., 1992), provides smoother wavelet coefficients than the others such as the Haar wavelet filter. This study hence adopts an LA (8) filter, by the principle of retaining a balance between the sample size and the length of the wavelet filter (In and Kim, 2013).

The continuous wavelet transform $Wx\ (s,\tau)$ is obtained by projecting a mother wavelet ψ onto the examined time series $x(t) \in L2(R)$. That is,

$$W_x(s,\tau) = \int_{-\infty}^{\infty} \frac{1}{\sqrt{s}} \psi(\frac{t-\tau}{s}) x(t) dt \quad (1)$$

The positions of wavelet in the time and frequency domains are specified by τ and s, respectively. The wavelet transform therefore provides information concurrently on time and frequency by mapping the original series into a function of τ and s. To look into the interaction between two time series x and y or how closely they are integrated by linear transformation, the wavelet coherence is considered.

$$R^2(s,\tau) = \frac{\left|S\left(s^{-1}W_{xy}(s,\tau)\right)\right|^2}{S(s^{-1}|W_x(s,\tau)|^2 S\left(s^{-1}\left|W_y(s,\tau)\right|^2\right)}, \tag{2}$$

where S is a smoothing operator, s is a wavelet scale, $W_x(s,\tau)$ is the wavelet transform of $x, Wy(s,\tau)$ is that of y, and $W_{xy}(s,\tau) = W_x(s,\tau)\, W_y^*(s,\tau)$ is the cross wavelet transform of the two time series (Aguiar-Conraria et al., 2008; Grinsted et al., 2004; Vacha and Barunik, 2012).

The wavelet squared coherence $R^2(s,\tau) \in (0,1)$ measures the closeness of the co-movement between x and y. A value close to zero indicates weak correlation and a value close to one implies strong correlation.

2.2. Multivariate GARCH

When the multivariate GARCH model is adopted, the estimation of DCC method involves two steps. The univariate volatility parameters are first measured for each variable. For two variables, there are hence two GARCH equations to be estimated. For instance, in the asymmetric GARCH equation (Glosten et al., 1993),

$$h_t = b_0 + b_1 h_{t-1} + c_1 \varepsilon_t^2 + c_2 \varepsilon_t^2 I_{\{\varepsilon>0\}} \tag{3}$$

where I is an indicator function equivalent to 1 if the standardized residual of the series $\varepsilon = \{\varepsilon_t\}$ is positive and to 0 otherwise. A negative value of c2. implies that periods of higher variances follow more immediately periods of negative residuals compared with those of positive residuals. For estimating the residual, the GARCH equation is measured for each variable.

The residuals resulting from the first stage are then taken as inputs to estimate a time-varying correlation matrix by measuring the DCC equation parameters,

$$H_t = D_t R_t D_t \tag{4}$$

where H_t is the conditional covariance matrix, D_t is the diagonal matrix of the conditional time-varying standardized residual that is acquired from the univariate GARCH model as the on-diagonal elements or variance, and R_t is the time-varying correlation matrix as the off-diagonal elements (Engle, 2002; Tse and Tsui, 2002).

Accordingly, the likelihood of the DCC estimator is

$$L = -\frac{1}{2}\sum_{t=1}^{T}(nlog2\pi + 2\,log|D_t| + log|R_t| + \varepsilon_t' R_t^{-1} - \varepsilon_t). \tag{5}$$

The volatility component D_t is maximized in the first step. That is, the log likelihood is reduced to the sum of that of the univariate GARCH equations.

Conditional on the estimated D_t, the correlation component R_t is maximized in the second step, with elements ε_t being obtained from the first step. The nonnegative parameters α and β satisfying $\alpha + \beta \leq 1$ in the following DCC equation are then evaluated.

$$R_t = (1-\alpha-\beta)R + \alpha\varepsilon_t - 1\varepsilon_{t-1}' + \beta R_{t-1}. \tag{6}$$

R_t is hence the weighted average of three matrices. A strong degree of persistence is indicated in the series for correlation R_t if β is close to 1 and high persistence is suggested in the conditional variance if $\alpha + \beta$ is close to

1. For both the conditional correlation and variance, the model has the GARCH-type dynamics. The time-varying conditional variance hence measures the uncertainty that provides insight into the causes of movement in the variance.

If $\alpha = \beta = 0$, then R_t is simply the time-invariant R with unit diagonal elements and the constant conditional correlations (CCC) model, a univariate GARCH process followed by the conditional variance for each return (Bollerslev, 1990), is sufficient. Specifically,

$$h_{it} = w_t + \sum_{j=1}^{p} \alpha_{ij} \varepsilon_{i,t-j}^2 + \sum_{j=1}^{q} \beta_{ij} h_{j,t-j}\,, \tag{7}$$

where α_{ij} represents the ARCH impact on or short-term persistence of shocks to return j and β_{ij} reflects the GARCH effect or impact of shocks on return i to long term persistence. The CCC model hence assumes independence of conditional variance across returns and does not support asymmetric behavior.

3. Results

To investigate the interrelation between the asset classes including the wavelet coherence, which is analyzed by using MATLAB, the data used for the study are described first in Section 3.1, followed by the findings presented in Section 3.2.

3.1. Data

Extracted from Investing.com, the data span from 12th April 2019 to 15th April 2021, covering periods both before and after the announcement of the pandemic. Six representative indices of both emerging and developed economies are considered, including Bovespa, Nifty 50, Nikkei 225, FTSEMY, FTSE 100, and S&P 500. The indices, along with the gold and Bitcoin prices, are transformed to market returns by using the natural logarithmic difference.

Bovespa consists of 70 stocks accounting for the majority of trading and market capitalization in the Brazilian stock market. As the flagship index on the NSE, the NIFTY 50 tracks the behaviour of a portfolio of the largest and most liquid Indian securities listed on the NSE. The Nikkei 225 is a price-weighted average of 225 top-rated Japanese companies listed in the first section of the Tokyo Stock Exchange. The FTSE Bursa Malaysia KLCI Index comprises the largest 30 companies by full market capitalization on the main board of Bursa Malaysia. The FTSE 100 is a capitalization-weighted index of the 100 most highly capitalized companies traded on the London Stock Exchange. The S&P 500 is widely regarded as the best single gauge of the large-cap U.S. equities and serves as the foundation for a wide range of investment products. The respective tickers of the data are specified in Table 1.

Table 1. Specification of Data.

Index	Ticker
Gold Spot Price	GOLD
Bitcoin Price	BITCOIN
Bovespa	Brazil
NSE Nifty 50	NIFTY
Nikkei 225	NIKKEI
FTSE Bursa Malaysia KLCI	FTSEMY
Financial Times Stock Exchange 100 Index	FTSE 100
Standard & Poor’s 500	S&P 500

3.2. Findings

The continuous wavelet power spectrum and coherence are examined between gold & Bitcoin and the market indices. As the absolute value of the square of the wavelet transform, the wavelet power spectrum provides a measure of the time series variance for each time and each scale (frequency). In Section 3.2.1, the wavelet coherence of the gold and Bitcoin returns with the respective market returns is illustrated in Figure 1 to Figure 12, where the horizontal and vertical axes represent the time and frequency components, respectively. To simplify the interpretation, the frequency is transformed into time units in days, ranging from scale 1 (one day) up to scale 128 (more than 128 days). It is interpreted as 1-16 days for short-term, 16-64 days for medium-term, and 64-128 days for long-term investment periods, respectively.

The figures comprise colour codes in a power range from blue to yellow. Blue hints low correlation, which suggests a weak linkage between the two time series, whereas yellow indicates high correlation, which shows a strong interdependence between them. The area where the co-movement between the two time series is statistically significant is separated by a dark thick line for the significance level of 5%. Outside the contour where the inference is reliable is the cone of influence shown in lighter shade, where edge effects might distort the illustration (Grinsted et al., 2004; Torrence and Compo, 1998).

Complementarily, the conditional volatility and correlation are demonstrated in Figure 13 to Figure 15 in Section 3.2.2.

3.2.1. Wavelet Coherence

Figure 1 and Figure 2 display the wavelet coherence of the gold and Bitcoin returns with the market return of Bovespa, respectively.

Figure 1 and Figure 2 suggest that both gold and Bitcoin have weak linkage with Brazil's index in the short-term investment range. For the medium-term investment range, both pairs show high interdependence for the first half of 2020, with Bitcoin having a strong correlation starting from 2021 as well. For the long-term horizons, Bitcoin features a comparatively strong correspondence with Brazil's index, which is not the case for gold.

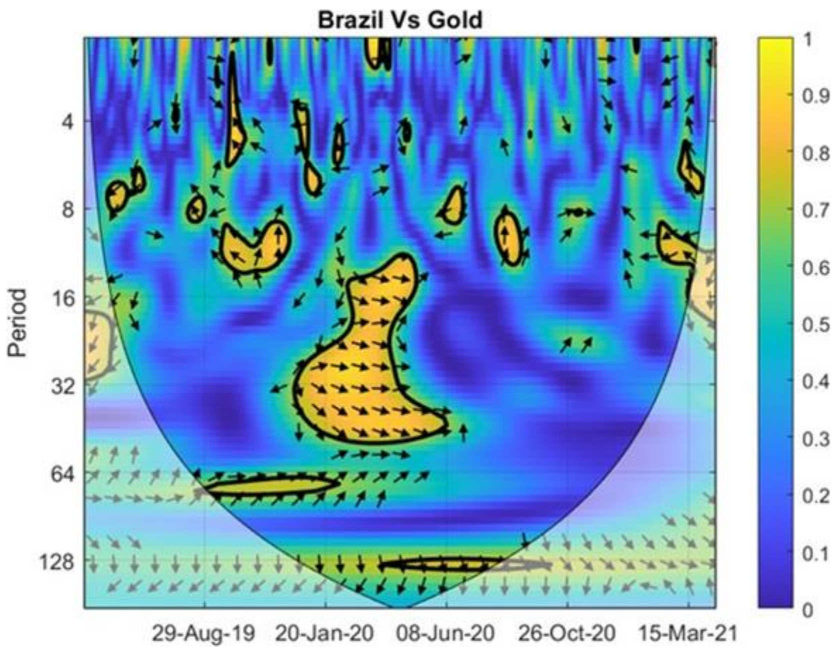

Figure 1. Wavelet Coherence between Gold and Brazil.

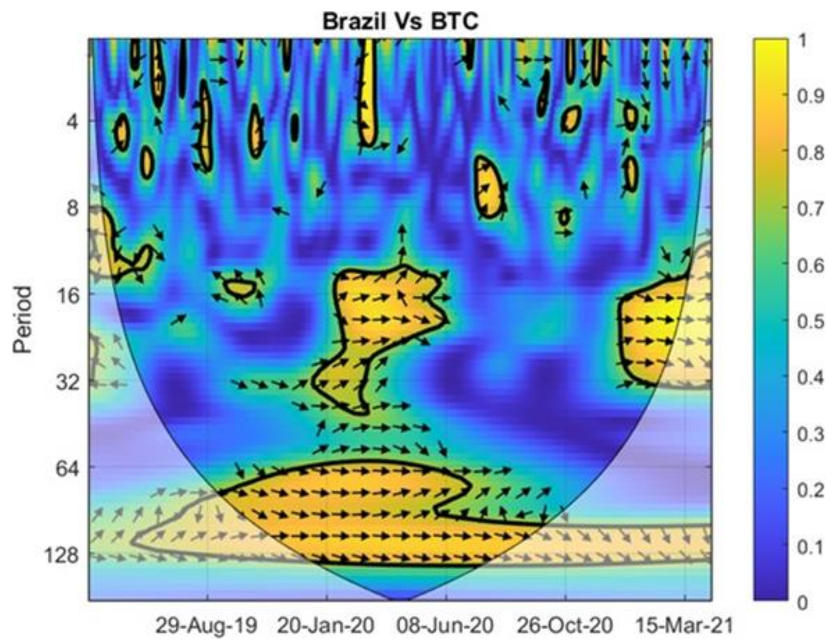

Figure 2. Wavelet Coherence between Bitcoin and Brazil.

Compared with Figure 4, Figure 3 shows that gold and Nifty has significantly weaker correlation between them than Bitcoin and Nifty. The pair mainly see high level of correlation in the fourth quarter of 2019 and the first quarter of 2020 at the medium-term investment horizon of 16-64 days, likely due to the pandemic effect. Thereafter, it mostly displays blue for almost all horizons, except a minor yellow mark in the early fourth quarter of 2020 with horizons of 16-32 days.

In contrast, Figure 4 indicates that the pair of Bitcoin and Nifty features strong correlation for horizons of over 64 days throughout the sample period. For short-term and medium-term horizons of 1-64 days, the correlation matrix seems to weaken in general with moderate exceptions, e.g., 16 to 32 days during the first quarter of 2020.

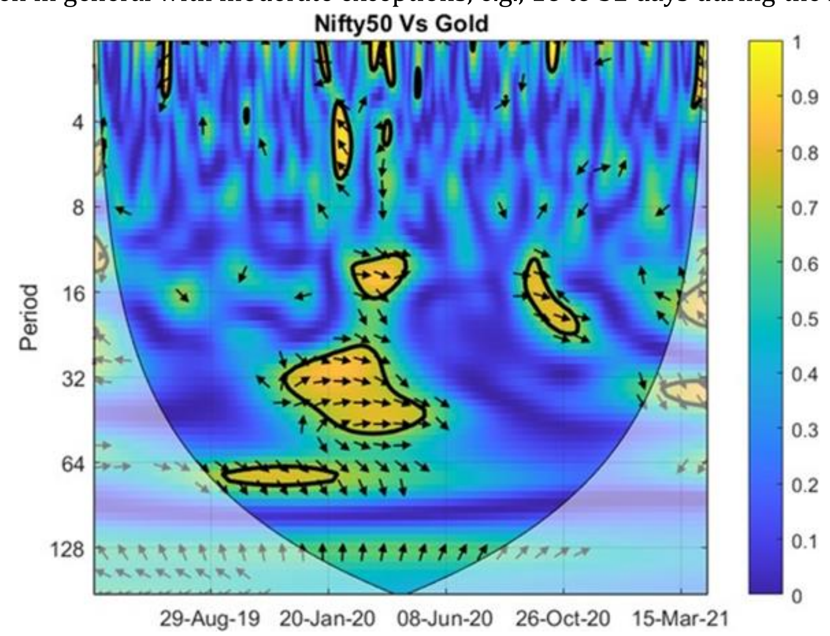

Figure 3. Wavelet Coherence between Gold and NIFTY 50.

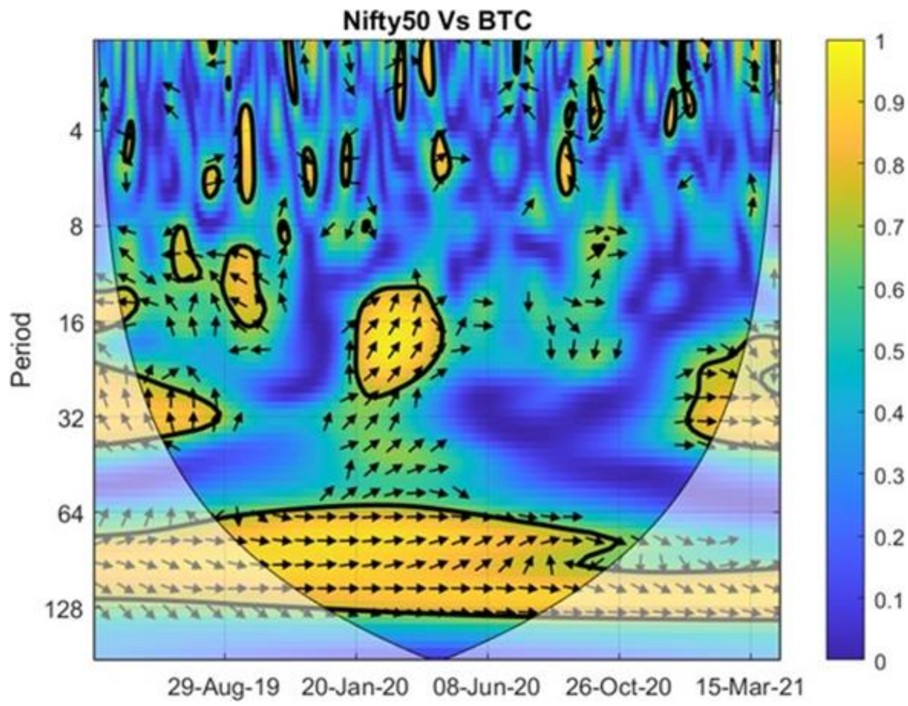

Figure 4. Wavelet Coherence between Bitcoin and NIFTY 50.

Figure 5 and Figure 6 exhibit high dependence of both gold and Bitcoin with NIKKEI over the medium-term horizons of 16-64 days, except for the time period from June 2020 to October 2020, which is in line with the announcement of vaccines. Between gold and Bitcoin, the former seemingly outpaces the latter for long-term horizons of over 64 days, but vice versa for short-term horizons of 1-8 days.

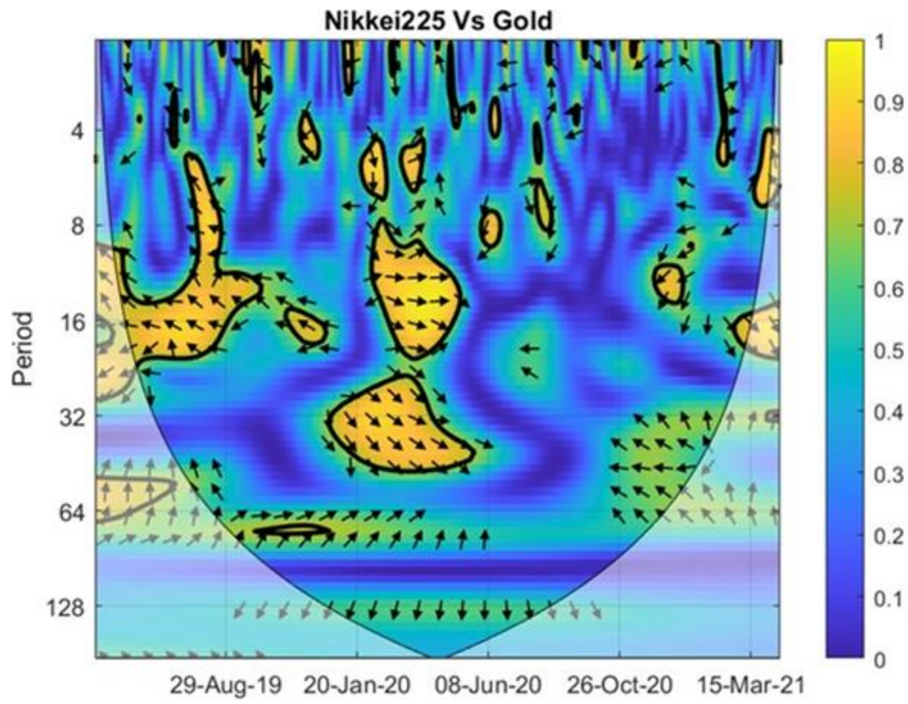

Figure 5. Wavelet Coherence between Gold and NIKKEI.

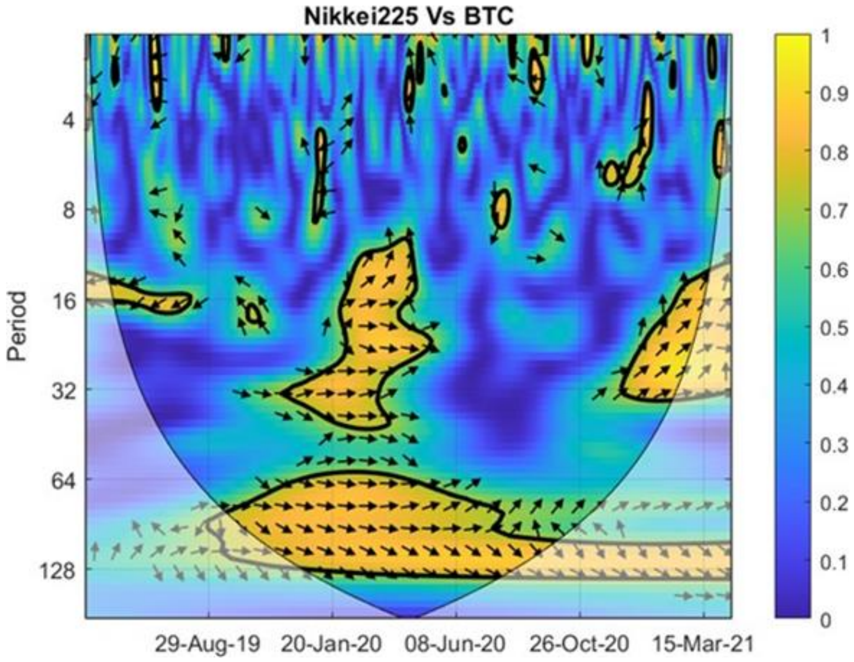

Figure 6. Wavelet Coherence between Bitcoin and NIKKEI.

In the case of FTSEMY as shown in Figure 7 and Figure 8, both pairs see a high level of correlation in the mid-range quantiles during the early phase of the COVID-19 pandemic, for which most yellow marks are visible for horizons of 8-64 days in the first half of 2020 and for horizons of 64-128 days up to October 2020 and even beyond. The correlation becomes much weaker thereafter. In terms of short-term strategies, both pairs experience weak correlation with little exception for the pair with Bitcoin, which exhibits moderately high correlation for 4-16 days in the first quarter of 2020.

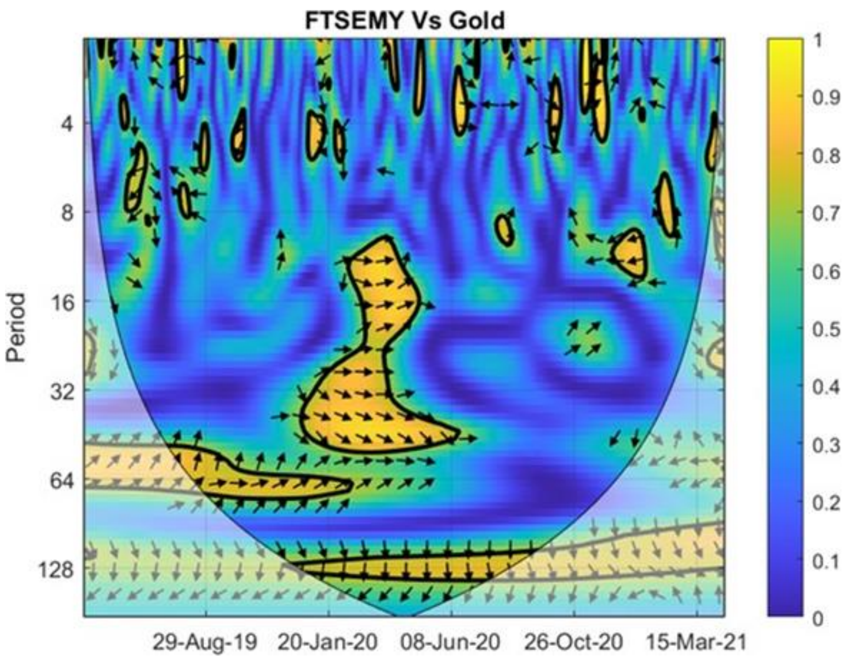

Figure 7. Wavelet Coherence between Gold and FTSEMY.

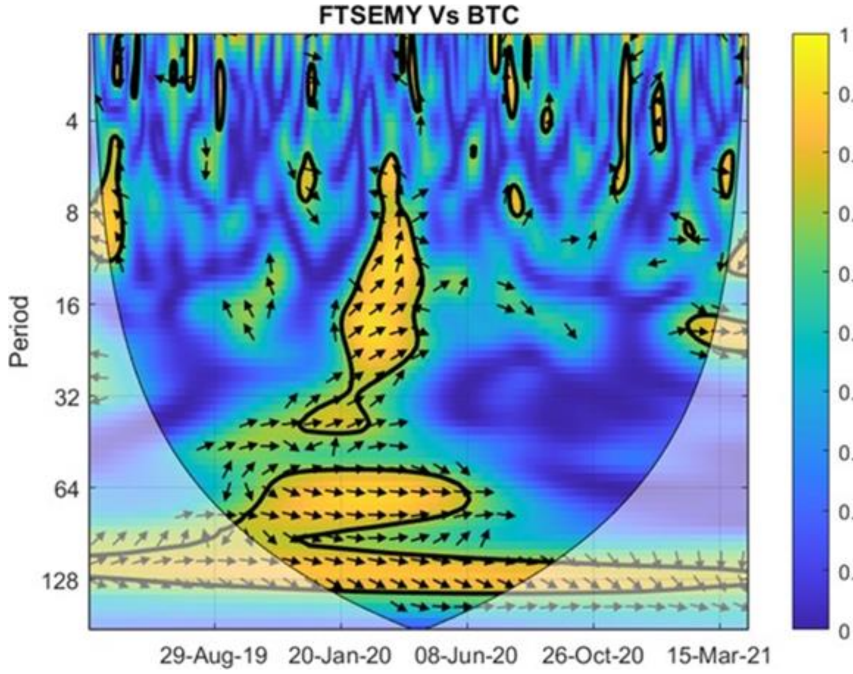

Figure 8. Wavelet Coherence between Bitcoin and FTSEMY.

As illustrated in Figure 9 and Figure 10, FTSE 100 exhibits a high volume of connection with both gold and Bitcoin in the mid-range investment timeframe during the first six months of COVID-19 outbreak and later again in late 2020. Considering the long-term horizons, the pair with gold significantly excels as there are only minimum yellow regions compared with the case of Bitcoin, for which a heavy thick yellow region is evidenced for the two-year period. Meanwhile, for short-term strategies, both pairs show mostly blue and green regions with yellowish occasionally, indicating weak correlation.

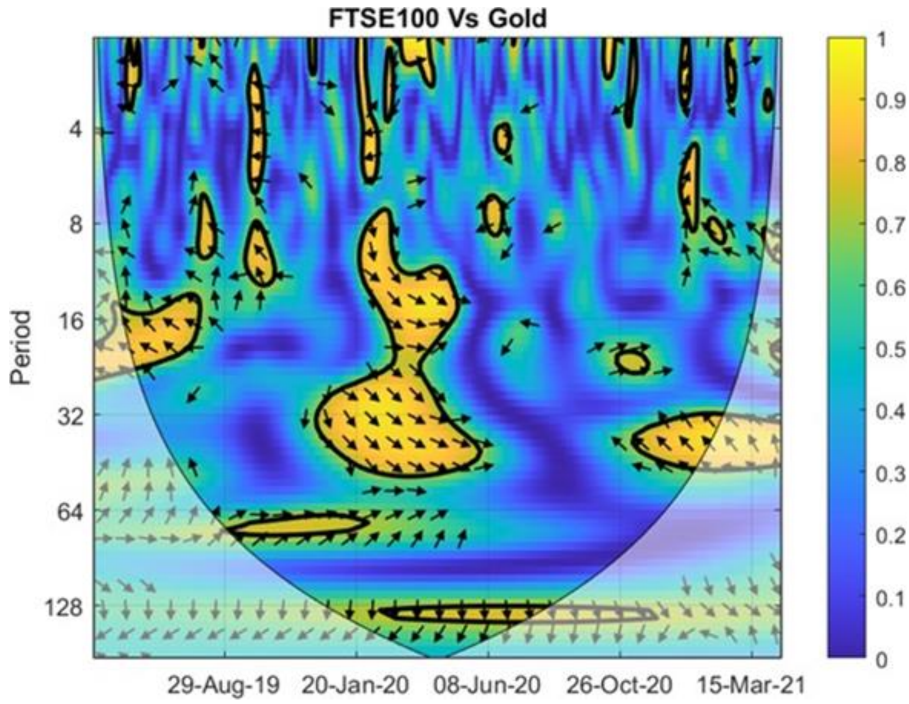

Figure 9. Wavelet Coherence between Gold and FTSE 100

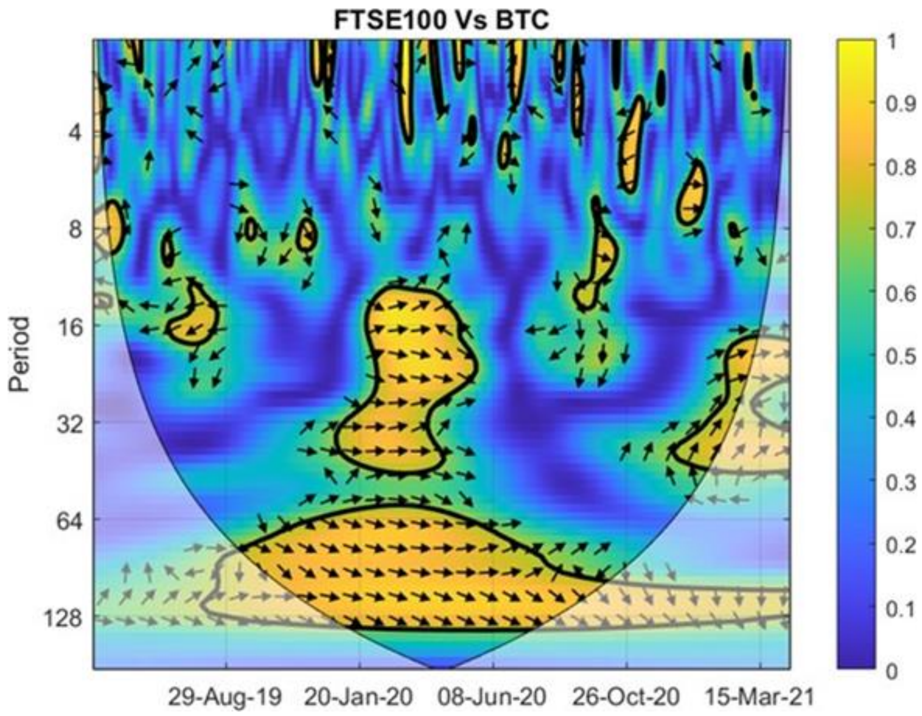

Figure 10. Wavelet Coherence between Bitcoin and FTSE 100.

Interestingly, Figure 11 and Figure 12 display different patterns for gold and Bitcoin when pairing with S&P period Gold shows weak correlation with S&P 500 for all horizons starting from the middle of 2020, while Bitcoin exhibits weak correlation with S&P 500 all throughout the sample size up to 64 days until the beginning of 2020. For horizons of 64-128 days, the dominating yellow block hints strong dependence between Bitcoin and S&P 500.

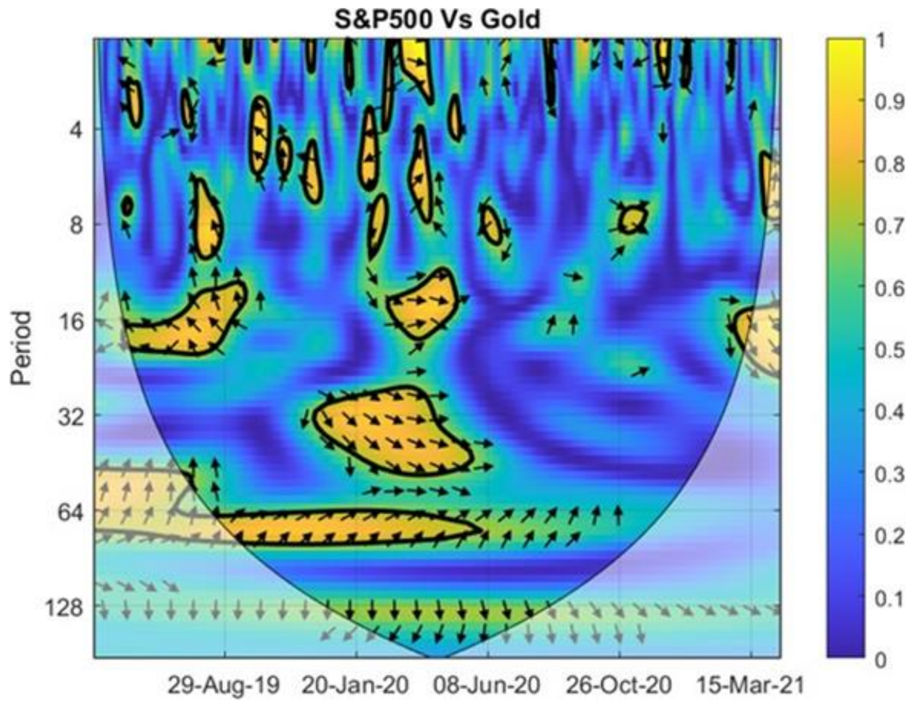

Figure 11. Wavelet Coherence between Gold and S&P 500.

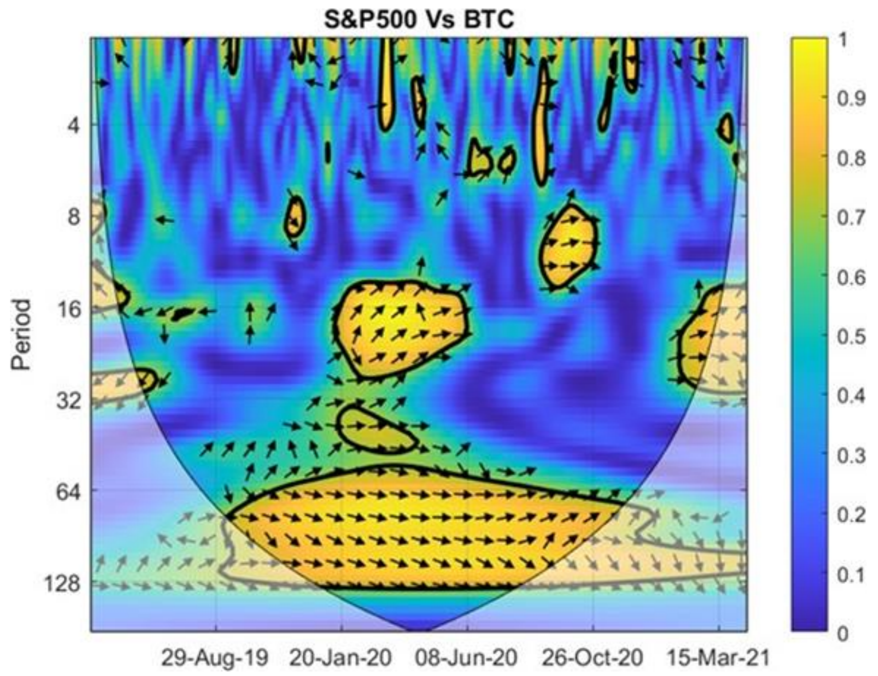

Figure 12. Wavelet Coherence between Bitcoin and S&P 500.

To sum up, the wavelet coherence analysis illustrated in Figure 1 to Figure 12 reveals that for the two-year sample time period examined, spanning from 12th April 2019 to 15th April 2021, gold holds low correlation with all the six indices for both short-term investors with horizons of 1-16 days and long-term investors with horizons over 64 days. For Bitcoin, the weak correlation seems more limited to short-term horizons only. The two investment types hence offer similarity in hedging opportunities for short-term investors, while gold is more the option for long-term investors. Meanwhile, opportunities for medium-term seeking investors seem to be dimmed in the current experimented period.

3.2.2. Conditional Volatility and Correlation

For a complementary visual demonstration of what behind the coherence exhibited in Figure 1 to Figure 12, the estimated conditional volatility and correlation of Bitcoin, gold, and the market indices from the multivariate DCC-GARCH method discussed in Section 2.2 are additionally displayed in Figure 13 to Figure 15, respectively. Figure 13 compares the levels of volatility of gold and Bitcoin as well as the indices. It can be clearly seen that Bitcoin leads the run being the most volatile, while the rest follow each other with a stable trend. Meanwhile, a steep decline in the volatility is evident, followed by a significant hike in the first quarter of 2020. Concerning the level of volatility in gold which features a tamed nature, there is however a positive signal towards investors seeking to protect their investments with minimum level of risk involved.

Figure 14 and Figure 15 illustrate the correlation of gold and Bitcoin with the indices, respectively. Apparently, both gold and Bitcoin hold negative correlation with all indices until March 2020, which indicates a positive hope for investors in the indices to hedge their risk using either or both gold and Bitcoin during the economic turmoil before the announcement of the pandemic. The correlation then turns to be positive for both in the rest of the period analyzed, which hints that either gold or Bitcoin may fail to be a reliable hedge for investors in the indices thereafter.

The detailed estimated parameters of multivariate GARCH and unconditional volatilities & correlations are given in Table 2 and Table 3, respectively, in Appendix.

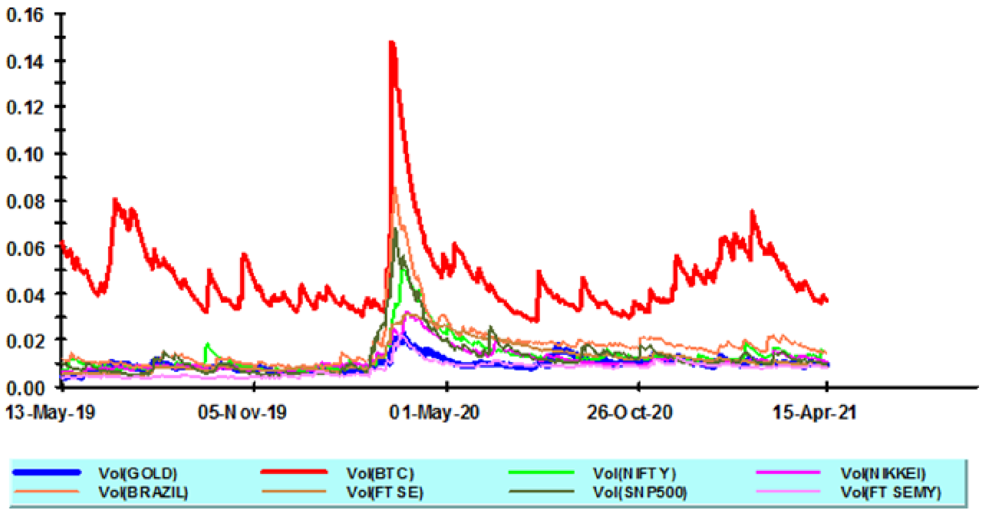

Figure 13. Estimated Conditional Volatilities of Bitcoin & Gold and Indices.

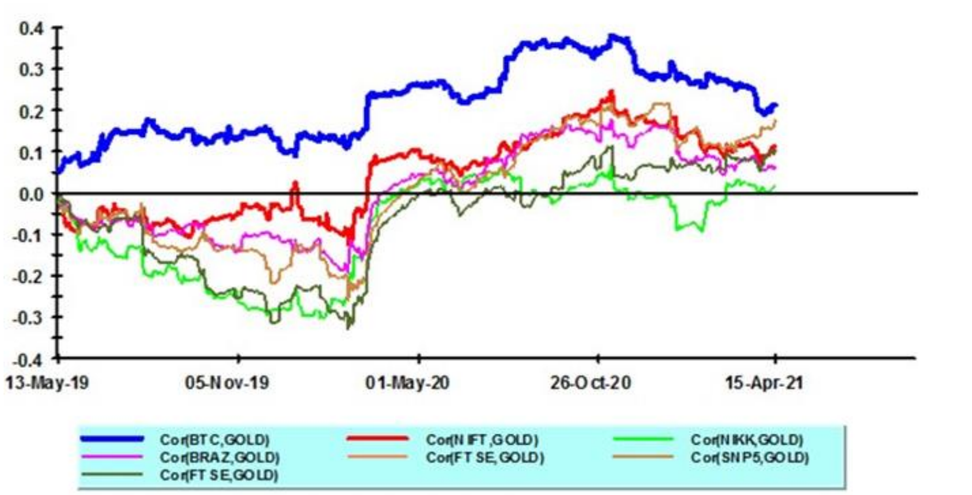

Figure 14. Estimated Conditional Correlations of Gold and Indices.

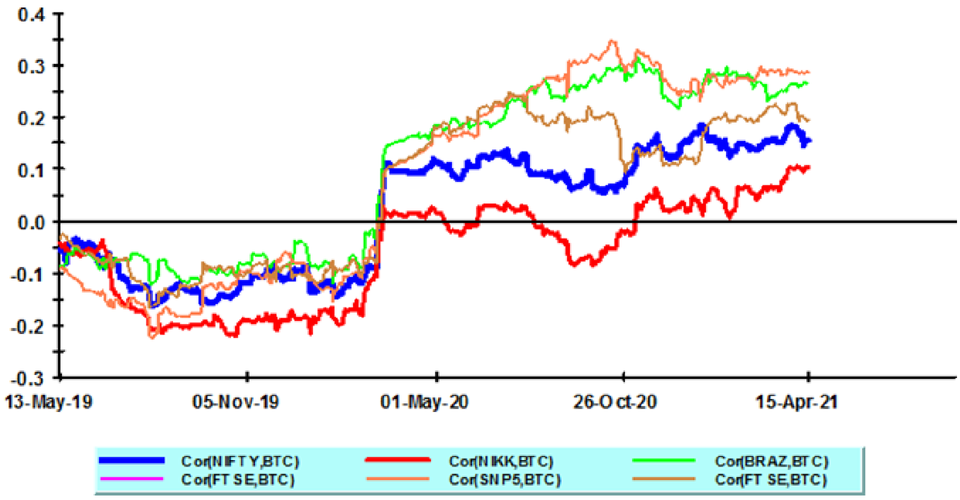

Figure 15. Estimated Conditional Correlations of Bitcoin and Indices.

4. Conclusion

The hedging property of gold has been well established and that of Bitcoin has been a focus as well in recent years. Since the outbreak of COVID-19, it has become critically necessary and important to examine the ability of gold and Bitcoin to hedge crisis risks such as the COVID-19 pandemic. This paper hence employs both wavelet and multivariate GARCH methods to explore the hedging ability of gold and Bitcoin with six representative market indices during the present crisis using the daily data from 12th April 2019 to 15th April 2021, spanning approximately one year before the announcement of the pandemic and one year after. The analysis is expected to be helpful to identify if gold and Bitcoin can be used to hedge such risks.

It is found that gold and Bitcoin exhibit similar behavior in most of the cases studied. In general, investors in all the six indices, representing both developed and emerging economies, can benefit through gold, as well as Bitcoin, in terms of hedging during the COVID-19 crisis. In addition to what revealed by the wavelet coherence analysis, the complementary GARCH method shows that the conditional correction between the respective pairs is mostly within the range of ±0.2 during the time period examined.

The only modest exception observed is the time period from February to May 2020, that is, right before and after the announcement of the pandemic, during which comparatively higher correlations are observed, particularly for medium-term investment horizons. This may be partially due to the substantially high rolling anxiety index observed during the time period in many countries including the six examined in this study, resulting from the fluctuating emotions associated with the COVID-19 cases and deaths reported (Yu et al., 2022). During this panic-leads-market phase caused by COVID-19, the panic selling or buying of currency and cryptocurrency leaves nearly no room for diversification strategy (Umar and Gubareva, 2020). This is further supported by the observed medium- and long-term strong risk spillovers triggered by the pandemic, which is closely correlated with investor panic (Fang et al., 2023). A working hedge strategy under normal market conditions may fail during times of global crisis such as the pandemic in this case (Umar and Gubareva, 2020). The anxiety and panic surrounding the period of the pandemic announcement may hence cause higher correlation and lower the effectiveness of gold and Bitcoin as hedging assets during crisis periods.

Meanwhile, compared with Bitcoin, gold shows to be relatively less correlated with the indices, particularly for holding periods beyond 64 days. The evidence becomes slightly less significant for both gold and Bitcoin in medium-term investment horizons of 16-64 days.

The findings are in line with recent observations (Dwita Mariana et al., 2021; Goodell and Goutte, 2021a; Grobys, 2021; Shehzad et al., 2021), while complementary to some others (Baur and Hoang, 2021; Conlon and McGee, 2020; Kyriazis, 2020; Telli and Chen, 2020).

To enrich the study, possible extensions can be made, for example, to investigate the behavior of other cryptocurrencies such as Ethereum, Litecoin, and Tether (Conlon et al., 2020; da Gama Silva et al., 2019; Goodell and Goutte, 2021b).

A better understanding about the systematic risk related to COVID-19 could help investors vigilantly design risk management strategies and policymakers effectively support economic recovery. Based on the sample period studied, the impact of the pandemic seems to be more transitory rather than permanent. Referable to global investors in strategizing their investment plans under a crisis comparable to the current one, the study also implies that policymakers should keep closely monitoring the systematic risk posted by the COVID-19 pandemic and design appropriate strategies to maintain financial stability and support economic recovery.

In the meantime, it can be expected that the unexpected COVID-19 pandemic has changed and is going to keep changing the daily life worldwide significantly. In short term, particularly from the economic and financial perspectives, the impact shows to be notably weighted. Meanwhile, in long term, from the environmental and societal perspectives, for instance, the pandemic brings a rare lesson worth thinking more about the future of the earth, including air pollution and health (Berman and Ebisu, 2020; Chen et al., 2020; Cole et al., 2020; He et al., 2020; Kerimray et al., 2020; Le et al., 2020; Otmani et al., 2020; Tanaka and Okamoto, 2020; Venter et al., 2020).

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Conflict of interest

All the authors claim that the manuscript is completely original. The authors also declare no conflict of interest.

Appendix

Table A1. Parameter Estimates for Multivariate GARCH with Underlying Multivariate t-Distribution.

Parameter	Estimate	Standard Error	t-ratio	p-value
λ^1_{GOLD}	0.86488	0.042079	20.5539	0.000
λ^1_{BTC}	0.89377	0.052410	17.0535	0.000
λ^1_{BRAZIL}	0.85326	0.059583	14.3205	0.000
λ^1_{NIFTY}	0.88466	0.033386	26.4979	0.000
λ^1_{NIKKEI}	0.91809	0.024131	38.0454	0.000
λ^1_{FTSEMY}	0.86639	0.058860	14.7193	0.000
λ^1_{FTSE}	0.96715	0.011204	86.3197	0.000
$\lambda^1_{S\&P500}$	0.82633	0.044849	18.4249	0.000
λ^1_{GOLD}	0.07441	0.019096	3.8966	0.000
λ^1_{BTC}	0.08074	0.032522	2.4825	0.013
λ^1_{BRAZIL}	0.09422	0.030739	3.0650	0.002
λ^1_{NIFTY}	0.07896	0.020108	3.9267	0.000
λ^1_{NIKKEI}	0.05698	0.014550	3.9163	0.000
λ^1_{FTSEMY}	0.05392	0.017369	3.1045	0.002
λ^1_{FTSE}	0.02879	0.005882	4.8946	0.000
$\lambda^1_{S\&P500}$	0.12831	0.030495	4.2075	0.000
δ^1	0.98663	0.002644	373.2014	0.000
δ^2	0.00823	0.001504	5.4764	0.000
df	7.1351	0.58124	12.2755	0.000

Table A2. Estimated Unconditional Volatility Matrix of Gold and Bitcoin with Six Indices.

	GOLD	BTC	BRAZIL	NIFTY	NIKKEI	FTSEMY	FTSE	S&P500
GOLD	0.01081	0.27658	0.20293	0.14747	0.07097	0.14624	0.15747	0.25722
BTC	0.27658	0.04994	0.31020	0.14337	0.04466	0.02419	0.27493	0.30541
BRAZIL	0.20293	0.31020	0.02201	0.41137	0.26248	0.21734	0.59906	0.76515
NIFTY	0.14747	0.14337	0.41137	0.01593	0.32582	0.46862	0.49388	0.34961
NIKKEI	0.07097	0.04466	0.26248	0.32582	0.01302	0.41864	0.42617	0.28228
FTSEMY	0.14624	0.02419	0.21734	0.46862	0.41864	0.00930	0.31625	0.15098

FTSE	0.15747	0.27493	0.59906	0.49388	0.42617	0.31625	0.01430	0.66461
S&P500	0.25722	0.30541	0.76515	0.34961	0.28228	0.15098	0.66461	0.01654

Notes: The diagonal elements correspond to the unconditional volatilities and the off-diagonal elements to the correlations.

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