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Is gold favourable than bitcoin during the COVID-19 outbreak? Comparative analysis through wavelet approach

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A B S T R A C T

The novel coronavirus (COVID-19) has tremendously oscillated the global financial markets. Consequently, investors feel pressured to find safe-haven investments during the pandemic crisis. Numerous studies have evaluated bitcoin’s safe-haven properties during the COVID-19; however, the present study considered gold as a potential safe-haven for investors of renowned stock markets of Asia, Europe, and the US. The present investigation computed the ratio of gold to bitcoin (Gold/Bitcoin) and compared the safe-haven properties of gold in contrast to bitcoin. The present study analysed the Morlet Wavelet approach and found that most of the time during the COVID-19, gold investments proved to be more beneficial than bitcoin. Remarkably, the findings highlighted that the Gold/Bitcoin ratio increased in higher and lower frequencies combined with CAC40. In the long run, the return on investments in gold increased in contrast to bitcoin returns pooled with DAX30. Also, the Gold/Bitcoin ratio of the US stock market increased during the one-week and one-month cycles of January and August. Likewise, the Hang Seng Index caused the Gold/Bitcoin ratio to rise at a much higher frequency (i.e., during January, February, and April); whereas IBEX35 surged Gold/Bitcoin at a lower frequency (i.e., during January, February, and March). In higher frequency bands, LSE increased the Gold/Bitcoin ratio (i.e., in February and March); nevertheless, Gold/Bitcoin showed a positive connection with FTSEMIB in the one-to-two month’s frequency band (i.e., throughout January, February, and March). Interestingly, the returns on the Gold/Bitcoin ratio increased in the SSEC stock market in the high-frequency band (i.e., during March, May, and July 2020).

1. Introduction

The world has recently encountered a new viral pandemic known as the novel coronavirus (COVID-19) that emerged from Wuhan, China, in December 2019. Subsequently, Europe became the epicentre of COVID-19 in mid-March 2020, as the outbreak accelerated from its troubled hot spot (i.e., Italy) to the entire region and later reached every corner of our planet (Albulescu, 2020). The transmission of COVID-19 from one person to another is a terrifying feature of the pandemic that formed a global emergency (WHO, 2020). As a result of the alarming and unprecedented situation propelled by the COVID-19, numerous firms had to suspend their business activities during the pandemic temporarily (Shehzad et al., 2020a).

A market diagnosis accomplished by Bloomberg concludes that COVID-19 has reduced China’s first quarter of GDP growth to about 4.5%, whereas the fear of COVID-19 has also reshaped the financial markets worldwide. The US’ Standard & Poor Index (S&P 500) market value plunged to almost 30% since the outbreak of COVID-19 in the US (Yahoo, 2020). Shehzad et al. (2020a) highlighted that the S&P 500 and Nasdaq index’s market value has distilled to 14.9% and 12.4% from March 6 - March 18, respectively during the COVID-19. Also, in recent times, the outbreak of COVID-19 increased the level of VIX at the highest point equated with the Global Financial Crisis (GFC) 2007–09 (Shehzad et al., 2021a). Hence, the COVID-19 crisis emerged as more destructive for the global financial markets than the GFC (Shehzad et al., 2020b).

Conversely, the gold prices revealed a positive attitude during the
pandemic period, as it touched the highest price of $2060 during the COVID-19 period, representing a 30% increase in 2020 (Khan, 2020). Hence, the intensification of the gold prices created an optimistic projection for gold investments as a new safe-haven for investors, especially when the global stock market returns experienced a declining trend. This behaviour has created the opportunity to revisit the safe-haven properties of gold after the outbreak of the COVID-19 pandemic. Moreover, countless studies have enlightened the investment benefits and safe-haven properties of gold during the standard period (Chan et al., 2011; Mensi et al., 2019; Symitsi and Chalvatzis, 2019; Jin et al., 2019; Thuraïsamy et al., 2013; Choudhry et al., 2015; Bildirici and Türkmen, 2015; Baur and McDermott, 2010; Bouri et al., 2020). Mensi et al. (2018) analysed the stock markets of BRICS nations with oil and gold futures by employing the wavelet approach. The study revealed that low-frequency co-movement existed between WTI oil and BRICS index returns; additionally, this relationship became more robust during the financial crisis (Shehzad et al., 2021b).

Nevertheless, the investigation indicated that gold could be used as a safe-haven for these emerging markets during the crisis period. Jin et al. (2019) employed the multivariate GARCH model and concluded that the correlation between gold and crude oil was positive. The affiliation of gold with bitcoin remained negative throughout the sample period analysed in the present study. However, it is crucial to evaluate the role of gold as a safe-haven asset, especially during the crisis period of the COVID-19 pandemic.

Importantly, COVID-19 impact on the safe-haven properties of cryptocurrencies cannot be ignored, as they comprise substantial prospects to avoid possible risk during typical days (Bouri et al., 2017; Kliber et al., 2019; Kliber et al., 2019, 2019; Symitsi and Chalvatzis, 2019; Qureshi et al., 2020; Kristjanpoller et al., 2020; Katsampa et al., 2019; Conlon et al., 2020; Kang et al., 2019; Kajtazi and Moro, 2019; Wu and Le, 2018; Jin et al., 2019). Symitsi and Chalvatzis (2019) found substantial benefits of the inclusion of bitcoin in the investment portfolio. Kajtazi and Moro (2019) explored bitcoin’s role in the Chinese, US, and European financial markets. The study concluded that the performance of the investment portfolio increased by introducing bitcoin. Bouri et al. (2017) reported that bitcoin has durable hedging and safe-haven characteristics paired with other commodities, especially energy commodities. However, after the crash of the bitcoin price in 2013, it could not maintain these properties. Kliber et al. (2019) revealed that bitcoin worked as a safe-haven for Venezuela’s stock market.

Nonetheless, bitcoin proved nothing except a diversifier for the stock markets of Japan and China. In Estonia and Sweden, bitcoin has performed as a weak hedging asset. Bouri et al. (2020) applied the wavelet coherence analysis to explain the safe-haven features of gold, bitcoin, and commodities. The study documented that bitcoin, gold, and commodities’ hedging property varies according to time and frequency. However, bitcoin revealed as a superior diversifier asset in contrast to commodities and gold. Kang and Lee (2019) found a significant correlation between gold and bitcoin. The study reported an imperative causality between bitcoin and gold futures prices. Urquhart and Zhang (2019) examined bitcoin’s safe-haven and hedging features and discovered that bitcoin acts as a safe-haven for other international currencies. Shahzad et al. (2019) employed the cross quantilogram approach and argued that bitcoin, commodity index, and gold cannot be categorized as robust safe-haven investments; especially, due to the time-varying and uncompromising attitudes of the investors. Guèsmi et al. (2019) stated that a portfolio consisting of oil, gold, bitcoin, and emerging stock markets had imperatively abridged the portfolio risk.

On the other hand, Smales (2019) mentioned that bitcoin is not a safe-haven asset because of its high volatility and less liquidity. Further, some studies evaluated bitcoin’s role during the COVID-19 period for different stock markets globally, e.g., Dutta et al. (2020) reported that bitcoin acted as a diversifier during the COVID-19 period. However, gold is a potential safe-haven asset combined with global oil markets. Goodell and Goutte (2020) discovered that correlation among stock markets and cryptocurrencies imperatively upsurge because of COVID-19. The investigation documented that cryptocurrencies do not possess a diversification role during the COVID-19 era. Mnif et al. (2020) quantified that the COVID-19 has momentarily dwindled the efficiency of bitcoin, while Conlon and McGee (2020) reckoned that bitcoin does not provide safe-haven opportunities with the S&P500 stock market of the US. Lahmiri and Bekiros (2020) argued that cryptocurrencies’ instability and irregularity had been augmented during the pandemic.

Further, these investigations stated that cryptocurrencies showed a lower level of regularity than the world’s stock markets. Hence, these studies designated mixed findings on the role of bitcoin as a safe-haven, as evidenced through the variation in safe-haven properties over time. Moreover, no one study enlightened the hedging features of bitcoin pooled with the stock markets of Europe, Asia, and the US in a single research. Likewise, the present research could not trace any prior study that evaluated the safe-haven abilities of gold during the COVID-19. Hence, the current investigation compares the hedging properties of gold and bitcoin, especially during the COVID-19 pandemic.

The on-hand investigation analyses the impact of COVID-19 on the reputed stock markets of the US, Europe, and Asian countries. Notably, the study explored the S&P500 and Nasdaq Composite index in the US; CAC40, DAX30, IBEX 35, London stock exchange (LSE), FTSE MIB, in Europe; Hang Seng, Nikkei225, and Shanghai Composite index (SSEC) in Asia during the COVID-19 pandemic. Additionally, this inspection evaluates the hedging properties of gold and bitcoin for these markets after considering the most important financial markets of Asia, Europe, and America, as included in the present study as control variables. The current investigation applies a substantial econometric model, i.e., Morlet wavelet, to gauge the upshots of COVID-19 on the combined movement of the top ten stock markets with gold and bitcoin futures. The primary purpose of the present study is to evaluate the hedging characteristics of gold and bitcoin during the COVID-19.

Further, the study also evaluates which stock market is more suitable to be paired with gold or bitcoin to reduce the maximum financial risk. To this end, the present study calculated the proportion variable between gold and bitcoin (Gold/Bitcoin), representing the ratio of the rate of return on gold in contrast to bitcoin. An increase in this ratio means a more significant return held by gold in comparison with bitcoin. Hence, the present research compared the safe-haven properties of gold with bitcoin that can significantly guide investment decisions to maintain optimal portfolios during the COVID-19. These investment decisions have become more critical and challenging during the ongoing pandemic; hence, the current investigation aims to answer the following queries of investors, policymakers, academicians, and researchers. Firstly, does the gold and bitcoin possess safe-haven properties during the COVID-19? Secondly, which stock market out of the above-defined ten stock markets is more suitable to be hedged with gold or bitcoin? Thirdly, do the increasing gold prices make it a safe-haven asset during the COVID-19? Lastly, does gold perform better to diversify financial risk than bitcoin? The present study argues that these queries’ and corresponding answers can clarify the role of bitcoin and gold during the COVID-19. Besides, the current research will also assist the investors in making optimal portfolios, considering the devastating global financial impact of the COVID-19 crisis. Furthermore, the current investigation has substantial implications for financial analysts as well as policymakers.

The proceeding sections of the present study are structured as follows: Section 2 describes the methodological framework employed in this examination. Section 3 discusses the results-driven from the analysis. Lastly, section 4 contains the conclusions.

2. Methodology and data

Wavelet analysis is one of the most commonly used frequency analysis in non-stationary time series data analysis. The advantage of the wavelet analysis relates to its flexibility in the use of various non-
stationary signals (Aguiar-Conraria and Joana Soares, 2011; Bilgili, 2015; Bravo et al., 2020; Jiang and Yoon, 2020; Kus¸kaya and Bilgili, 2020; Tiwari et al., 2020; Bilgili et al., 2020a, 2020b). As wavelets are structured over finite intervals of time and are not perforce homogeneous over time, they are localised in time scale (Ramsey, 2014). Wavelet considers the time and frequency domain at the same time. This differs from the classical Fourier transform, which is limited to frequency domain analysis.

The wavelet function $W_{a,b}(t)$ can be written as below,

$$W_{a,b}(t) = \frac{1}{\sqrt{b}} \int_{-\infty}^{\infty} X(x) \frac{1}{b} \left( \frac{t-x}{a} \right) dx$$  (1)

In Eq. (1), the term $1/\sqrt{b}$ is the normalisation factor. The parameter $a$ checks the width of the wavelet and represents the position of the wavelet in the time domain. The parameter $b$ is the location parameter that checks the wavelet’s location and indicates the position of the wavelet in the frequency domain.

In wavelet analysis, Monte Carlo procedures are used to calculate the degree of statistical significance between variables. Therefore, the confidence interval of the phase difference between $(X)$ and $(Y)$ can be calculated (Tiwari et al., 2020). Also, the phase difference analysis detects phase relationships between components, the correlation direction (positive and negative correlation), and the lead-lag relation. The phase difference (with $\hat{\tau}_{xy} \in [-\pi, \pi]$) between $(X)$ and $(Y)$ can be defined as,

$$\hat{\tau}_{xy} = \arctan \left[ \frac{\Im \{ \mathcal{W}_{xy}(a,b) \} }{\Re \{ \mathcal{W}_{xy}(a,b) \} } \right]$$  (2)

In Eq. (2), $\Re \{ \mathcal{W}_{xy} \}$ and $\Im \{ \mathcal{W}_{xy} \}$ represent the real part and imaginary part of the smooth power spectrum, respectively. If $\hat{\tau}_{xy} \in \left( 0, \frac{\pi}{2} \right)$, the series move in phase and $(X)$ leads $(Y)$. If $\hat{\tau}_{xy} \in \left( 0, \frac{\pi}{2} \right)$, the series moves again in phase, then $(Y)$ is leading.

In wavelet analyses, we will compare each market’s returns pattern with gold and bitcoin to analyse if gold (or bitcoin) is better for the portfolio. Moreover, the study also determines which stock market suggests gold (or bitcoin) for investment. In this research, the daily data for the period 6.01.2020–24.08.2020 has been observed. In the analysis, the variables employed are; Standard & Poor’s US Stock Market Index (S&P500), US Technology Stock Market Index (Nasdaqcomposite), French Stock Market Index (CAC40), Germany Stock Market Index (DAX30), Standard & Poor’s US Stock Market Index (S&P500), Hong Kong Stock Market Index (HangSeng), Madrid Stock Market Index (IBEX35), US Technology Stock Market Index (Nasdaqcomposite), Tokyo Stock Market Index (Nikkei 225), Shanghai Composite Index (SSEC), Italy Stock Market Index (FTSEMIB), London Stock Market Index (LSE), bitcoin, gold, and gold return/bitcoin return (Gold_Bitc), respectively.

3. Results and discussion

First, to provide an initial inspection for the time series, the below figures reveal the trend curves of the variables. From Fig. 1 to 13, one can monitor the line graphs together with their trends of variables of French Stock Market Index (CAC40), Germany Stock Market Index (DAX30), Standard & Poor’s US Stock Market Index (S&P500), Hong Kong Stock Market Index (HangSeng), Madrid Stock Market Index (IBEX35), US Technology Stock Market Index (Nasdaqcomposite), Tokyo Stock Market Index (Nikkei 225), Shanghai Composite Index (SSEC), Italy Stock Market Index (FTSEMIB), London Stock Market Index (LSE), bitcoin, gold, and gold return/bitcoin return (Gold_Bitc), respectively. They fit the data well through their polymorphs trends. Table 1 depicts the trend equations for each relevant time series from Figs. 1–13.

Figures yield some remarks. (1) The volatility of all stock exchange markets, in general, is more generous in March in comparison with other months, which indicates that COVID-19 has substantially impacted the stock markets. (2) The Asian stock markets keep their high volatilities after March, as French, German, Spanish, English, Italian, and the US stock markets continue to fluctuate relatively less around their means. (3) The gold fluctuates ups and downs relatively more than bitcoin does. (4) The ratio of gold’s return to bitcoin’s return (Gold_Bitc), on the other hand, surprisingly, except the 2nd weeks of March, and July and 3rd weeks of April, May, keeps its steady state. After these preliminary observations of the series’ trends and cycles, this paper has conducted wavelet analyses and partial analyses to reach if the co-movements between Gold_Bitc and all individual stock markets exist.

3.1. Summary statistics and correlation

The descriptive statistics indicate that most stock markets have negative mean returns except the Nasdaq Composite index, LSE, S&P 500, and SSEC. Moreover, gold and bitcoin have positive mean returns during the sample period. The study signifies that bitcoin and FTSE MIB have the highest skewness and standard deviation from January 06, 2020–August 08, 2020 (see Table 2). The Spearman correlation outcomes reveal that SSEC has a significant and highest positive correlation with gold, while IBEX 35 exposed the lowermost positive affiliation with gold. The paper signifies that the Nasdaq composite index has a significant uppermost positive association with bitcoin, tough Hang Seng nominated negative but insignificant correlation with bitcoin (see Table 3).

3.2. Wavelet estimation outputs

This paper employs the Morlet method of wavelet transform model to analyse the co-movements between stock exchange markets and Gold_Bitcoin from January 2020 to August 2020. Gold_Bitcoin is the ratio of the rate of return of gold to the rate of return of bitcoin \( \frac{\text{GOLD}}{\text{BITCOIN}} \). The higher this ratio, the higher the return of gold compared to bitcoin will be. In all wavelet coherency figures (Figs. 14–23), the thick black lines represent the cone of influence, which depicts the regions influenced by edge effects. Next to partial
wavelet coherency figures, the colour bar code indicates coherency power varying from blue to red. The red and blue colours represent a strong association (power) and the weak association, respectively. Fig. 14a depicts the outputs of partial wavelet coherency between the CAC40 and Gold_Bitcoin ratio with the control variables of S&P500, LSE, and SSEC. Fig. 14b and 14c denote the outputs from phase difference analyses in 1 week-1 month frequency band and phase difference analyses in a 1-2-month frequency band, respectively. When we observe the co-movement of CAC40 and Gold_Bitcoin, we reach the evidence in a shorter cycle (in 1 week-1 month frequency band) as follows; first, Gold_Bitcoin ratio and CAC40 have high coherency during the whole period, except the 2nd and 3rd weeks of August. Second, during the high coherency period, there exists a positive association between the variables. Third, during the high coherency period, the CAC40 stock
exchange market leads the Gold_Bitcoin ratio (as Gold_Bitcoin is lagging). Fourth, the CAC40 index rise causes the Gold_Bitcoin ratio to increase from 2020:1 to 1st half of 2020:2, and from 2020:4 to the end of August except 1st weeks of July and August. Hence, the findings stated that the return on investing in gold scaled up (compared to bitcoin returns) at the CAC40 stock exchange market in a short cycle (high-frequency band) during the whole period except February (2nd half), March, and July (1st and 4th weeks). In the 1-2-month frequency band (in the long cycle), the Gold_Bitcoin ratio and CAC40 have high coherency during the whole period except June. Second, during the high coherency period, the Gold_Bitcoin ratio and CAC40 have a positive association. Third, in January, February, July, and August, while the CAC40 stock market gained value, gold, compared to bitcoin, also gained value. Fourth, in March, April, May, and July, while the gold is
gaining value, the CAC40 stock market also gains value.

Consequently, investing in gold also increased the value of the CAC40 index. Further, the return on investing in gold increased (compared to bitcoin returns) at the CAC40 stock exchange market in a long cycle during January, February, and August 2020. Similarly, after observing the partial wavelet coherency in other stock exchange markets in detail, we obtained the below-concluding remarks. Fig. 15a depicts the outputs of partial wavelet coherency between DAX30 and Gold_Bitcoin ratio with the control variables of S&P500, LSE, and SSEC. Fig. 15b and 15c depict the lead-lag relations in the short cycle (1 week-1 month frequency band) and long cycle (1-2-month frequency band), respectively. The aftermaths revealed that the DAX30 index and Gold_Bitcoin ratio have high coherency with that the DAX30 index and Gold_Bitcoin ratio have high coherency with a positive correlation a
higher frequency. They also have high coherency with a positive correlation at lower frequency except for May and June. Second, the DAX30 index increases the Gold_Bitcoin ratio from 2010:4 to 2020:8, except the 1st week of August 2020 in the short cycle.

Third, the DAX30 index increases the Gold_Bitcoin ratio during January, February, and August in the long cycle. Hence, an upswing in the DAX30 index brought about an upswing in the Gold_Bitcoin ratio from April until the end of the period (the end of August) in a short cycle (1-week 1-month frequency band). Also, an upswing in the Gold_Bitcoin ratio resulted in an upswing in the DAX30 index from April until the end of the long cycle (1-2-month frequency band). The return on investing in gold increased (compared to Bitcoin returns) at the DAX30 stock exchange market in a long cycle during January, February, and August 2020. Fig. 16a gives the partial wavelet coherency between S&P500 and Gold_Bitcoin ratio after controlling the variables of DAX30, LSE, and SSEC. Fig. 16b and 16c explore the lead-lag relations in the short cycle and long cycle, respectively. The partial wavelet coherence and phase difference analyses state that the variables have a positive association, except the 2nd half of April, in the short cycle (high frequency). Second, the variables have a positive association, except June, in the long cycle. Third, the rise in S&P500 leads to a rise in the Gold_Bitcoin ratio after July during August in the longer term (1–2 month frequency band). Consequently, gold’s value at the US stock market (S&P500) improved in January, February, and August at 1 week-1 month cycle (frequency). The value of gold at the US stock market (S&P500) also improved in August at a 1-2-month cycle (frequency).

Fig. 17a gives the partial wavelet coherence analyses to monitor the co-movements between the HangSeng and Gold_Bitcoin ratio with the control variables of S&P500, LSE, and SSEC. Fig. 17b and 17c depict the lead-lag relations in higher frequency and lower frequency, respectively. There exists a positive association between the HangSeng index and Gold_Bitcoin ratio except for the 1st week of February, the last week of March, the 3rd week of May in a higher frequency (1-week 1-month frequency). Moreover, they also have a positive association with a lower frequency (1-2-month frequency) during the whole period. The Hang-Seng index leads the Gold_Bitcoin ratio (Gold_Bitcoin ratio is lagging) at a higher frequency during the 2nd half of January, 1st half of February,

| Variables | Trend chart | Trend equation |
|-----------|-------------|----------------|
| French Stock Market Index (CAC40) | Fig. 1 | -1E-06x^2 + 0.1553x^2 - 6828.2x + 1E+08 |
| Germany Stock Market Index (DAX30) | Fig. 2 | -1E-06x^2 + 0.1797x^2 - 7896.7x + 1E+08 |
| Standard & Poor’s US Stock Market Index (S&P500) | Fig. 3 | -7E-07x^2 + 0.0906x^2 - 3981.7x + 6E+07 |
| Hong Kong Stock Market Index (HangSeng) | Fig. 4 | -5E-07x^2 + 0.0678x^2 - 2982.7x + 4E+07 |
| Madrid Stock Market Index (IBEX35) | Fig. 5 | -1E-06x^2 + 0.1499x^2 - 6588.9x + 1E+08 |
| US Technology Stock Market Index (Nasdaqcomposite) | Fig. 6 | -7E-07x^2 + 0.0965x^2 - 4240.7x + 6E+07 |
| Tokyo Stock Market Index (Nikkei 225) | Fig. 7 | -1E-06x^2 + 0.141x^2 - 6198x + 9E+07 |
| Shanghai Composite Index (SSEC) | Fig. 8 | -3E-07x^2 + 0.0454x^2 - 1955.3x + 3E+07 |
| Italian Stock Market Index (FTSEMIIB) | Fig. 9 | -2E-06x^2 + 0.1991x^2 - 8753.8x + 1E+08 |
| London Stock Market Index (LSE) | Fig. 10 | -5E-07x^2 + 0.0669x^2 - 3628.4x + 4E+07 |
| Bitcoin | Fig. 11 | -1E-06x^2 + 0.1703x^2 - 7487.8x + 1E+08 |
| Gold | Fig. 12 | -4E-07x^2 + 0.0516x^2 - 2268.7x + 3E+07 |
| Gold Return/Bitcoin Return (Gold_Bite) | Fig. 13 | -2E-06x^2 + 0.285sx^2 - 12549x + 2E+08 |

Source: Author’s calculation.

| Table 1 | Trend equations. |
|---------|------------------|
| Variables | Trend equation |
| French Stock Market Index (CAC40) | Fig. 1 -1E-06x^2 + 0.1553x^2 - 6828.2x + 1E+08 |
| Germany Stock Market Index (DAX30) | Fig. 2 -1E-06x^2 + 0.1797x^2 - 7896.7x + 1E+08 |
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Source: Author’s calculation.

| Table 2 | Summary statistics. |
|---------|---------------------|
| Variables | Trend chart | Trend equation |
| French Stock Market Index (CAC40) | Fig. 1 | -1E-06x^2 + 0.1553x^2 - 6828.2x + 1E+08 |
| Germany Stock Market Index (DAX30) | Fig. 2 | -1E-06x^2 + 0.1797x^2 - 7896.7x + 1E+08 |
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Source: Author’s calculation.
April, 1st half of June, and August. The outcomes revealed that the Gold_Bitcoin ratio steepened at the Hong Kong stock exchange market during these periods at a higher frequency. Gold_Bitcoin ratio also

Table 3

|       | CAC40 | DAX30 | FTSEMIB | GOLD | HANGSENG | IBEX35 | NASDAQ | LSE | NIKKEI225 | S&P500 | SSEC | BITCOIN |
|-------|-------|-------|---------|------|----------|--------|--------|-----|-----------|--------|------|---------|
| Correlation | 1 | 0.946553 | 0.911685 | 0.912516 | 0.494285 | 0.513166 | 0.676242 | 0.513166 | 0.494285 | 0.513166 | 0.676242 | 1 |
| Probability | 1 | 0.808655 | 0.891685 | 0.912516 | 0.875039 | 0.911685 | 0.946553 | 0.912516 | 0.875039 | 0.911685 | 0.946553 | 1 |
| Source: Author’s calculation |

Fig. 14a. Wavelet partial coherency (CAC40, Gold_Bitcoin || SP500, LSE, SSEC).

Fig. 14b. Phase difference: 1 week-1 month frequency band.

Fig. 14c. Phase difference: 1–2 months frequency band.

Fig. 15a. Wavelet partial coherency (DAX30, Gold_Bitcoin || SP500, LSE, SSEC).
improved the Hong Kong stock exchange market value in June (2nd half) and July.

Further, the Hong Kong stock exchange market increased the Gold_Bitcoin ratio after May during June, July, and August in a 1-2-
month frequency band (lower frequency). During January, February, and March, the Hong Kong stock exchange market and Gold_Bitcoin ratio negatively associate as HangSeng leads Gold_Bitcoin. It means that an increase in HangSeng resulted in a decrease in the Gold_Bitcoin ratio. Fig. 18a reveals the partial wavelet coherency of IBEX35 and Gold_Bitcoin with control variables of S&P500, LSE, and SSEC. Fig. 18b and 18c shows the output of phase difference analyses in higher frequency and lower frequency, respectively. IBEX35 and Gold_Bitcoin have strong coherency and a positive association in the high-frequency band. They also have strong coherency in the lower frequency band except for May, June, and July and have positive associations except for June. In June, they have a negative association. Hence, except for February, March, April, and the 1st week of July, IBEX35 leads Gold_Bitcoin to gain value in higher frequency. Gold_Bitcoin leads IBEX35 to increase during January and August at a lower frequency. IBEX35 also leads Gold_Bitcoin to increase in lower frequency during January, February, and August.

Fig. 19a depicts wavelet partial coherency analyses for the LSE index and Gold_Bitcoin ratio with control variables of S&P500, DAX30, and SSEC. Fig. 19b and 19c exhibit the results of phase difference analyses in higher and lower frequency. LSE and Gold_Bitcoin have strong coherency and a positive association in the high-frequency band. On the other hand, they have do not follow strong coherency in the longer term (1-2-month frequency) except August. The investigation discovered that LSE leads the Gold_Bitcoin ratio to increase in February (second half) and March in a higher frequency band.

Additionally, LSE leads the Gold_Bitcoin ratio to increase in August in a lower frequency band. Fig. 20a depicts wavelet partial coherency analyses for the FTSEMIB index and Gold_Bitcoin ratio with control variables of S&P500, DAX30, and SSEC. Fig. 20b and 20c shows the results of phase difference analyses in higher frequency and lower frequency, respectively. FTSEMIB index and Gold_Bitcoin followed strong coherency and a positive association in the high-frequency band. The FTSEMIB index and Gold_Bitcoin followed strong coherency and positive association, except June and July, in the low-frequency band. These findings argued that an increase in the Gold_Bitcoin ratio followed the FTSEMIB index’s increase during the whole period except some weeks of March and July in a 1-week-1-month frequency band. Further, an increase in the Gold_Bitcoin ratio followed the FTSEMIB index increase during January, February, and August in a 1-2-month frequency band. An increase in the FTSEMIB index followed the increase in the Gold_Bitcoin ratio during March, April, and May in a 1-2-month frequency band.

Fig. 21a gives the output of wavelet partial coherency analyses for the SSEC index and the Gold_Bitcoin ratio with the control variables of S&P500, LSE, and HangSeng. Fig. 21b and 21c presents phase difference analyses in higher frequency and lower frequency, respectively. The SSEC and the Gold_Bitcoin ratio have strong coherency and a positive association in the high-frequency band. They also have robust co-movements and a positive association in the low-frequency band except for the 2nd half of April and 1st half of May. During the 2nd half of April and the 1st half of May, they have a negative association. The study indicated that the SSEC stock market improved the ratio of gold return to bitcoin return in March, May, and July 2020 in the high-frequency band. Later, in August, an increase in the Gold_Bitcoin ratio improved the value of the SSEC index. In addition, except for April and June, an increase in the Gold_Bitcoin ratio followed the increase in the value of SSEC in a longer cycle (low-frequency band). It means the Gold_Bitcoin ratio gained value during the whole period except April and June in a 1-2-month frequency band. Fig. 22a denotes the wavelet partial coherency outputs for the variables of NASDAQ and Gold_Bitcoin ratio after controlling the variables of DAX30, LSE, and SSEC. Since US technology and German technology have a close association, partnership, and competitiveness, DAX30, LSE, and SSEC were chosen as control variables instead of S&P500, LSE, and SSEC.

Fig. 22b and 22c explore the findings of phase difference analyses in higher frequency and lower frequency, respectively. According to the results, there is a strong coherency between NASDAQ and Gold_Bitcoin ratio and a positive relationship in the high-frequency band. They also have robust co-movements and a positive association in low-frequency
bands except for June and July. These aftermaths revealed that Gold-Bitcoin leads the NASDAQ in 1-week – 1-month frequency band. Conversely, in general, the NASDAQ leads Gold-Bitcoin in a 1-2-month frequency band.
4. Conclusion

COVID-19 has imperatively traumatised the stock markets worldwide. Moreover, it increased the level of VIX at the highest point equated with the Global Financial Crisis 2007–09. This investigation aims to find the safe-haven for speculators worldwide. This paper utilises the daily data of the French Stock Market Index (CAC40), Germany Stock Market Index (DAX30), Standard & Poor’s US Stock Market Index (S&P500), Hong Kong Stock Market Index (HangSeng), Madrid Stock Market Index (IBEX35), US Technology Stock Market Index (Nasdaq composite), Tokyo Stock Market Index (Nikkei 225), Shanghai Composite Index (SSEC), Italy Stock Market Index (FTSEMIB), London Stock Market Index (LSE), bitcoin, gold, and gold return/bitcoin return (Gold_Bitcoin) from the period of January 06, 2020, to August 24, 2020. The study stated that the Gold_Bitcoin ratio increased at CAC40 in a higher frequency. Gold_Bitcoin ratio also increased at CAC40 in lower frequency at the beginning and end of the sample period. The rise in the DAX30 increased the Gold_Bitcoin rate from April until the short cycle period. The return on investing in gold increased compared to bitcoin returns at the DAX30 stock exchange market in a long cycle during the beginning and end of the sample period.

Moreover, the value of the Gold_Bitcoin ratio at the US stock market (S&P500) improved at the beginning and end of the sample period at 1 week-1 month cycle. The value of gold at the US stock market (S&P500) also improved in August at a 1–2 month cycle. The HangSeng index leads the Gold_Bitcoin ratio to increase at a higher frequency during the 2nd half of January, 1st half of February, April, 1st half of June, and August. Hong Kong stock exchange market also increased the Gold_Bitcoin ratio during June, July, and August in lower frequency. In addition, the IBEX35 leads Gold_Bitcoin to gain value, except February, March, April, and the 1st week of July, in higher frequency. IBEX35 also leads Gold_Bitcoin to increase in lower frequency during January, February, and August. LSE leads the Gold_Bitcoin ratio to increase in February (second half) and March in the higher frequency band. Moreover, LSE leads the Gold_Bitcoin ratio to increase in August in a lower frequency band.

Conversely, an increase in the Gold_Bitcoin ratio followed the FTSEMIB index increase during January, February, and August in a 1-2-month frequency band. The Gold_Bitcoin ratio increase followed the FTSEMIB index increase during January, February, and August in a 1-2-month frequency band. The SSEC stock market improved the ratio of Gold return to Bitcoin return in March, May, and July 2020 in the high-frequency band. Gold_Bitcoin ratio also gained value during the whole period except April and June in a 1-2-month frequency band. In general, NASDAQ leads Gold_Bitcoin in 1-2- month frequency band. Gold_Bitcoin gained value by following the increase in the index of NASDAQ in this frequency band. Finally, Nikkei225 leads the Gold-Bitcoin ratio to boost the high-frequency band during June, July (1st half), and August. Nikkei225 also leads the Gold-Bitcoin ratio to increase in the low-frequency band during March (1st half), April (2nd half), May (1st half), July (2nd half), and August.

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CRediT authorship contribution statement

Khurram Shehzad: Conceptualization, Methodology, Resources, Data curation, Writing – original draft, Project administration. Faik Bilgili: Software, Validation, Writing – review & editing. Umer Zaman: Methodology, Visualization, Supervision. Emrah Kocak: Conceptualization, Investigation, Formal analysis, Writing – original draft, Writing – review & editing, Project administration. Sevda Kuskaya: Software, Validation, Writing – original draft.

Declaration of competing interest

The authors reported no potential conflict of interest.
