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STOCK RETURNS-BITCOIN NEXUS: EVIDENCE FROM PRE AND DURING COVID-19 OUTBREAK

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ABSTRACT

The extant literature showed that interaction between cryptocurrency and stock markets was not comprehensively supported during the COVID-19 pandemic. This study aims to examine the relationship of bitcoin and international stock markets to evaluate how the role of cryptocurrency has changed over the COVID-19 period. Using the daily data of 12 international stock markets from the advanced economies and emerging economies, the study showed that cryptocurrency as measured by the price dynamics of bitcoin had more interactions with the international stock markets during the onset of COVID-19. Bitcoin was a hedge asset for the Japan stock market prior to COVID-19. In the period of COVID-19, bitcoin has important portfolio diversification implications for seven international stock market indices, i.e., US, UK, France, Germany, Thailand, India and Turkey, but it is neither a hedge asset nor safe haven for the remainder of the markets in advanced economies and emerging economies. The study further revealed that negative shocks have a larger effect on the conditional volatility of the stock than positive shocks in the observed samples and confirmed the existence of the asymmetric effect on the international stock markets during the pandemic COVID-19 period. This study contributes to complement the existing body of knowledge on the bitcoin and stock markets nexus pre and during the COVID-19 period.

1. Introduction

The global health crisis prompted by the coronavirus disease (COVID-19) had severely impacted the global economies. The COVID-19 pandemic has substantially increased the global financial market risks (Zhang et al., 2020). The performance of global stock markets has been drastically affected due to the expected shrink in the global economies in years to come. The S&P 500 stock market index lost 33.7% of its value between 19 February and 23 March 2020, while the Dow Jones Industrial Average plummeted 6400 points in March 2020 (Cox et al., 2020; Mazur et al., 2021). Though the economy was recovering after a year of the pandemic, a new variant of the virus posted new challenges which witnessed the disruption of the global supply chain. Subsequently, higher demand on goods and services pushed up the prices and put pressure on higher inflation.

The uncertainty posted by COVID-19 pandemic and rising inflation have prompted investors to search for alternative safe haven assets for stock investment. An asset that is uncorrelated with stocks during a market plunge is considered a safe haven asset (Baur and Lucey, 2010). Among the safe haven assets, cryptocurrency is found to have the ability to sustain returns during the extreme stock market crash (Mariana et al., 2021). The market for cryptocurrency has greatly expanded since 2009 in terms of consumer base and the types of new digital currency. The popularity of cryptocurrency and the disruption it caused in the financial markets offer opportunity to entrepreneurs and investors, and at the same time poses great challenges to policymakers and economists. A question arises as to whether cryptocurrency is a form of medium of exchange or an investment asset? A virtual currency like bitcoin is reasonably liquid as it can exchange for any currency at any time, yet it is subject to liquidity limitation due to its scarcity. According to Glaser et al. (2014), users involved in bitcoin investments consider it as a speculative asset rather than as a means of payment. This supports that digital currency is useful as an investment asset for investors.

The extant studies on the interaction between cryptocurrency and stock markets was not comprehensively supported. Lack of consensus on the interrelation between cryptocurrency and stock market has called into question its relevance as a good hedge, safe haven or diversifier with the onset of pandemic COVID-19. Therefore, it is in this spirit that this study examines the nexus between cryptocurrency and stock markets to evaluate how the role of cryptocurrency has changed over the COVID-19 period in comparison to the pre-COVID-19 period.

The objective of this study is to examine how COVID-19 has influenced the way cryptocurrency interacted with the international stock markets. The examination of cryptocurrency – stock market nexus is timely as the global financial sectors are undergoing rapid technology development and rapid information flows that require investors to understand how the digital currencies such as bitcoin can act as a source of portfolio diversification and a store of value during the period of market turbulence.

This study examines how the cryptocurrency can be used in risk management in 12 stock markets from advanced economies and emerging economies over the period of pre and during COVID-19 ranging from January 1, 2018 to March 1, 2022. The results of the study indicated the impact of bitcoin on the international stock markets was stronger over the COVID-19 period compared to pre-COVID-19 period. Bitcoin was found to interact with Japan's stock market in the pre-COVID-19 period, supporting its safe haven and hedging roles. This study further reveals that except Japan, none of the stock markets in advanced economies and emerging economies exhibit negative significant relationships pre and during the onset of COVID-19. This implies that bitcoin

does not act as a safe haven or hedge for stock market investment but acts as a diversifier for the seven stock markets, i.e., US, UK, France, Germany, Thailand, India and Turkey during the period of COVID-19. On the other hand, the results show the persistence of volatility on conditional variance only during the period of COVID-19 in the stock markets. Last but not least, the study further reveals the asymmetric effects of stock returns during the period of COVID-19. Finally, the robustness test shows that the main conclusion of the study remained intact.

The findings of this study have several important implications. Knowing and understanding the role of bitcoin is important to financial market participants who seek protection for their investment against downward price movement and market turbulence. Furthermore, the findings of this study may provide insights to the regulators to engage more discussions on the role of bitcoin in the financial markets. This study has two main contributions. First, the study adds to the existing body of knowledge on the topic of cryptocurrency-stock market nexus pre and during the pandemic COVID-19 period. Second, it contributes to the study on the asymmetric effect of cryptocurrency pre and during the pandemic COVID-19 period.

2. Literature Review

There were strand of studies researching the roles of cryptocurrencies as investment assets. Over time, the focus of the study has grown from the technical facts of cryptocurrency markets to the hedging and safe haven properties of cryptocurrencies (Bariviera et al., 2017; Chan et al., 2019). The role for cryptocurrencies in an investment portfolio is supported by Corbet et al. (2018). High returns in cryptocurrency could be due to the high volatility nature of prices of cryptocurrency which posted challenges in this type of investment (Katsiampa, 2017). Bitcoin that exhibits an inverse relationship with stock exchanges provides strong diversification benefits (Akhtaruzzaman et al., 2020). According to Baur and Lucey (2010), a hedge or safe haven asset is the asset that is negatively correlated with another asset or portfolio on average and an asset is a diversifier if it correlates positively with other assets. The probable diversification benefit of including cryptocurrency in a portfolio is further identified by Liu (2019) and Gil-Alana et al. (2020). Jeribi and Manzli (2021) found that cryptocurrency possesses hedging characteristics prior to the COVID-19 outbreak but act as diversifiers during the pandemic. Zhang et al. (2018) found that cryptocurrency composite index is cross correlated with the Dow Jones Industrial Average. Isah and Raheem (2019) as well as Lahiani and Jlassi (2021) supported the predictive power of cryptocurrency on stock market returns.

However, not all past researches support bitcoin's safe haven potential. Smales (2019) argued whether bitcoin can be a safe haven for stocks due to the high volatility and costs involved in trading bitcoin. Corbet et al. (2020) discovered an insignificant relationship between bitcoin and Chinese stock markets. Ghorbel and Jeribi (2021) claimed that digital assets are not considered hedges for investors during the COVID-19 period. Conlon and McGee (2020) revealed that bitcoin failed to be either a safe haven or a hedge as its price moves closely with the stock market index. Bouri et al. (2017) showed that bitcoin is a weak hedge thus is appropriate for diversification purposes only. Jana and Das (2020) pointed out that bitcoin is a weak safe haven and a weak hedge but a diversifier for Chinese sectoral stock indices. Kurka (2019) disclosed minimum connectedness of cryptocurrency and other financial assets such as stocks, foreign exchange and commodities.

3. Estimation Method

This study collects daily closing price data for 12 stock market indices, i.e., six stock market indices each from advanced economies and emerging economies. The lists of stock market indices are reported in Table 1. The 12 selected economies are among the top 40 countries with the most number of cryptocurrency owners (TripleA, 2021). Bitcoin, the most liquid digital currency, is a proxy for cryptocurrency used in our study. The study sourced all the daily stock market data from the DataStream and from previous study; the data of bitcoin was obtained from https://coinmarketcap.com (Lahiani and Jlassi, 2021). The overall sample of this study covers the period from January 1, 2018 to March 1, 2022. The data were categorised into two sub-samples, i.e., pre-COVID-19 and COVID-19 period which is expected to reveal the changes in investor's risk attitude during the course of market turbulence. Pre-COVID-19 period started from January 1, 2018 to December 30, 2019 with a total of 521 observations and COVID-19 period started from December 31, 2019 when the first case of COVID-19 was reported, to March 1, 2022, with a total of 566 observations.

Table 1 reported the list of stock market indices and their notations adopted by this study. Cryptocurrencies were found to influence stock markets in the advanced and emerging economies (Bouri et al. 2018). Accordingly, this study divides the stock market indices into two sub-categories: advanced economies and emerging economies, with six samples from each category. The samples of stock market indices selected for the advanced economies include the United States of America, United Kingdom, Japan, Singapore, Germany and France, while samples for the emerging economies encompass Malaysia, Philippines, Thailand, India, Indonesia and Turkey.

Table 1
Stock Market Indices

Advanced Economies		Emerging Economies	
Countries (Notation)	Stock Market Indices	Countries (Notation)	Stock Market Indices
United States of America (US)	S&P 500	Malaysia (MY)	FTSE BM KLCI
United Kingdom (UK)	FTSE 100	Philippines (PH)	Philippine SEi
Japan (JP)	NIKKEI 225	Thailand (TH)	Bangkok SET
Singapore (SP)	Straits Times Index	India (IN)	NIFTY 500
Germany (GM)	DAX	Indonesia (ID)	IDX Composite
France (FC)	CAC 40	Turkey (TK)	BIST National 100

In this study, the daily returns of stock market indices and bitcoin are calculated using the continuously compounding method as follows:

$$r_t = ln\left(\frac{P_t}{P_{t-1}}\right) \quad (1)$$

where r_t denotes the daily stock index return, ln denotes the natural logarithm, P_t and P_{t-1} denotes the daily closing price for the indices in day *t* and day *t-1*.

The study tests the effect of bitcoin on the stock markets by using the generalised autoregressive conditional heteroscedasticity, GARCH (1,1) model. This method has been employed in studying the relationship between financial assets (Akyildirim et al., 2020; Chan et al., 2019). The conditional mean and variance equations can be written as:

$$r_t = \mu + \beta_1 r_{t-1} + \beta_2 btc_t + \varepsilon_t \quad (2)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \delta_1 \sigma_{t-1}^2 \quad (3)$$

where r_t is the return on stock market index, btc_t is the return on bitcoin, r_{t-1} are the lagged values of r_t, β_1 and β_2 are the coefficients for mean equation, ε_t is the error term, μ and α_0 are the intercept for conditional mean and conditional variance, σ_t^2 is the conditional variance, α_1 and δ_1 are coefficients of ε_{t-1}^2, the lag of squared residual from the mean equation and σ_{t-q}^2, the lag of forecast variance.

In this study, interaction between bitcoin and the international stock markets is exhibited by β_2 coefficient in equation (2). A significant negative relationship between bitcoin and stock markets suggests that bitcoin is a hedge asset and safe haven while a positive correlation suggest that bitcoin is a diversifier that offer diversification benefit to investors (Baur and Lucey, 2010; Kang et al., 2019; Tiwari et al., 2019, Corbet et al., 2020). The persistence of the estimated conditional variance in a GARCH *(1,1)* model is confirmed if $\alpha_1 + \delta_1 = 1$ (Engle and Bollerslev, 1986).

This study employs the exponential GARCH (EGARCH) model as a robustness test to check the sensitivity of our main findings. The EGARCH model is proposed by Nelson (1991) that has the advantage of capturing the property of the asymmetric volatility. The model is described as follows:

$$\log(\sigma_t^2) = \alpha + \sum_{j=1}^{q} \omega_j \left| \frac{u_{t-j}}{\sqrt{\sigma_{t-j}}} \right| + \sum_{j=1}^{q} \gamma_j \frac{u_{t-j}}{\sqrt{\sigma_{t-j}}} + \sum_{i=1}^{p} \theta_i \log(\sigma_{t-i}) \quad (4)$$

where α denotes constant, ω denotes ARCH effect, γ denotes asymmetric effect and θ denotes GARCH effect. The model is symmetric if $\gamma_1 = \gamma_2 = \ldots = 0$. If $\gamma_j < 0$, there is evidence of an asymmetric effect which shows that bad news has larger effects on the volatility of the returns than good news of the same magnitude.

4. Results and Discussion

Table 2 presents the summary of the selected descriptive statistics for the returns on stock market indices and bitcoin pre and during the COVID-19 period. In the table, Panel A, B and C show the selected descriptive statistics for bitcoin and the selected stock markets indices for advanced economies and emerging economies.

The results indicate that bitcoin and the stock market indices have higher average returns during COVID-19 compared to pre-COVID-19 period in all the samples except mean returns in UK, France and Malaysia. The report showed that stock markets faced higher risk after the onset of COVID-19. The Jarque-Bera statistics show that the null hypothesis of normality is rejected at 1% confidence level in all observations except the Philippines stock market. The Augmented Dickey Fuller unit root tests support the rejection of null hypothesis of unit roots at 1% significance level for all samples. The unit roots tests indicate that the related series are stationary and implies that the returns of stock markets and bitcoin can be modelled directly by the volatility models such as GARCH.

Table 2
Selected Descriptive Statistics

Panel A: Bitcoin										
	Pre-COVID-19					COVID-19				
	Mean	Median	SD	JB	ADF	Mean	Median	SD	JB	ADF
BTC	-0.0017	-0.0006	0.0417	0.0000	0.0000	0.0030	0.0020	0.0449	0.0000	0.0000
Panel B: Advanced Economies										

	Pre-COVID-19					COVID-19				
	Mean	Median	SD	JB	ADF	Mean	Median	SD	JB	ADF
US	0.0004	0.0006	0.0093	0.0000	0.0000	0.0005	0.0012	0.0160	0.0000	0.0000
UK	-0.00003	0.0002	0.0076	0.0000	0.0000	-0.00006	0.0004	0.0140	0.0000	0.0000
JP	0.00007	0.0002	0.0103	0.0000	0.0000	0.0002	0.0000	0.0137	0.0000	0.0000
SP	-0.0001	0.0000	0.0073	0.0000	0.0000	0.00003	0.00003	0.0113	0.0000	0.0000
FC	0.0002	0.0007	0.0085	0.0000	0.0000	0.0001	0.0010	0.0157	0.0000	0.0000
GM	0.00005	0.0004	0.0092	0.0000	0.0000	0.0009	0.0004	0.0159	0.0000	0.0000
Panel C: Emerging Economies										
	Pre-COVID-19					COVID-19				
	Mean	Median	SD	JB	ADF	Mean	Median	SD	JB	ADF
MY	-0.0002	0.0000	0.0057	0.0000	0.0000	-0.00002	0.0000	0.0095	0.0000	0.0000
PH	-0.0002	0.0000	0.0100	0.1994	0.0000	-0.0001	0.0000	0.0163	0.0000	0.0000
TH	-0.0002	0.0000	0.0066	0.0000	0.0000	0.0001	0.0000	0.0136	0.0000	0.0000
IN	0.00009	0.0000	0.0083	0.0000	0.0000	0.0006	0.0015	0.0146	0.0000	0.0000
ID	-0.00002	0.0000	0.0085	0.0000	0.0000	0.0002	0.0000	0.0125	0.0000	0.0000
TK	-0.00001	0.0000	0.0132	0.0000	0.0000	0.0010	0.0017	0.0169	0.0000	0.0000

Note: SD denotes standard deviation, JB denotes Jarque-Bera statistic and ADF denotes the Augmented Dickey-Fuller test. The reported JB and ADF are the probability value for the statistics. BTC in Panel A denotes bitcoin. For Panel B on Advanced Economies, US, UK, JP, SP, FC and GM denote the United States of America, United Kingdom, Japan, Singapore, France and Germany. For Emerging Economies in Panel C, MY, PH, TH, IN, ID and TK denote Malaysia, Philippines, Thailand, India, Indonesia and Turkey.

The results of the GARCH (1,1) estimation are summarised in Table 3. The results indicate that the ARCH and GARCH terms are significant and the sum of ARCH and GARCH terms in all countries are close to unity during the COVID-19 period in comparison to the pre-COVID-19 observation. This reveals that in general, volatility persists for the conditional variances during the period of COVID-19 in the stock markets.

Table 3
GARCH Estimation

Panel A: Advanced Economies								
	Pre-COVID-19				COVID-19			
	1st lag	BTC	ARCH	GARCH	1st lag	BTC	ARCH	GARCH
US	-0.0072	0.0078	0.2334***	0.7485***	-0.1011**	0.0589***	0.2260***	0.7434***
UK	0.0133	0.0041	0.2562***	0.0028	-0.0952*	0.0348***	0.1019***	0.8657***
JP	-0.0202	-0.0158*	0.1045***	0.7906	-0.0507	0.0153	0.1186***	0.7956***
SP	-0.0003	-0.0025	-0.0121*	1.0176***	-0.0372	0.0044	0.2129***	0.7151***
FC	0.0631	0.0127	0.1982***	0.6630***	-0.0637	0.0412***	0.1594***	0.8017***
GM	-0.0085	0.0104	0.0914***	0.7695***	-0.0870*	0.0481***	0.1423***	0.8316***
Panel B: Emerging Economies								
	Pre-COVID-19				COVID-19			
	1st lag	BTC	ARCH	GARCH	1st lag	BTC	ARCH	GARCH
MY	0.0736	0.0009	0.0935**	0.7015***	-0.0628	0.0044	0.0822***	0.8750***
PH	-0.0549	0.0019	0.0927*	0.4370	-0.0544	0.0078	0.1706***	0.7769***
TH	0.0510	0.0078	0.0607**	0.8594***	0.0146	0.0178**	0.0931***	0.8893***
IN	0.1074**	0.0012	0.1543***	0.7030***	0.0508	0.0136*	0.1066***	0.8771***
ID	0.0070	-0.0056	0.0291***	0.9588***	-0.0597	0.0126	0.1684***	0.7641***
TK	0.0398	-0.0135	0.0550**	0.8474***	-0.0188	0.0551***	0.1007***	0.8524***

Note: BTC denotes bitcoin. 1st lag denotes the lagged values of the return of the stock market index. For Advanced Economies as stated in Panel A, US, UK, JP, SP, FC and GM denote the United States of America, United Kingdom, Japan, Singapore, France and Germany. For Emerging Economies in Panel B, MY, PH, TH, IN, ID and EY denote Malaysia, Philippines, Thailand, India, Indonesia and Turkey.

The results of the study revealed mixed findings with regard to the stock market – bitcoin interactions. Overall, bitcoin was observed to relate to seven stock market indices, i.e., US, UK, France, Germany, Thailand, India and Tukey (column 7, Table 3) during the COVID-19 period. Prior to COVID-19, none of the stock markets observed in advanced economies and emerging economies had significant interaction with bitcoin except Japan (column 3, Table 3). Bitcoin was found to interact significantly and negatively with the stock market in Japan (advanced economies) prior to the pandemic, but such a significant relationship disappeared after the outbreak of COVID-19. The findings that bitcoin only served as a safe haven and hedge for investors prior to COVID-19 pandemic is in line with Jeribi and Manzli's (2021) study.

During the period of COVID-19, bitcoin significantly and positively interacted with seven stock market indices, i.e., US, UK, France, Germany (advanced economies), Thailand, India and Turkey (emerging economies). The positive relationships suggest that though bitcoin is not a hedge and safe haven in these markets, it is a diversifier and incorparating it in an investment portfolio does have important diversification implications. Bitcoin was found to have no significant interaction with the remainder of the markets, i.e., Japan and Singapore (advanced economies); Malaysia, Philippines and Indonesia (emerging economies) during the embark of COVID-19. With the findings that bitcoin is neither a safe haven nor a hedge for the seven observed markets during the onset of COVID-19, this study seems to support the findings of Conlon and McGee (2020) who discovered that the price of cryptocurrency moves closely with the stock market index. According to Smales (2019), high costs in trading bitcoin and its price volatility challenges its role as a safe haven. Yet, cryptocurrencies are regarded as independent financial instruments that pose little to no systematic risk compared to traditional asset classes that may add to their attractiveness for investors (Gil-Alana et al., 2020).

Table 4
EGARCH Estimation

Panel A: Advanced Economies					
			Pre-COVID-19		
	1st lag	BTC	e	ARCH	GARCH
US	0.0178	-0.0016	-0.2396***	0.1911***	0.9380***
UK	0.0265	-0.0011	-0.1743***	0.0247	0.8574***
JP	-0.0032	-0.0190**	-0.2694***	0.0171	0.9070***
SP	0.0125	-0.0051	-0.0153	0.1994**	-0.1448
FC	0.0648	0.0105	-0.3486***	0.0929**	0.8491***
GM	-0.0225	0.0023	-0.2599***	-0.1390***	0.8728***
			COVID-19		
	1st lag	BTC	e	ARCH	GARCH
US	-0.0939**	0.0588***	-0.0983***	0.3845***	0.9422
UK	-0.0860*	0.0325***	-0.1396***	0.0786***	0.9765***
JP	-0.0396	0.0237**	-0.1014***	0.1206***	0.9641***
SP	-0.0521	0.0159**	-0.1095***	0.2786***	0.9430***
FC	0.0021	0.0269***	-0.1790***	0.0069	0.9797***
GM	-0.0676	0.0410***	-0.1421***	0.0481***	0.9885***
Panel B: Emerging Economies					
			Pre-COVID-19		
	1st lag	BTC	e	ARCH	GARCH
MY	0.0943**	-0.0027	-0.1488***	0.0228	0.9045***
PH	-0.0479	0.0026	-0.0583	0.1780**	0.6007**
TH	0.0348	0.0090	0.0397	0.2351**	-0.5995**

IN	0.1266**	0.0034	-0.2377***	0.1248***	0.9064***
ID	0.0145	-0.0079	-0.0909***	0.0007	0.9880***
TK	0.0571	-0.0074	-0.1035***	-0.0185	0.9683***
			COVID-19		
	1st lag	BTC	e	ARCH	GARCH
MY	-0.0470	0.0025	-0.0446***	0.1675***	0.9675***
PH	-0.0440	0.0168*	-0.0941***	0.2844***	0.9596***
TH	0.0104	0.0174**	-0.0628***	0.1689***	0.9808***
IN	0.0916*	0.0269***	-0.1483***	0.0845***	0.9723***
ID	-0.0441	0.0128	-0.0772***	0.2211***	0.9507***
TK	-0.0385	0.0583***	-0.0452***	0.2354***	0.9463***

Note: BTC denotes bitcoin. 1st lag denotes the lagged values of the return of the stock market index and e denotes coefficient of asymmetric effect. For Advanced Economies as stated in Panel A, US, UK, JP, SP, FC and GM denote the United States of America, United Kingdom, Japan, Singapore, France and Germany. For Emerging Economies in Panel B, MY, PH, TH, IN, ID and TK denote Malaysia, Philippines, Thailand, India, Indonesia and Turkey.

This study employs the EGARCH model to check the sensitivity of the main findings. The results are presented in Table 4. The overall results suggest that the findings of EGARCH are intact with the GARCH model. Prior to COVID-19, similar to the results produced by the GARCH model, EGARCH showed that bitcoin was found to significantly and negatively affect the stock market of Japan. However, the model reported statistical significant interaction between bitcoin and all the stock markets observed in the advanced economies during the COVID-19. Similarly, the EGARCH model showed none of the stock markets in emerging economies interacted with bitcoin prior to COVID-19, but such interaction exhibited in four stock markets, i.e., Philippines, Thailand, India and Turkey during the pandemic. The results of bitcoin suggest that the EGARCH model gives equal statistically significant coefficients for most of the stock markets that are observed in the GARCH model.

In addition, the results of the EGARCH model suggest that there exists an asymmetric effect. The asymmetric effects were captured by the negative asymmetric terms in the EGARCH model for all the stock markets prior and during the COVID-19 except Singapore, Philippines and Thailand which showed no asymmetric effect before the COVID-19. The findings of asymmetric effects imply that negative shocks tend to generate large volatility in all the observed stock markets compared to positive shocks during the period of COVID-19.

5. Conclusion

This study evaluates the interaction of the bitcoin and international stock markets. The study is motivated by the call to review how a shock, as devastating as the current COVID-19 has influenced the bitcoin-stock market interactions over the period of January 1, 2018 to March 1, 2022. Using daily data of 12 stock markets from the advanced economies and emerging economies, the study examines the relationship of stock markets and bitcoin pre and during the period of COVID-19. In summary, the results of the study showed that cryptocurrency as measured by the price dynamics of bitcoin do interact significantly and negatively with the stock market index prior to COVID-19 in Japan's stock market. This provides evidence that bitcoin acts as a hedge asset for Japan's stock market prior to COVID-19. The observation in the advanced economies revealed that bitcoin was positively related to the stock markets in US, UK, France and Germany, but no interaction was found for Japan and Singapore during the period of COVID-19. During the same period, only the stock markets of Thailand, Indonesia and Turkey were reported to have positive relationships with bitcoin in emerging economies. Thus, the findings suggest that

bitcoin is not a safe haven nor a hedge but instead it is a diversifier for the seven stock markets during the pandemic period. On the other hand, the result of the study further revealed the negative and statistically significant asymmetric effect coefficients for all the observed stock markets, thus suggesting that negative shocks have greater impacts on the conditional volatility than positive shocks of the same magnitude in the observed samples during the outbreak of COVID-19.

The spread of COVID-19 is closely related to global financial instability (Ali et al., 2020). The main contribution of our study is it complements the existing literature on the interactions between bitcoin and international stock markets pre and during the COVID-19 period. It provides some insights to the ongoing debate on the usefulness of bitcoin for investment. The findings that cryptocurrency has stronger interactions with the international stock markets after the pandemic COVID-19 has important portfolio and policy implications. However, the ability of bitcoin to be a stable asset class renders much concern as its prices remain volatile. From a portfolio perspective, the positive linkages between cryptocurrency and stock market indices found in this study may have implications on investor's choice of asset class as bitcoin can serve as a diversifier in the portfolio. Therefore, the findings of this study provide some insights to the investors and financial market participants in understanding the role of bitcoin in an investment portfolio and to the regulators in engaging more discussions on the role of bitcoin in the financial market. Furthermore, this study adds to the literature on the asymmetric effects of the international stock markets pre and during the pandemic COVID-19 period. As the results of the study show that bitcoin serves as a safe haven and hedge asset only in one of the observed stock markets prior to COVID-19, there is a need for future study to investigate the roles of other financial assets such as gold and foreign exchange in helping to diversify and hedge against investment risks.

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