THE FINANCIAL CONTAGION EFFECTS OF THE COVID-19 PANDEMIC: EVIDENCE FROM ASIAN DEVELOPED COUNTRIES

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Abstract: ***This study investigates the existence and extent of the effect of financial contagion between the Asian developed stock market and the Bitcoin market, as well as between these stock markets and the gold market, during the global Covid-19 period. The time-varying correlation coefficients of DCC-GARCH were tested using daily data from 2016 to 2021. The empirical results show that, with the exception of Japan, the dynamic correlation between stocks and Bitcoin increased significantly during the Covid-19 turmoil period in four developed Asian countries, while the DCCs between stocks and gold increased significantly in three countries, including Japan, Korea and Taiwan, indicating that the global Covid-19 pandemic caused financial contagion in the form of a shift in dynamic correlation between stocks and Bitcoin a, as well as between stocks and gold in these countries. However, the magnitude of the increase in DCCs was greater for the stock-Bitcoin pair than for the stock-gold pair, implying that Bitcoin plays a more important role in financial contagion transmission than gold and that gold has a greater potential to be considered as a hedge or safe haven tool for Asian developed stock investors in the light of this rapidly escalating pandemic.***

• Keywords: *contagion, cryptocurrency, gold, covid-19.*

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Tóm tắt: *Nghiên cứu này điều tra sự tồn tại và mức độ ảnh hưởng của sự lây lan tài chính giữa thị trường chứng khoán phát triển châu Á và thị trường Bitcoin, cũng như giữa các thị trường chứng khoán này và thị trường vàng, trong suốt thời kỳ Covid-19 toàn cầu. Hệ số tương quan thay đổi theo thời gian của DCC-GARCH đã được kiểm tra bằng cách sử dụng dữ liệu hàng ngày từ năm 2016 đến năm 2021. Kết quả thực nghiệm cho thấy, ngoại trừ Nhật Bản, mối tương quan động giữa cổ phiếu và Bitcoin đã tăng đáng kể trong thời kỳ dịch Covid-19 trong 4 nước châu Á phát triển, trong khi DCC giữa chứng khoán và vàng tăng đáng kể ở ba quốc gia, bao gồm Nhật Bản, Hàn Quốc và Đài Loan, cho thấy rằng đại dịch Covid-19 toàn cầu đã gây ra sự lây lan tài chính dưới dạng sự thay đổi tương quan động giữa chứng khoán và Bitcoin, cũng như giữa chứng khoán và vàng ở các nước này. Tuy nhiên, mức độ gia tăng của DCC đối với cặp chứng khoán-Bitcoin lớn hơn đối với cặp chứng khoán-vàng, ngụ ý rằng Bitcoin đóng một vai trò quan trọng hơn trong việc truyền lây lan tài chính so với vàng và vàng có tiềm năng lớn hơn được coi là một công cụ phòng hộ hoặc trú ẩn an toàn cho các nhà đầu tư chứng khoán phát triển ở Châu Á trong bối cảnh đại dịch đang leo thang nhanh chóng này.*

• Từ khóa: *sự lây lan, tiền điện tử, vàng, covid-19.*

1. Introduction

Today, many investors are always looking for strategies to diversify their portfolios in order to protect their investments from market hazards. Most assets are influenced in some way by market shocks such as crises, epidemics, etc. Some investors are gravitating toward safer assets, namely, they move from risky assets to safer assets (Caballero & Krishnamurthy, 2008). Furthermore, gold has long been regarded a secure and effective asset in the stock market, particularly during times of market volatility (Baur & Lucey, 2010; Beckmann, Berger & Czudaj, 2015; Wen & Cheng, 2018). Historically, gold has been used as a hedge in portfolio diversification and as a safe haven during times of severe economic and financial instability (Baur et al., 2010; Bredin et al., 2015; O'Connor et al., 2015; Lucey et al., 2017; Bilgin et al., 2018). It is reasonably stable during deflationary or deflationary periods, and it has the potential for diversification during periods of inflation, as assessed by the Consumer Price Index (CPI) (Baur et al., 2010a; Bredin et al., 2010a; Bredin et al., 2015).

Another appealing asset is Bitcoin, a completely decentralized cryptocurrency that is not dependent on any government or authority and can be

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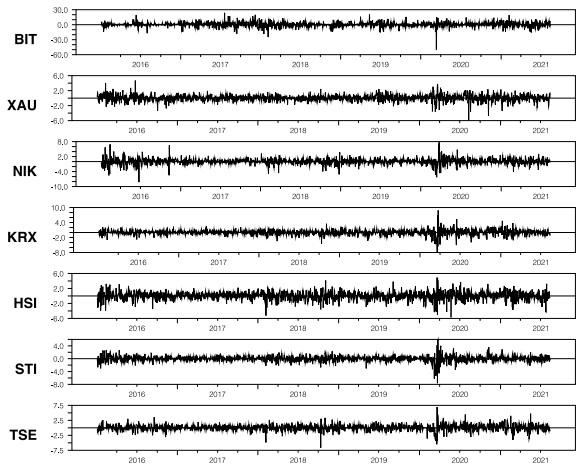
exchanged anonymously through a third party, such as a digital wallet (Urquhart et al., 2016; Nadarajah et al., 2017). Bitcoin was mentioned in the prospectus for a peer-to-peer payment protocol by anonymous Satoshi Nakamoto in 2008, and it began to be used as a means of transaction and an alternative to cash on January 3, 2009. in cash. Relying on the blockchain and its application to Bitcoin makes it the first digital currency to solve the problem of double spending and make it safer. Although its returns are often accompanied by significant fluctuations, Bitcoin has become an investment asset due to its tradability on specialized exchanges (Polasik, Piotrowska, Wisniewski, Kotkowski & Lightfoot, 2015). According to the literature, Bitcoin has a relatively weak link to traditional assets, making it an effective diversifier, as well as a somewhat unconnected relationship to other assets, making Bitcoin an ideal hedging tool. Bitcoin is also a highly stable asset, making it appealing to investors looking for a safe haven. Bitcoin is viewed as a "safe haven asset" that helps hedge against global economic volatility (Bouri et al., 2017a; Aysan, Demir, Gozgor, & Lau, 2018; Bouri, Molnar, Azzi, Roubaud & Hagfors, 2017; Shahzad et al., 2019). It has provided investors with resilience during times of crisis. In the study by Luther and Salter (2017) in Cyprus, this point was proved in the context of the banking crisis in the period 2012–2013 and the European public debt crisis 2010–2013. However, Conlon, Corbet, & McGee, 2020; Klein, Autumn, & Walther, 2018; Smales, 2019; have another study that gives the opposite opinion. With the advent of Bitcoin, the virtual currency has moved from the periphery to the center of the financial world. The CME Group and CBOE released futures contracts that use Bitcoin as an underlying asset in December 2017, further confirming it. This has enabled Bitcoin to trade alongside commodities such as gold in futures markets, eventually becoming a mainstream investment alternative. The Bitcoin literature will occasionally incorporate gold and other commodities into its empirical research, with the aim of examining the link between gold and Bitcoin. Bitcoin values are determined by a unique set of qualities such as appeal (Kristoufek, 2015), user anonymity (Ober, Katzenbeisser, & Hamacher, 2013), or unlawful activities (Yelowitz & Wilson, 2015). On the one hand, Bitcoin's allure may be tied to its monetary properties. Although gold differs from bitcoin in many respects, there are similarities between the two assets. The absence of a central authority to control Bitcoin mining and transactions makes it independent of inflation (Baur et al., 2018). Bitcoin and other cryptocurrencies are separate from financial and economic assets. It is unknown if Bitcoin and gold (commodities) play similar safe-haven roles in a sample of global and national stock market indexes.

As corporate investors became increasingly concerned about the accumulation of corporate debt and the considerable liquidity shortfall that had developed, the Covid-19 pandemic transformed into an economic crisis magnified through financial channels through a whipsaw pattern (Ramelli & Wagner, 2020). Following the huge worldwide impact of the Covid-19 pandemic, literature on the impact of the Covid-19 pandemic on the financial market (Cepoi, 2020; Le et al., 2021; Okorie & Lin, 2021; Yarovaya et al., 2021), its contagion effect (Akhtaruzzaman, Boubaker, & Sensoy, 2021; Corbet et al., 2020, 2021) or safe haven properties of financial assets like gold or cryptocurrencies during this crisis time (Akhtaruzzaman, Boubaker, Lucey, et al., 2021; Conlon & McGee, 2020) has stared to grow rapidly. In this study, we follow the definition of 'shift contagion' proposed by Forbes & Rigobon (2001), that is, a shift contagion is a significant increase in correlation between two markets followed by a crisis in one market, to examine the existence of the financial contagion effect in terms of a change in dynamic correlation between the Asian developed stock market and Bitcoin, as well as between these stock markets and the gold market, during the Covid-19 period. Using daily data from January 2016 to August 2021, the DCC-GARCH model was used to test for a significant change in dynamic correlation for Bitcoin-stock and gold-stock pairs during the global Covid-19 pandemic. Our findings indicate that the dynamic correlation between stock and Bitcoin increased significantly during the Covid-19 turmoil period in four Asian developed countries, except Japan and the DCCs between stock and gold increased significantly in three countries including Japan, Korea, and Taiwan. Thus, the global Covid-19 pandemic has caused a financial contagion effect in terms of a shift in dynamic correlation between stock and Bitcoin as well as between stock and gold in these countries. However, the magnitude of the increase in DCC was greater for the pair of stock and Bitcoin than for the pair of stock and gold, implying that Bitcoin plays a more important role in financial contagion transmission than gold and that gold has a greater

potential to be considered as a hedge or safe haven tool for Asian-developed stock investors during the Covid period.

Figure 1: Bitcoin, gold and Asian developed stock return over the period 2016-2021



This study is presented as follows. Section 2 presents a review of the literature. Section 3 delves into our empirical models. Section 4 presents the empirical result and discussion. Finally, Section 5 presents our conclusions.

2. Literature review

In the past, gold was seen as a safe haven, whereas other asset classes were frequently volatile. Furthermore, gold is used as a hedge or diversification for other financial assets such as equities or foreign currencies. This is evidenced by the fact that gold is not correlated or adversely connected with various asset types (Bouri et al., 2020; Reboredo, 2013; Baur & Lucey, 2010). According to Baur et al. (2010), gold is seen as a safe haven asset in financial markets and may be utilized as a store of value during times of financial instability. Baur and Lucey (2010) established the definition of a safe haven in their study. Based on Baur and McDermott (2010) research, gold has adequate foundations to fulfill the character of a safe-haven asset for stock investors in Europe and America in the short term. However, Australia, Canada, Japan, and emerging countries have yet to benefit from a safe haven and hedging asset. Ciner et al. (2013) investigated the amount and condition of each asset, including stocks, bonds, oil, gold, and the US dollar. The findings demonstrate that, with the exception of oil, gold acts as a safe haven for most assets. Furthermore, Anand & Madhogaria (2012) validated the gold safe-haven hypothesis by examining the causal association between gold and stock market returns in six nations and concluded that gold does indeed act as a safe-haven asset. Joy (2011), on the other hand, used the GARCH model multivariable with dynamic conditional correlation to examine the exchange rates of sixteen currencies against the US dollar as well as the price of gold during 23 years. According to the author, gold functions as a hedge against the US currency and is a less secure refuge. Similarly, Dee et al. (2013) study whether gold may be used as a security or as a hedge against inflation in the Chinese mainland market. According to empirical evidence, gold does not protect short-term investors from inflation and equity risks. If an investor retains gold for an extended period of time, it can serve as a reliable hedge against the stock market or inflation. However, gold is hardly a safe haven for investors in China's capital markets, which are already fraught with equities and inflation concerns. According to Theo Dee et al. (2013), investors should not pursue gold mindlessly.

Since the inception of Bitcoin, there have been a variety of perspectives on Bitcoin as a fantastic solution (Bouri et al., 2017; Luther & Salter, 2017) Several investigations have been conducted to investigate the attractiveness of Bitcoin and its hedging property. Its dangers are comparable to those described by Dyhrberg (2016), and as a result, Bitcoin can be incorporated into a portfolio to reduce risk. Baur et al. (2015) evaluated the properties of Bitcoin and found correlations. There is no significant difference between digital assets (Bitcoin) and traditional asset classes such as stocks, bonds, and commodities in normal times and in turbulent financial times. This analysis shows whether Bitcoin can act as a hedge and a safe-haven investment for the US stock market, showing that Bitcoin's role as a hedge and a safe-haven is time-varying. Furthermore, Bouri et al. (2017a) evaluated the role of Bitcoin as a diversifier, a hedge, or a safe haven for the movement of energy derivatives but not for non-energy commodities. They realize that Bitcoin may be used as an effective hedge and a safe haven against swings in commodity indices but not in non-energy commodities. Other studies on cryptocurrencies, particularly Bitcoin, have yielded conflicting results. For example, Klein et al. (2018) and Smales (2019), for example, contend that Bitcoin fails as both a hedge and a safe haven for developed markets. In Covid-19, Cheema et al. (2020), Conlon & McGee (2020), and Conlon et al. (2020) found equivalent results. According to Wu et al. (2019), their article uses the GARCH model to

investigate whether gold or Bitcoin may operate as a hedge for economic policy uncertainty. The impact of gold and Bitcoin on an investor's portfolio is correlated with a bear or bullish market situation, and these two assets can be considered for portfolio diversification in the normal market. Bitcoin is more responsive to shocks of economic policy uncertainty and gold maintains stability with smaller safe-haven and hedge coefficients. Their results suggest that Bitcoin could be a gold-like alternative to hedging against uncertainty, which is partially consistent with Bouri et al. (2017) and Demir & Wang (2018). Stenss et al. (2019) investigated the diversification, hedging and safe-haven capabilities of Bitcoin in financial markets in different markets and regions. Regarding Bitcoin's ability as a hedge, the article finds evidence of differences between developed and developing markets regarding Bitcoin's ability as a hedge. In the study by Bouri et al., in 2020, the dependence of Bitcoin, gold, commodities, and the stock market on the US stock market was not so strong. The ranking of Bitcoin as the least dependent and most dependent commodity emerges clearly, even though they are all highly correlated. Selmi et al. (2018) said that the outcomes of Bitcoin and gold can act as a hedge, a safe haven, and a deterrent against oil price swings. The relationship between Bitcoin/gold and oil prices appears to be nonlinear. The global Covid-19 pandemic is one of the recent crises that has affected the crude oil and stock markets around the world. To protect investors from such catastrophic losses, it is necessary to reassess the safe haven ability of traditional assets, namely gold.

According to Manohar et al. (2021), the article was driven by a large body of previous work. The cross-quantum histogram approach of Han et al. (2016) was used for tail analysis in this work. By examining possible variability across a wide range of quanta, the analytical approach allows complete monitoring of safe-haven assets. Daily statistics on energy and gold sector indices of a variety of nations strategically tied to significant commodities, such as gold and oil, and also heavily influenced by Covid-19, have been of interest. According to Manohar et al. (2021), the findings show that, prior to the Covid crisis, gold was no longer a safe haven or hedge against a specific cluster of nations' energy sector indices. Saudi Arabia, Russia, and Canada are among the largest oil exporters and the energy industry contributes significantly to their profits. Due to the obvious Covid-19 pandemic, these nations' energy industries have been seriously hit, and investors have turned to gold, the traditional safe-haven alternative. Melki et al. (2022) compare the hedging and safe-haven features of three cryptocurrency giants, Bitcoin, Ethereum, and Ripple, to the stock, forex, and commodities markets. Using a quadratic LSTR model, the Covid-19 inquiry provides an early testing ground for crypto's safe-haven features. The authors demonstrate that Ripple is considered a weak safe-haven asset for the commodity and forex markets in times of pandemic crisis. For the commodity and forex markets, Bitcoin and Ripple provide a safe haven and a hedge function, respectively. The behavior of Ethereum was an unexpected discovery. During both the pre-crisis and Covid-19 periods, the coin outperformed Bitcoin by providing a stronger safe haven for commodity markets.

3. Data and Methodology

3.1. Data

The DCC-GARCH model was estimated for the largest market capitalizations of cryptocurrencies, namely Bitcoin; and 5 Asian developed stock indices: South Korea (KRX 100), Hong Kong (HSI), Japan (NIK), Singapore (STI) and Taiwan (TSE 50). The daily price of Bitcoin and Ethereum has been collected from the website www.CryptoDataDownload.com. This website provides historical time series data for traded prices using the Application Programming Interface (API) service. We choose five main cryptocurrency exchanges, including Bitstamp, Gemini, Poloniex, Bitfinex, and Binance, which are common exchanges for the two cryptocurrencies under consideration. We then computed the market capital-weighted indices of Bitcoin and Ethereum based on the five exchanges. Data on Asian stock indices were obtained from Investing (2021). In order to control for the (possibly) distorting effects of the common currency denomination of stock market indices, Bitcoin, and gold prices, we have used the local currency-denominated price to calculate the daily return of stock indices and the USD-denominated price series to calculate the daily return of Bitcoin. From the daily closing price, we calculate the daily returns as natural logarithmic price differences. Since cryptocurrencies are traded 7 days a week, we only consider the price of crytocurrencies during the week to synchronize our data set.

The sample period spans from 4 January 2016 to 13 August 2021, thus yielding 1463 daily

observations. Our sample periods cover both the pre-Covid-19 period (1 January 2016 to 29 January 2020) and the Covid-19 period (30 January 2020 to 13 August 2021). We choose 30 January 2020 as the first day for Covid period because WHO declares the novel coronavirus outbreak a public health emergency of international concern (PHEIC), which is the highest level of alarm of WHO. The turbulence dummy variable was created to capture the impact of the Covid-19 pandemic on the return and the spillover of volatility between the Asian stock market and the cryptocurrency market. To be more specific, a DCOV dummy is constructed for days after the Covid-19 arrival date in each country.

Table 1: Variable Definition

Variable	Description
RBIT	Bitcoin log returns
RETH	Ethereum log returns
RNIK	NIK log returns (Japan)
RKRX	KRX 100 log returns (South Korea)
RHSI	HSI log returns (Hong Kong)
RSTI	STI log returns (Singapore)
RTSE	TSE 50 log returns (Taiwan)
COVID	Dummy variable for the Covid-19 period in country. It takes the value of 1 for the period from 30 January 2020 to 13 August 2021.

Notes: The data cover the period from 4 January 2016 to 13 August 2021.

3.2. Methodology approach

We employ the DCC-GARCH approach proposed by Engle (2002) to examine the time-varying and dynamic relationships across return series. The DCC representation of GARCH model is used to parameterize the conditional correlation directly and has the flexibility of a univariate GARCH model (Engle, 2002). For the purpose of this study that is investigating the dynamic cross correlation and given the large number of return series, the DCC model is estimated for each pair of return series separately.

The estimation of the bivariate GARCH-DCC model is carried out in two steps. In the first step, the univariate GARCH (1,1) model is estimated. In the second step. The time-varying correlation matrix is computed using the standardized residuals of the first-step estimate.

The mean equation of the DCC-GARCH model is as follows:

$$r_t = \mu_t + \omega r_{t-1} + \varepsilon_t \qquad (1)$$

$$\varepsilon_t = H_t^{1/2} \eta_t \qquad (2)$$

Where r_t is a logarithmic difference matrix for price indexes, μ_t is a fixed parameter matrix, ϖ is a coefficient matrix of cross-mean transmission and own-lagged, η_t is a innovation matrix, ε_t is a vector of residuals and $H_t^{1/2}$ is the conditional volatility matrix. The variance equation is expressed as:

$$H_t = c + \alpha \varepsilon^2_{t-1} + \beta H_{t-1}$$

Where c is the constant, α is the parameter which captures the ARCH effect or the short-run persistence and β represents the GARCH effect or the long-run persistence of volatility.

The equation of DCC (1,1) equation is given by Q_t, which is the time-varying conditional correlation of the residuals. Q_t is specified as:

$$Q_t = (1-\alpha-\beta)\overline{Q} + \alpha \varepsilon_{t-1} \varepsilon'_{t-1} + \beta Q_{t-1} \qquad (3)$$

Where α and β are parameters that represents the effects of previous shocks and previous DCCs on the current DCC respectively. α and β are non-negative scalar parameters with $\alpha + \beta<1$. Q is the unconditional correlation matrix of the standardized residuals ε_t.

The conditional correlation between assets i and j is represented as:

$$\rho_{ij,t} = \frac{q_{ij,t}}{\left(\sqrt{q_{ii,t}}\sqrt{q_{jj,t}}\right)} \qquad (4)$$

To ensure that the DCC model is well fitted, the existence of autocorrelation and heteroskedasticity in the return series will be examined through diagnostic tests.

According to Forbes & Rigobon (2002), a tranquil period is the period of relative market stability, and a turmoil period is a period directly after a shock or crisis. We follow their definition and define the turmoil period as the Covid period, whereas the tranquil period is pre-Covid period. To examine the contagion effect between stocks and Bitcoin as well as between stocks and gold during Covid-19 pandemic, we used used t tests to evaluate whether there is a significant increase in the dynamic correlation between stock and gold/bitcoin during this pandemic period as follows:

$$H_0: \rho_c = \rho_{nc}$$
$$H_1: \rho_c > \rho_{nc}$$

Where ρ_c denotes the dynamic correlation between stock and gold/bitcoin during crisis period and ρ_{nc} refers to the dynamic correlation between stock and gold/bitcoin during the tranquil period. If the null hypothesis is not rejected, we are convinced that there is no contagion, only interdependence.

4. Result and Discussion

Table 2: Summary statistics of daily return (Full sample)

	Obs	Mean	Standard Deviation	Min	Max	Skewness	Kurtosis	Jarque-Bera
RBIT	1464	0.321	4.758	-50.423	23.812	-0.857	11.472	8206.700
RXAU	1464	0.034	0.857	-5.893	4.693	-0.362	4.463	1246.752
RNIK	1464	0.028	1.238	-8.253	7.731	-0.210	6.572	2645.400
RKRX	1464	0.038	1.071	-7.925	8.868	-0.086	9.462	5463.200
RHSI	1464	0.015	1.137	-5.720	4.925	-0.453	2.402	402.100
RSTI	1464	0.008	0.904	-7.637	5.895	-0.519	9.943	6095.773
RTSE	1464	0.056	1.019	-6.637	6.943	-0.245	5.357	1765.200

The time series of the dynamic conditional correlation coefficients ($\rho_{ij,t}$) between the pair of Bitcoin and Asian developed stock and the pair if Gold and Asian developed stock during the period from 2016 to 2021 are extracted from the DCC-GARCH model and graphed in Figure 2 and Figure 3 respectively. These figures show that the dynamic correlation between stock and Bitcoin, as well as between stock and gold, vary over time. The sign of the correlation coefficients between stock and Bitcoin is primarily negative for the Japanese and Singapore equity markets and positive for the Korean, Hong Kong and Taiwan markets, indicating that Bitcoin could be used as a portfolio hedge in these three countries. Almost throughout the sample period, the DCCs between gold and stock returns in Japan, Hong Kong and Singapore are negative, indicating that gold may be a hedge for these equity indices, whereas the DCCs between gold and stock returns in Korea and Taiwan are positive, indicating that gold is neither a hedge nor a safe haven asset, but rather a diversifier. The extent of the negativity/positiveness and variability of the correlation coefficients is distinct for each asset pair. It should be noted that the dynamic correlation of almost all asset pairs considered shows a significant variation during the Covid-19 pandemic. Some of them have increased while others have decreased.

Figure 2: Dynamic Conditional Correlations Between Bitcoin and Stock

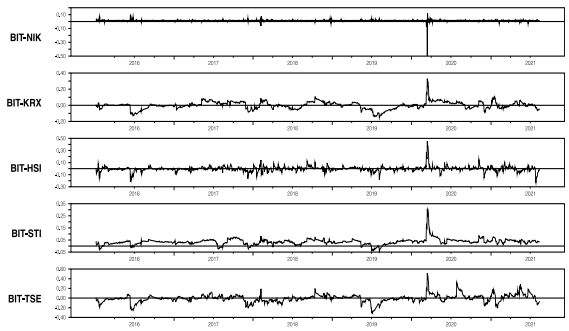


Figure 3: Dynamic Conditional Correlations Between Gold and Stock

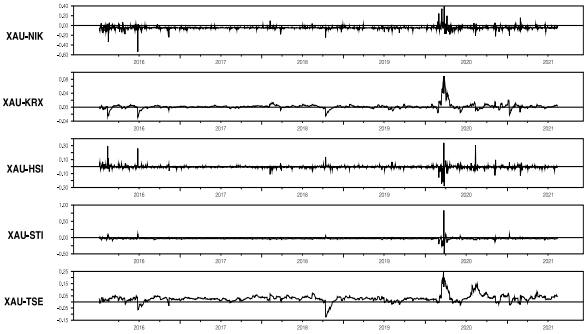


Table 3: Parameter estimates for the mean and variance equations of the DCC-GARCH model for the Bitcoin-stock pair

Variable	Japan	Korea	Hong Kong	Singapore	Taiwan
Mean Model(RBIT)					
Constant	0.315***	0.311***	0.327***	0.324***	0.322***
RBIT{1}	-0.000	-0.004	-0.009	-0.005	-0.011
RNIK{1}	0.094	0.185*	0.017	0.098	0.131
Mean Model(RNIK)					
Constant	0.058**	0.035	0.030	0.021	0.075***
RBIT{1}	0.020***	0.009**	0.013***	0.009**	0.010**
RNIK{1}	-0.049*	-0.017	0.004	0.025	0.005
Conditional variance equation					
C(1)	1.376***	1.373***	1.362***	1.365***	1.363***
C(2)	0.076***	0.027***	0.018***	0.031***	0.054***
A(1)	0.155***	0.161***	0.153***	0.157***	0.155***
A(2)	0.123***	0.076***	0.048***	0.113***	0.088***
B(1)	0.804***	0.800***	0.806***	0.804***	0.805***
B(2)	0.822***	0.893***	0.937***	0.839***	0.856***
DCC(A)	-0.006***	0.013	0.028	0.007	0.027**
DCC(B)	-0.001	0.956***	0.734***	0.934***	0.909***
Q test	33.29194	53.40265	43.70081	52.22994	39.46304
Sign Q test	0.35626	0.00745	0.06474	0.00991	0.1416
ARCH test	6.08	4.74	3.17	4.51	6.9
Sign ARCH test	0.73151	0.85672	0.95721	0.87463	0.64744
Observation	1463	1463	1463	1463	1463

*Note: This table reports the estimates of the DCC-GARCH model for the pair of Bitcoin and Asian developed stock return. ***,** and * indicate statistical significance at the level of 1%, 5%, and 10%, respectively.*

Table 4: Parameter estimates for the mean and variance equations of the DCC-GARCH model for gold-stock pair

Variable	Japan	Korea	Hong Kong	Singapore	Taiwan
Mean Model(RXAU)					
Constant	0.029	0.017	0.024	0.016	0.017
RXAU{1}	-0.010	0.008	0.014	0.015	0.006
RNIK{1}	-0.041**	0.005	0.009	0.007	0.006
Mean Model(RNIK)					
Constant	0.071**	0.038*	0.008	0.027	0.075***

Variable	Japan	Korea	Hong Kong	Singapore	Taiwan
RXAU{1}	-0.124***	0.047*	0.068**	-0.003	0.051*
RNIK{1}	-0.049*	-0.019	-0.020	0.030	0.001
Conditional Variance Equation					
C(1)	0.013***	0.009*	0.010***	0.010*	0.009*
C(2)	0.043***	0.026***	0.019***	0.031***	0.050***
A(1)	0.062***	0.045***	0.046***	0.047***	0.045***
A(2)	0.101***	0.075***	0.050***	0.111***	0.083***
B(1)	0.920***	0.941***	0.939***	0.938***	0.941***
B(2)	0.870***	0.895***	0.934***	0.841***	0.866***
DCC(A)	0.028*	0.002	-0.014**	-0.009***	0.008
DCC(B)	-0.050	0.884***	-0.050	0.531**	0.915***
Q test	27.24568	39.70099	35.64227	38.88733	31.78824
Sign Q test	0.65978	0.13592	0.25906	0.1561	0.42705
ARCH test	13.21	5.75	3.28	11.16	4.68
Sign ARCH test	0.15326	0.76488	0.95223	0.2648	0.86128
Observation	1463	1463	1463	1463	1463

*Note: This table reports the estimates of the DCC-GARCH model for the pair of gold and Asian developed stock return. ***,** and * indicate statistical significance at the level of 1%, 5%, and 10%, respectively.*

Table 5: DCCs between Bitcoin and stock (Panel A) and gold and Stock (Panel B)

	Japan	Korea	Hong Kong	Singapore	Taiwan
Panel A: BIT-STOCK					
Mean DCC in tranquil period	0.0158	-0.0061	-0.0073	0.0295	-0.0219
Mean DCC in turmoil period	0.0137	0.0151	0.0011	0.0489	0.0330
Different in Mean DCC	-0.0021	0.0211	0.0084	0.0193	0.0549
Reject Ho:		***	***	***	***
Panel B: XAU-STOCK					
Mean DCC in tranquil period	-0.0491	0.0006	-0.0049	-0.0307	0.0229
Mean DCC in turmoil period	-0.0432	0.0043	-0.0078	-0.0342	0.0420
Different in Mean DCC	0.0059	0.0037	-0.0030	-0.0035	0.0191
Reject Ho:	***	***			***

Note: The difference is calculated from the mean of the turbulent period minus the mean of the tranquil period.

DCCs between Bitcoin and Asian advanced stock indices are higher during the Covid-19 turmoil period compared to those during the preCovid-19 period, except for the case of Japan (Panel A_Table 5). The difference in DCCs between the turmoil and the calm period varies between countries. The Taiwanese equity market exhibits the highest difference in mean DCC (0.0549) with Bitcoin, while the lowest difference in mean DCC is recorded in Japan (-0.0021). The T test rejects the null hypothesis that there is no difference in DCC between stock and Bitcoin in the tranquil period and these DCCs in the Covid-19 period in Korea, Hong Kong, Singapore, and Taiwan at the 1% significance level. The results of a higher dynamic correlation between Bitcoin and the traditional equity market during the turbulent period are consistent with previous studies in the context of the global Covid-19 pandemic (Akhtaruzzaman, Boubaker, & Sensoy, 2021; Nguyen et al., 2021) or other crisis periods (Bouri, Molnár et al., 2017; Klein et al., 2018; Park & Song, 2001). As a result, our findings not only confirm the existence of financial contagion between stocks and Bitcoin in four out of five Asian developed countries during the Covid-19 period, but also show that the degree of contagion varies between countries, thus supporting the finding of Corbet et al. (2020); Goodell & Goutte (2021); Huang et al. (2021). Evidence suggests that investors, financial advisors, or portfolio managers who own Bitcoin and Asian developed stocks should be particularly cautious due to the potential for greater systematic risk caused by the global Covid-19 pandemic.

When considering the cross-linkage between gold and Asian advanced stock indices (Panel B_Table 5), the DCCs between gold and stock in Japan, Korea and Taiwan increased, while the DCCs between gold and stock in Hong Kong and Singapore decreased during the Covid-19 pandemic period compared to those during the tranquil period. To be more specific, the DCCs between gold and Hong Kong (Singapore) decreased from -0.0049 (-0.0307) in the pre-Covid-19 period to -0.0078 (-0.0342) in the pandemic period. During this rapidly escalating pandemic, the negative and decreased dynamic correlation suggests that gold has greater potential as a safe haven against the Hong Kong and Singapore equity markets. However, in the case of Japan, Korea and Taiwan, the T-test on the hypothesis of whether there is a significant increase in the dynamic correlation between stock and gold during this pandemic period was rejected at the 1% significance. This finding suggests that the Covid-19 pandemic caused a financial contagion effect between the gold and stock markets in Japan, Korea and Taiwan. However, the level of contagion in the gold and stock markets during the Covid-19 period is lower than that in Bitcoin and the stock market. Furthermore, with the exception of Taiwan, the mean DCCs between stocks and gold are lower than those between stocks and Bitcoin, despite the fact that the DCCs between stocks and gold increased during the Covid period in some countries. This implies that, compared to Bitcoin, gold can provide a better hedge and safe haven for developed Asian

equity markets. These findings are in line with Klein et al. (2018); Kumar & Padakandla (2022); Wu et al. (2019) who also point out that gold provides more hedge and safe haven properties for stock compared to cryptocurrencies. Our finding also corroborate previous studies on the contagion effect between gold and stock market during various turmoil periods (Zhang & Wang, 2021).

5. Conclusions

This study analyzes the existence of the financial contagion effect of the global Covid-19 pandemic exists between the Asian developed equity market and the Bitcoin market, as well as between these stock markets and the gold market. The empirical results show that dynamic correlation between stock and Bitcoin increased significantly during the Covid-19 turmoil period in four Asian developed countries, except Japan, whereas the DCCs between stock and gold increased significantly in three countries including Japan, Korea, and Taiwan, thus indicating that the global Covid-19 pandemic has caused financial contagion effect in terms of a shift in dynamic correlation between stock and Bitcoin, as well as between stock and gold in these countries. However, the magnitude of the increase in DCC was greater for the pair of stock and Bitcoin than for the pair of stock and gold, implying that Bitcoin plays a more important role in financial contagion transmission than gold and that gold has a greater potential to be considered as a hedge or safe haven tool for Asian-developed stock investors during the Covid period. These findings may be of interest to market participants, policymakers, regulators, and practitioners interested in understanding how financial markets shape and change during the global Covid-19 pandemic and recognising the possibility of increased systematic risk in Bitcoin, gold, and Asian developed stock markets during this period of high uncertainty.

References:

Akhtaruzzaman, M., Boubaker, S., & Sensoy, A. (2021). Financial contagion during COVID–19 crisis. Finance Research Letters, 38, 101604. https://doi.org/10.1016/j.frl.2020.101604

Akhtaruzzaman, M., Boubaker, S., Lucey, B. M., & Sensoy, A. (2021). Is gold a hedge or a safe-haven asset in the COVID–19 crisis? Economic Modelling, 102(June), 105588. https://doi.org/10.1016/j.econmod.2021.105588

Bouri, E., Molnár, P., Azzi, G., Roubaud, D., & Hagfors, L. I. (2017). On the hedge and safe haven properties of Bitcoin: Is it really more than a diversifier? Finance Research Letters, 20, 192–198. https://doi.org/10.1016/j.frl.2016.09.025

Cepoi, C. O. (2020). Asymmetric dependence between stock market returns and news during COVID-19 financial turmoil. Finance Research Letters, 36, 101658. https://doi.org/10.1016/j.frl.2020.101658

Conlon, T., & McGee, R. (2020). Safe haven or risky hazard? Bitcoin during the Covid-19 bear market. Finance Research Letters, 35(May), 101607. https://doi.org/10.1016/j.frl.2020.101607

Corbet, S., Hou, Y., Hu, Y., Lucey, B., & Oxley, L. (2021). Aye Corona! The contagion effects of being named Corona during the COVID-19 pandemic. Finance Research Letters, 38, 101591. https://doi.org/10.1016/j.frl.2020.101591

Corbet, S., Larkin, C., & Lucey, B. (2020). The contagion effects of the COVID-19 pandemic: Evidence from gold and cryptocurrencies. Finance Research Letters, 35(May), 101554. https://doi.org/10.1016/j.frl.2020.101554

Engle, R. (2002). Dynamic Conditional Correlation. Journal of Business & Economic Statistics, 20(3), 339–350. https://doi.org/10.1198/073500102288618487

Forbes, K. J., & Rigobon, R. (2002). No contagion, only interdependence: Measuring stock market comovements. Journal of Finance, 57(5), 2223–2261. https://doi.org/10.1111/0022-1082.00494

Forbes, K., & Rigobon, R. (2001). Measuring Contagion: Conceptual and Empirical Issues. In International Financial Contagion (pp. 43–66). Springer US. https://doi.org/10.1007/978-1-4757-3314-3_3

Goodell, J. W., & Goutte, S. (2021). Diversifying equity with cryptocurrencies during COVID-19. International Review of Financial Analysis, 76(June 2020), 101781. https://doi.org/10.1016/j.irfa.2021.101781

Handika, R., Soepriyanto, G., & Havidz, S. A. H. (2019). Are cryptocurrencies contagious to Asian financial markets? Research in International Business and Finance, 50(February), 416–429. https://doi.org/10.1016/j.ribaf.2019.06.007

Huang, Y., Duan, K., & Mishra, T. (2021). Is Bitcoin really more than a diversifier? A pre- and post-COVID-19 analysis. Finance Research Letters, March, 102016. https://doi.org/10.1016/j.frl.2021.102016

Klein, T., Pham Thu, H., & Walther, T. (2018). Bitcoin is not the New Gold – A comparison of volatility, correlation, and portfolio performance. International Review of Financial Analysis, 59, 105–116. https://doi.org/10.1016/j.irfa.2018.07.010

Kumar, A. S., & Padakandla, S. R. (2022). Testing the safe-haven properties of gold and bitcoin in the backdrop of COVID-19: A wavelet quantile correlation approach. Finance Research Letters, xxxx, 102707. https://doi.org/10.1016/j.frl.2022.102707

Le, L. T. N., Yarovaya, L., & Nasir, M. A. (2021). Did COVID-19 change spillover patterns between Fintech and other asset classes? Research in International Business and Finance, 58, 101441. https://doi.org/10.1016/j.ribaf.2021.101441

Nguyen, K. Q., Putnins, T., Foley, S., & Pham, T. P. (2021). The correlation between the stock market and Bitcoin during COVID-19 and other uncertainty periods. Finance Research Letters, 102284. https://doi.org/10.1016/j.frl.2021.102284

Okorie, D. I., & Lin, B. (2021). Stock markets and the COVID-19 fractal contagion effects. Finance Research Letters, 38(June 2020), 101640. https://doi.org/10.1016/j.frl.2020.101640

Park, Y. C., & Song, C.-Y. (2001). Financial Contagion in the East Asian Crisis: With Special Reference to the Republic of Korea. In International Financial Contagion (pp. 241–265). Springer US. https://doi.org/10.1007/978-1-4757-3314-3_10

Ramelli, S., & Wagner, A. F. (2020). Feverish Stock Price Reactions to COVID-19. The Review of Corporate Finance Studies, 9(3), 622–655. https://doi.org/10.1093/rcfs/cfaa012

Wu, S., Tong, M., Yang, Z., & Derbali, A. (2019). Does gold or Bitcoin hedge economic policy uncertainty? Finance Research Letters, 31, 171–178. https://doi.org/10.1016/j.frl.2019.04.001

Yarovaya, L., Matkovskyy, R., & Jalan, A. (2021). The effects of a "black swan" event (COVID-19) on herding behavior in cryptocurrency markets. Journal of International Financial Markets, Institutions and Money, xxxx, 101321.https://doi.org/10.1016/j.intfin.2021.101321

Zhang, H., & Wang, P. (2021). Does Bitcoin or gold react to financial stress alike? Evidence from the U.S. and China. International Review of Economics and Finance, 71(October 2020), 629–648. https://doi.org/10.1016/j.iref.2020.10.007