



## Are bitcoin and gold safe haven assets? Evidence from Thailand

Suthawan Prukumpai<sup>a</sup>, Yuthana Sethapramote<sup>b,\*</sup>

<sup>a</sup> Department of Accounting, The Faculty of Business Administration, Kasetsart University, Chatuchak, Bangkok 10900, Thailand

<sup>b</sup> School of Development Economics, National Institute of Development Administration, Bangkok, Bangkok 10240, Thailand

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### Abstract

This paper aims to investigate the role of Bitcoin and gold in equity portfolio formation. The dynamic relationships among four asset classes: Bitcoin, gold, equities, and bonds are examined, using Thai data from April 30, 2013 to February 27, 2021. The dynamic conditional correlations based on the DCC-GARCH model show that stock-gold correlations are generally negative while stock-Bitcoin correlations are close to zero. Interestingly, stock-bond correlations display the highest value over time. The spillover indices also show that gold and Bitcoin are less connected with stock while bonds receive the largest spillover from stock. To formally test which assets can be used as a safe haven against stock, dummy variable regression models with three different dependent variables: namely asset returns, DCCs, and pairwise spillovers are estimated. The results from the dummy variable regressions reveal that only gold acts as a safe haven for Thai equity portfolio. Moreover, Bitcoin and bonds tend to provide weaker diversification benefits than gold.

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### Introduction

It is important for investors to manage risk. During periods of market turbulence, stock market volatility tends to be extreme, and investors typically reinvestigate their existing risk management strategies for wealth preservation. The hedging strategy through portfolio diversification is the standard risk management tool. Bond and stock markets tend to move in opposite directions during times of crisis, as documented in several studies and referred to as flight-to-quality.

However, recent literature reveals interesting results in which stock-bond correlations even increase under certain market conditions. For instance, Boucher and Tokpavi (2019) found that under the current environment of low yields, the strength of flight-to-quality from equities to bonds weakens. Recently, a study in Thailand by Pisedtasalasai (2021) reported that stock-bond correlations even increase during market turmoil, including that caused by the COVID-19 pandemic.

Besides the controversial result in stock-bond correlation, a substitution effect occurs on other hedged and safe haven assets like gold and digital assets. Several studies focus on gold due to its outstanding performance since the Global Financial Crisis. Despite the high price volatility, gold's hedging ability against stocks has been confirmed in several studies, such as that conducted by

\* Corresponding author.

E-mail address: [yuthana.s@nida.ac.th](mailto:yuthana.s@nida.ac.th) (Y. Sethapramote).

Baur and McDermott (2010). Recently, digital assets such as Bitcoin are receiving increasing attention from portfolio investors because of some common characteristics with gold. Hence, many recent papers investigate the properties of Bitcoin in portfolio management, such as Bouri et al. (2017) and Wang et al. (2019b).

A number of papers examine the role of bonds, gold, and Bitcoin in portfolio risk management. Most of them focus on the US and other developed markets. In this paper, we perform an empirical study based on Thai data. Our focus on Thailand is motivated by several factors. The Thai stock market is the second largest in ASEAN, and the number of market participants has increased significantly. The number of investors opening accounts has risen from 1.35 million clients at the end of 2016 to 2.15 million at the end of 2020, equating to about 60 percent over five years. As in most emerging markets, the Thai stock market is quite volatile due to domestic and external risk factors. Numerous studies have focused on the linkage between the Thai stock market and other markets or asset classes; for example, among the ASEAN stock markets (e.g., Prukumpai & Sethapramote, 2018), stock-bonds during COVID-19 in Khanthavit (2021), and the stock-gold relationship (e.g., Pisedtasalasai, 2021). Although evidence of safe haven assets has been well established for developed markets, explicit evidence on whether these assets can be used as diversifiers, hedges, or safe havens against Thai equity portfolio formation remains limited. Therefore, this study aims to answer an important investment question: *Do gold and Bitcoin act as hedges or safe havens against equities in Thailand?*

This study contributes to the existing literature by examining the roles of each asset in risk management, not only in terms of the co-movements between different asset types but also the return spillover between asset classes. The results of this study will provide useful information to enable equity investors to improve their asset allocation. The following conclusions can be drawn for Thai equity portfolios: (1) gold is the only safe haven; (2) Bitcoin is a weak hedge in normal periods and a diversifier in turbulent periods; and (3) in similarity to Bitcoin, government bonds provide a weak hedge in tranquil periods and act as diversifiers in times of crisis.

The rest of this paper is organized as follows. Section 2 reviews the literature related to hedge and safe haven assets. Section 3 outlines the data and econometric methodology used in this study, while the findings are reported in Section 4. Finally, the conclusion and implications are contained in Section 5.

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## Literature Review

This section summarizes the recent literature on the safe haven properties of government bonds, gold, and Bitcoin for equity investors.

### *The Stock-Bond Relationship*

In the present value model, the discount factor is based on market interest rates. Under the expectation of an increase in interest rates, the current value of expected cash flows decreases. This causes a fall in the price of both equities and bonds, demonstrating a positive correlation between them. Contrary to the present value model, one may argue that the response to a decline in interest rates differs between equities and bonds. A fall in interest rates occurs under the expectation of less growth and hence lower expected cash flows, adversely affecting equity prices. However, the expected bond cash flows are discounted at a lower rate, positively affecting bond prices. In other words, an expected reduction in discount rates should cause long-term interest rates to decrease, thus making short-term bonds a more attractive investment. A study by Shiller and Beltratti (1992) showed a positive relationship between equities and bond prices or a negative relationship between equity price and (long-term) bond yields. In related work, Campbell and Ammer (1993) found that equity and bond returns were negatively correlated when the expected inflation varies. An expected increase in long-run inflation (higher interest rate) is bad news for bonds but good news for equities. Besides the present value model, many studies have also documented certain periods of negative correlation, referred to as “flight-to-safety” or “flight-to-quality.” Government bonds are viewed as a safe haven for investors engaging in “flight-to-safety” during times of crisis. As investors move from risky assets to safer ones, they sell equities to buy bonds; hence, bond and stock market returns become negatively correlated.

Recent empirical studies present a time-varying pattern in the stock-bond relationship. Baur and Lucey (2009) estimated the Dynamic Conditional Correlation (DCC) between stocks and bonds and performed dummy variable regression to analyze the stock-bond correlation during periods of crisis. Their findings confirmed the evidence of flight-to-safety from stocks to bonds in eight advanced economies at times of crisis. Similarly, Flavin et al. (2014) documented a statistical difference in correlation patterns between tranquil and high volatility periods. Specifically, they applied a regime-switching

model to separate between high and low volatility regimes and found that during large fluctuations in the US stock market, investors tended to move toward gold and longer-horizon bonds. Recently, the flight-to-quality studies have received significant attention since the first wave of COVID-19 pandemic. Khanthavit (2021) examined stocks and government bonds in Thailand and discovered evidence to support that the correlation between flight-to-quality and returns during the COVID-19 pandemic was more negative than in the pre-COVID-19 period. However, another study by Pisedtasalasai (2021) explored the hedging properties of bonds in Thailand via dummy variable regression and found increasing correlations between bonds and stocks in periods of crisis. This result is consistent with the work of Johansson (2010), who found that stock-bond correlations in Asian countries were time-varying in nature and increased during market turbulence. Therefore, during times of turmoil, the flight-to-quality effect in Asia seems to be moving toward new investment destinations (either countries or asset classes) rather than the bond market.

### *The Stock-Gold Relationship*

Much of the early literature focused on the stock-bond relationship, with the findings mostly supporting the character of government bonds as safe haven assets. More recent studies have turned their focus toward gold due to its outstanding performance prior to and during the Global Financial Crisis. In recent years, the gold price has shown tremendous growth, especially during the COVID-19 pandemic, thus making it more attractive for portfolio formation and hedging objectives.

Gold's hedging ability against equities has been investigated in several studies. For example, Flavin et al. (2014) reported that both gold and long-term bonds act as safe haven assets for US equity portfolios. Similarly, Baur and Lucey (2010), Baur and McDermott (2010), and Liu (2020) employed dummy variable regression and found that gold acts as a safe haven and hedge asset for advanced economies. However, several studies revealed that gold was neither a safe haven nor a hedge against stocks in emerging markets (e.g., Baur & McDermott, 2010; Bekiros et al., 2017).

In contrast to the aforementioned studies, recent research by Wen and Cheng (2018), Aftab et al. (2019), and Pisedtasalasai (2021) documented evidence in favor of the safe haven role for gold against emerging equity markets, including Thailand. In addition, gold can be considered a safe haven during some crises, such as the Asian financial crisis and subprime mortgage crisis.

### *The Stock-Bitcoin Relationship*

Recently, the development of blockchain technology has made digital assets publicly reliable. Among the digital assets, Bitcoin is the most popular, and topics relating to Bitcoin are growing in literature. One strand of finance literature attempts to investigate the relationship between Bitcoin and traditional financial assets. For instance, Baur et al. (2018) documented that Bitcoin had a low correlation with other assets such as stocks, bonds, hard currencies, commodities, hedge funds, and real estate. Therefore, adding Bitcoin will improve the risk-return profile of portfolios. Although Bitcoin is highly volatile, Bouri et al. (2017) found marginal evidence to support its hedge and safe haven properties for US equities based on dummy variable regression. Wang et al. (2019b) estimated the DCC model to assess the evolution of correlations over time and then investigated the property of Bitcoin by using dummy variable regression. Their results revealed the hedging ability of Bitcoin against bonds and equities in China and its use as a safe haven during downturns.

Dummy variable regression was also employed in the research by Wang et al. (2019a), who revealed that Bitcoin has experienced a small spillover effect from other assets such as bond and gold markets. In addition, they provided positive evidence to support that Bitcoin could be used as a safe haven for international equity indices, especially in developed markets. Nonetheless, there was no evidence to support Bitcoin as a safe haven for emerging markets with small market capitalization and low liquidity. Similarly, Stensås et al. (2019) documented the hedging ability of Bitcoin in most developing countries. Moreover, they found it could be used as a safe haven during crises, e.g., the Brexit referendum in 2016. Using data collected during the COVID-19 outbreak, Huang (2021) examined the property of Bitcoin through a Bayesian panel VAR model and found that it can be effectively used in a risk management strategy against traditional assets.

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## **Methodology**

### *Measurement of Dynamic Correlations and Connectedness between Assets*

Since the co-movement between assets is more important than the volatility of each asset in portfolio management, this study examines the linkage between asset classes through dynamic correlations and risk spillovers.

*Dynamic conditional correlations*

Apart from the mean and volatility relationship, the dynamic conditional correlation (DCC) between candidate assets and stock markets is estimated in this study. The DCC model proposed by Engle (2002) is applied and the model specification defined as shown in Equation (1):

$$Q_t = (1 - \phi - \gamma)\bar{Q} + \gamma Q_{t-1} + \phi \sigma_{i,t-1} \sigma_{j,t-1}, \tag{1}$$

where  $Q_t$  is the  $N \times N$  time-varying covariance matrix of standardized residuals  $(\sigma_{i,t} = \frac{e_{i,t}}{\sqrt{h_{i,t}}})$  and  $\bar{Q}$  is the unconditional correlations of  $\sigma_{i,t} \sigma_{j,t}$ , and  $\phi$  and  $\gamma$  are non-negative scalar parameters that satisfies  $\phi + \gamma < 1$ . Thus, the DCC ( $\rho_{ij,t}$ ) between asset  $i$  and  $j$  is calculated by Equation (2):

$$\rho_{ij,t} = \frac{(1 - \phi - \gamma)\bar{\rho}_{ij} + \gamma \rho_{ij,t-1} + \phi \sigma_{i,t-1} \sigma_{j,t-1}}{[(1 - \phi - \gamma)\bar{\sigma}_{ii} + \gamma \sigma_{ii,t-1} + \phi \sigma_{ii,t-1}^2]^{1/2} [(1 - \phi - \gamma)\bar{\sigma}_{jj} + \gamma \sigma_{jj,t-1} + \phi \sigma_{jj,t-1}^2]^{1/2}} \tag{2}$$

These values will be used to examine the degree of dynamic relationship between each asset: stock-bond, stock-gold, and stock-Bitcoin.

*Dynamic connectedness indices*

The dynamic connectedness indices are computed from generalized variance decomposition in the VAR model. Diebold and Yilmaz (2009) introduced the method to measure the connections and spillovers in financial markets from shares of each cross-variable error in the total variance forecast. The econometric methodology of Diebold and Yilmaz (2009; 2012) can be summarized as follows.

Consider the simple case of the standard  $p$ -lag  $N$ -variable stationary VAR model in Equation (3),

$$X_t = \Phi_1 X_{t-1} + \dots + \Phi_p X_{t-p} + B_c + \varepsilon_t, \tag{3}$$

where  $X_t = \{X_{1,t}, X_{2,t}, \dots, X_{N,t}\}$  is a matrix of endogenous variables,  $c$  is a matrix of deterministic term (e.g., intercept term),  $\varepsilon_t$  is a vector of disturbance terms i.e.,  $\varepsilon_t \sim (0, \Sigma)$ , and  $\Sigma$  is a variance matrix of error terms that are assumed to have contemporaneous correlation with each other but are independent distributed over time.

After transformation of the VAR into the moving average representation, the variance decompositions (VDs) can be computed. The VDs ( $\theta_{ij}(h)$ ) represent the contribution of a one-standard-deviation shock of  $X_j$  to the variance of the  $h$ -step ahead forecast error of  $X_i$ .

Diebold and Yilmaz (2009, 2012) proposed the total spillover index by computing the contribution of spillovers across  $N$  variables to the total forecast error variances. Moreover, it is also suggested that the pairwise spillover indices can be used to measure the degree of connectedness between the pair of assets  $i$  and  $j$ . In this paper, we focus on the pairwise spillover indices between stocks and each of the potential safe haven assets, namely, government bonds, gold, and Bitcoin.

*Testing the Properties of Hedges and Safe Havens*

The specifications of a hedge and safe haven in this study follow those proposed by Baur and McDermott (2010) to distinguish the two terms from each other. Specifically, a hedge is referred to as an asset that is uncorrelated or negatively correlated with another, whereas a safe haven refers to an asset either uncorrelated or negatively correlated with another during crisis times only.

Instead of denoting the specific crisis periods, the objective measures for periods of extreme negative market returns are created. Dummy variables are constructed to account for asymmetries between extreme positive and negative shocks to the stock market. Hence, to represent extreme negative shocks,  $D(r_{\text{stock}} q_5)$ ,  $D(r_{\text{stock}} q_{2.5})$ , and  $D(r_{\text{stock}} q_1)$  are defined as dummy variables with a value of one when the stock returns drop to more than the threshold given by the 5 percent, 2.5 percent, and 1 percent quantiles of return distributions, respectively. To examine whether the candidate assets can be used as a safe haven against stock investment, the standard methodology for testing the safe haven property in previous studies is followed (e.g., Baur & Lucey, 2010; Bouri et al., 2017). Specifically, dummy variable regressions with different types of dependent variables are explained as follows.

Firstly, the asset returns ( $r_{i,t}$ ) are regressed according to the stock market returns under different conditions. The regressions are written as follows.

$$r_{i,t} = \beta_{0,i} + \beta_{1,i} r_{\text{stock},t} + \beta_{2,i} D(r_{\text{stock}} q_5) + \beta_{3,i} D(r_{\text{stock}} q_{2.5}) + \beta_{4,i} D(r_{\text{stock}} q_1) + \beta_{5,i} r_{i,t-1} + e_{i,t}, \tag{4}$$

$$\ln(\sigma_{i,t}^2) = \alpha_{0,i} + \alpha_{1,i} \frac{|e_{i,t-1}| + \gamma_{1,i} e_{i,t-1}}{\sigma_{i,t-1}} + \alpha_{2,i} \ln(\sigma_{i,t-1}^2), \tag{5}$$

where subscript  $i$  denotes three candidate assets, namely government bonds, gold, and Bitcoin. Equation (5) is estimated to capture the ARCH effect in dependent variable of Equation (4).

The parameters of dummy variables  $\beta_{2,i}$ ,  $\beta_{3,i}$ , and  $\beta_{4,i}$  measure the relationship during a turbulent period. If these parameters ( $\beta_{2,i}$ ,  $\beta_{3,i}$ , and  $\beta_{4,i}$ ) are non-positive (zero or negative value), the candidate asset acts as a weak safe haven for the Thai stock market. If these parameters are negative and significantly different from zero, the candidate asset acts as a strong safe haven for the Thai stock market.

Secondly, following the DCC-GARCH estimation, the dynamic conditional correlation between each of the candidate assets and stock market ( $\rho_{ij,t}$ ) are extracted from Equation (2) into separate models. Again, in Equation (6), the  $\rho_{ij,t}$  is regressed on dummy variables of extreme stock returns. The lagged dependent variable is included to control the autocorrelation in regression as follows:

$$\rho_{ij,t} = \gamma_{0,i} + \gamma_{1,i}D(r_{\text{stock}Q_5}) + \gamma_{2,i}D(r_{\text{stock}Q_{2,5}}) + \gamma_{3,i}D(r_{\text{stock}Q_1}) + \gamma_{4,i}\rho_{ij,t-1} + \epsilon_{i,t}, \tag{6}$$

where  $j$  is stock while  $i$  is Bitcoin, gold, and bond, respectively.

Lastly, the pairwise spillover indices are applied in the direction of the stock to each asset  $i_{S_{i,t}}$  as dependent variables in Equation (7). The independent variables are the dummy variables for the period of crisis. The lagged dependent variable is included to control the autocorrelation in regression.

$$S_{i,t} = \delta_{0,i} + \delta_{1,i}D(r_{\text{stock}Q_5}) + \delta_{2,i}D(r_{\text{stock}Q_{2,5}}) + \delta_{3,i}D(r_{\text{stock}Q_1}) + \delta_{4,i}S_{i,t-1} + \epsilon_{i,t}. \tag{7}$$

The interpretations of estimated parameters from Equation (6) ( $\gamma_{0,i}$ ,  $\gamma_{1,i}$ ,  $\gamma_{2,i}$ ,  $\gamma_{3,i}$ ) and Equation (7) ( $\delta_{0,i}$ ,  $\delta_{1,i}$ ,  $\delta_{2,i}$ ,  $\delta_{3,i}$ ) are similar to that of Equation (4).

### Data Collection

The representative indicators for each market were selected and data samples retrieved from April 30, 2013, to February 17, 2021. The earlier dates of the sample period were selected according to Wang et al. (2019b), who found that the Bitcoin trading volume prior to 2013 was too low. The SET50 index covers large market

capitalization and has good liquidity; thus, it effectively represents the overall Thai equity market. Local quoted buying prices released by the Gold Traders Association are representative of the gold market in this study. Since the majority of the Thai bond market consists of government bonds, the total return index of Thai government bonds is therefore selected in this paper to represent the bond market. The bond data was retrieved from the Thai Bond Market Association and the equity data collected from the Stock Exchange of Thailand.

Thailand originally banned cryptocurrencies in 2016 before changing its stance in 2019. Even though the number of licensed cryptocurrency service providers has grown recently in Thailand, the availability of price data on Bitcoin quoted in Thai baht remains limited. For example, Bitkub, the largest platform in Thailand, has displayed the continuous price data on Bitcoin in Thai baht since May 2018. Therefore, this paper employs data on Bitcoin denominated in USD, collected from the CoinMarketCap website, and then converted into Thai baht using the foreign exchange rate applied by the Bank of Thailand.

To avoid the potential day of the week effect, Wednesday-to-Wednesday weekly returns are calculated through the formula of  $\ln(P_t/P_{t-1})$ . In the case of a Wednesday not being an active trading day, the closing values are used from the subsequent day with valid prices from the sequence of the nearest days. The fact that the data is analyzed in local currencies implies that the study focuses on Thai domestic investors.

## Results and Discussion

### Time Series Plots and Descriptive Analysis

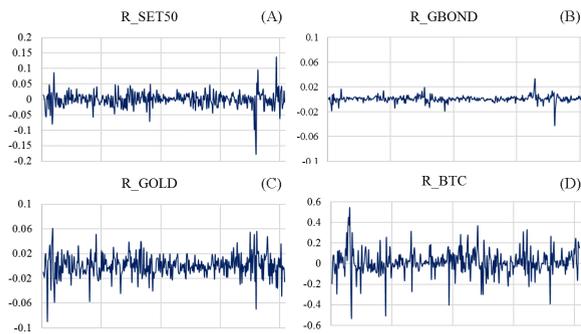
The data on the four assets: Bitcoin, gold, equities, and bonds span the period from April 30, 2013, to February 17, 2021. Each asset is subject to 408 weekly observations. As previously mentioned, this paper focuses on returns, defined as  $R_{i,t} = \ln(P_t/P_{t-1}) \times 100$ . Plots of each asset return and descriptive statistics are presented in Figure 1 and Table 2, respectively.

**Table 1** Candidate asset indicators

Assets	Indicator	Variable	Source
Bitcoin market	Daily closing price	BTC	CoinMarketCap website
Gold market	Daily quoted buying price	GOLD	Gold Traders Association
Equity market	Daily closing price	SET50	Stock Exchange of Thailand
Bond market	Daily closing price of government bond total return index	GBOND	Thai Bond Market

As can be observed from Figure 1 and Table 2, Bitcoin has the highest mean and variance of all the assets. All asset returns reject the normally distributed assumption with a left-skewed distribution.

The Q statistics (Q stat) for returns show that serial autocorrelation exists in government bonds and Bitcoin, while those for squared returns (Q<sup>2</sup> stat) show the existence of conditional heteroscedasticity in all assets, suggesting that each asset return is subject to volatility clustering (also revealed in Figure 1) and needs to be estimated by a GARCH-type model. Moreover, the ADF statistics show that none of the asset returns contain unit roots, indicating that they are suitable for regression modeling.



**Figure 1** (A) Weekly returns of stocks (the SET50 index: R\_SET50), (B) government bonds (the government bond total return index: R\_GBOND), (C) gold (local quoted buying price: R\_GOLD), and (D) Bitcoin (R\_BTC). The sample period spans from April 30, 2013, to February 17, 2021

**Table 2** Descriptive statistics

Weekly returns	SET50	GBOND	GOLD	BTC
Mean	-0.0003	0.0009	0.0005	0.0146
Max	0.1378	0.0327	0.0593	0.5409
Min	-0.1717	-0.0419	-0.0895	-0.5124
1% quantile	-0.0742	-0.0158	-0.0522	-0.3369
2.5% quantile	-0.0507	-0.0088	-0.0354	-0.2395
5% quantile	-0.0357	-0.0057	-0.0268	-0.1709
95% quantile	0.0341	0.0078	0.0266	0.2086
97.5% quantile	0.0438	0.0109	0.0365	0.2802
99% quantile	0.0487	0.0155	0.0503	0.3441
Variance	0.0006	0.0000	0.0003	0.0138
Skewness	-0.7630	-0.8073	-0.3351	-0.1232
Kurtosis	12.6901	18.9606	5.8040	6.7430
Jarque-Bera	1631.85***	4364.17***	140.95***	238.61***
Q stat	3.197	25.784***	1.341	9.088**
Q <sup>2</sup> stat	33.578***	29.512***	7.673**	41.111***
ADF	-18.539***	-16.2826***	-19.536***	-17.6837***
Multivariate Conditional Heteroscedasticity Test	60.814***			

Note: \*\*\*, \*\*, and \* denote statistical significance at the 1 percent, 5 percent, and 10 percent, respectively. Q stat (Q<sup>2</sup> stat) are Ljung-Box Q Statistics of returns (squared returns), up to a 2nd-order autocorrelation (conditional heteroskedasticity), respectively.

As can be seen in Table 3, gold has a significant and negative correlation with stock, implying that it may be used as a hedge against stock. In addition, there are significant and positive correlations between gold and bonds and between Bitcoin and stock. These less than perfect positive correlations indicate that gold may be used as a diversifier for bonds and Bitcoin for stock. Notably, the correlation values between Bitcoin and bonds and between Bitcoin and gold are not statistically different from zero, meaning that Bitcoin has no correlation and can be used as a hedge.

*Dynamic Conditional Correlation between Asset Classes*

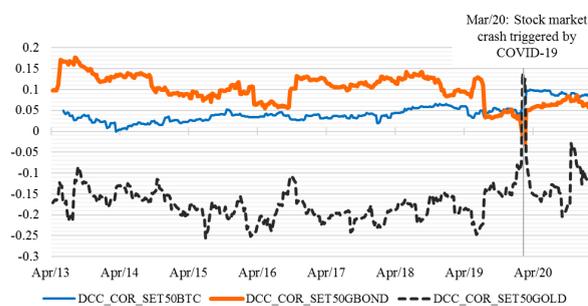
The conditional correlation between stock and other assets is further investigated in this study. According to Figure 2, the conditional correlation between stock and bonds has the largest value, meaning that stock is more closely related to bonds than to other assets. Moreover, on average, there is a negative conditional correlation between stock and gold, implying that gold can be used as a hedge, while the conditional correlation between stock and Bitcoin is positive and very close to zero, meaning Bitcoin possibly acts as a hedge and diversifier.

**Table 3** Pearson correlation coefficient matrix

Assets	SET50	GBOND	GOLD	BTC
SET50	1			
GBOND	0.1400***	1		
GOLD	-0.1187**	0.2657***	1	
BTC	0.1137**	-0.0148	0.0526	1

Note: \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5%, and 10%, respectively.

Since the conditional correlation between stock and gold exhibits the largest range, variations in the dynamic conditional correlation between stock and gold have the largest interval, as can be observed in Figure 2. A similar conclusion can be drawn when comparing the results with the correlation coefficient matrix in Table 3, namely, that gold negatively correlates with stock while Bitcoin exhibits almost no correlation.



**Figure 2** Dynamic conditional correlation estimated from DCC-GARCH (1, 1) models

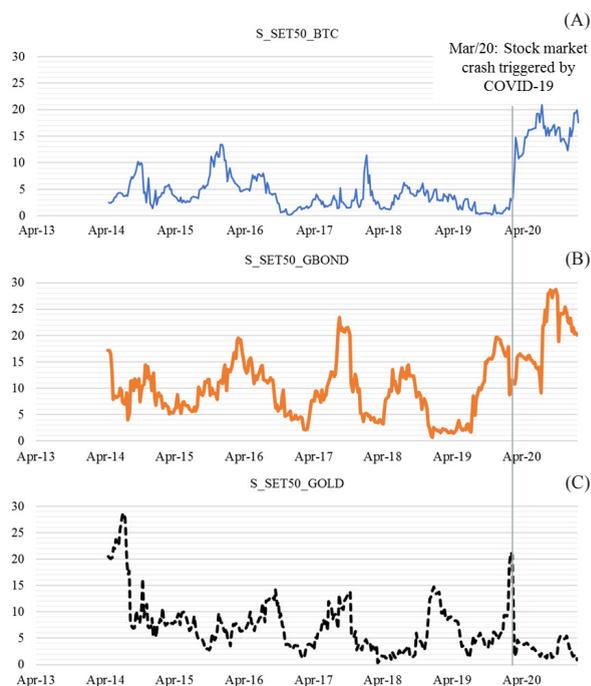
Interestingly, the Thai stock market crash triggered by COVID-19 in March 2020 identified the conditional correlation between stock and gold temporary surges, while the conditional correlation between stock and bonds fell dramatically. Moreover, stock and Bitcoin can be observed to move closer after March 2020. In particular, the conditional correlation doubles in absolute value.

*Returns Spillover between Asset Classes*

In addition to the co-movement between asset classes, the Diebold and Yilmaz (2009, 2012) spillover index is applied to show how financial shocks are transmitted across asset classes, with the results summarized in Table 4. Despite Bitcoin growing in popularity, its influence in terms of shock spillover to other asset classes is still relatively small when compared to others. For instance, government bonds display the highest shock contribution both to and from others. This may

be due to the fact that government bond yields reflect macroeconomic fundamentals and monetary policy expectations. For stock, bonds provide the highest shock contribution, followed by gold and Bitcoin, respectively.

Figure 3 plots the spillover index from stock to other assets. Government bonds received the largest spillover from stock compared to the others. One possible explanation is that stock and bonds may share the same source of fundamental risk, so both markets are closely connected. Gold and Bitcoin are less connected with stock since the levels of spillover are relatively low compared to government bonds. However, after the first wave of the COVID-19 pandemic in Thailand, Bitcoin and stock became more connected, as did government bonds and stock, indicating that Bitcoin may not act as a safe haven. Despite the spike in connectedness between



**Figure 3** Spillover indices from stock to other assets

**Table 4** Total spillover indices

Assets	SET50	GBOND	GOLD	BTC	From others
SET50	91.3	5.1	2.3	1.3	8.7
GBOND	7.9	85.1	6.5	0.5	14.9
GOLD	1.5	7.7	90.2	0.7	9.8
BTC	1.5	0.9	1.1	96.5	3.5
Contribution to others	10.9	13.6	10.0	2.5	36.9
Contribution including own	102.2	98.7	100.1	99	9.20%

Note: Spillover indices are estimated followed Diebold and Yilmaz’s (2009; 2012) methodology.

gold and stock in January 2020, they were found to be less connected since the spillover index bounced back to the prior level. The results of this study indicate that gold is an ideal asset for portfolio diversification. To formally reconcile the safe haven property of gold and Bitcoin, dummy variable regressions are examined in the next section.

**Dummy Variable Regression**

In this section, the dummy variable regression proposed by Baur and McDermott (2010) is used to assess the possibility of gold and Bitcoin as safe havens. Three dummy variables are denoted to capture extreme negative movements at 1 percent, 2.5 percent, and 5 percent quantiles of the stock return distribution.

As reported in Table 5, Bitcoin is considered to be a weak hedge and gold a strong hedge for stock due to these assets exhibiting no response ( $\beta_{1, \text{Bitcoin}} = 0$ ) and

a negative response ( $\beta_{1, \text{gold}} < 0$ ) to changes in the stock market during tranquil periods, respectively. Bonds are not a hedge for stock since they respond positively ( $\beta_{1, \text{bond}} > 0$ ) to stock market changes during normal periods. Moreover, to align with the safe haven property, the candidate assets must respond negatively to extreme negative movements in the stock market. The findings of this study reveal that only gold acts as a safe haven for stock during a very extreme market downfall (i.e., 1% quantile) ( $\beta_{4, \text{gold}} < 0$ ). However, when considering it at the 2.5 percent and 5 percent quantiles, gold is a hedge for stock. The Wald test statistics (p-value) are 0.8385 (0.3604) and 1.5970 (0.2071) for the testing of  $\beta_{4, \text{gold}} + \beta_{3, \text{gold}} = 0$  and  $\beta_{4, \text{gold}} + \beta_{3, \text{gold}} + \beta_{2, \text{gold}} = 0$ , respectively.

The regression results for dynamic conditional correlations in different stock market movements are summarized in Table 6. During normal periods, Bitcoin and bonds act as weak hedges for stock, and gold a strong

**Table 5** Dummy variable regression

Estimated parameters	Bitcoin	Gold	Bond
$r_{i,t} = \beta_{0,i} + \beta_{1,i} r_{\text{stock},t} + \beta_{2,i} D(r_{\text{stock}q_5}) + \beta_{3,i} D(r_{\text{stock}q_{2.5}}) + \beta_{4,i} D(r_{\text{stock}q_1}) + \beta_{5,i} r_{i,t-1} + \epsilon_{i,t}$			
$\ln(\sigma_{i,t}^2) = \alpha_{0,i} + \alpha_{1,i} \frac{ \epsilon_{i,t-1}  + \gamma_{1,i} \epsilon_{i,t-1}}{\sigma_{i,t-1}} + \alpha_{2,i} \ln(\sigma_{i,t-1}^2)$			
Intercept ( $\beta_0$ )	0.0086** (0.0042)	0.0010 (0.0007)	0.0009*** (0.0002)
Hedge ( $\beta_1$ )	0.0994 (0.1672)	-0.0914*** (0.0307)	0.0213*** (0.0064)
Safe-haven 5% ( $\beta_2$ )	0.2907 (1.0095)	-0.2643 (0.4292)	-0.0642 (0.0511)
Safe-haven 2.5% ( $\beta_3$ )	3.1717 (2.6803)	1.0221** (0.5141)	-0.0013 (0.1213)
Safe-haven 1% ( $\beta_4$ )	-2.2739 (2.5296)	-0.6158** (0.3004)	-0.0491 (0.1245)
Lagged dependent variable ( $\beta_5$ )	0.0781 (0.0507)	0.0093 (0.0434)	0.0993** (0.0467)

Note: The standard errors are reported in the parenthesis. \*\*\*, \*\*, and \* denote statistical significance at 1 percent, 5 percent, and 10 percent, respectively.

**Table 6** Dummy variable regression based on the dynamic conditional correlation

Estimated parameters	Stock - Bitcoin	Stock - Gold	Stock - Bond
$\rho_{ij,t} = \gamma_{0,i} + \gamma_{1,i} D(r_{\text{stock}q_5}) + \gamma_{2,i} D(r_{\text{stock}q_{2.5}}) + \gamma_{3,i} D(r_{\text{stock}q_1}) + \gamma_{4,i} \rho_{ij,t-1} + \epsilon_{i,t}$ , where $\rho_{i,t}$ is the dynamic conditional correlation between stock and other assets ( $i$ ).			
Hedge ( $\gamma_0$ )	0.0006 (0.0004)	-0.0146*** (0.0045)	0.0014 (0.0013)
Safe-haven 5% ( $\gamma_1$ )	-0.0006 (0.0013)	-0.0049 (0.0065)	-0.0002 (0.0025)
Safe-haven 2.5% ( $\gamma_2$ )	0.0006 (0.0023)	0.0065 (0.0104)	0.0059 (0.0041)
Safe-haven 1% ( $\gamma_3$ )	0.0073*** (0.0028)	-0.0438*** (0.0135)	0.0190*** (0.0052)
Lagged dependent variable t-1 ( $\gamma_4$ )	0.9865*** (0.0090)	1.0061*** (0.0366)	0.9821*** (0.0119)
Lagged dependent variable t-3 ( $\gamma_5$ )		-0.0954*** (0.0358)	

Note: The standard errors are reported in the parenthesis. \*\*\*, \*\*, and \* denote statistical significance at 1 percent, 5 percent, and 10 percent, respectively.

hedge. Interestingly, the results also confirm that gold has a safe haven property since the correlations between stock and gold are generally negative, even more so ( $c_{3,\text{gold}}$ ) during times of crisis. Neither Bitcoin nor bonds provide hedging benefits to stock but still enhance a portfolio's risk and return tradeoff through diversification during turbulent periods.

Finally, the degree of shock spillover from the stock market to other markets is investigated in this study by monitoring the spillover or connectedness index. As presented in Table 7, on average, stock and bond markets are mostly connected, whereas stock and Bitcoin markets exhibit the least connection. The results of this study show no evidence of statistical change in the connectedness level between stock-bond markets and stock-Bitcoin markets during periods of crisis. Nevertheless, during market turmoil, stock and gold markets are less connected since the spillover index declines significantly ( $\delta_{4,\text{gold}}$ ).

## Conclusion and Recommendation

This paper examines the risk management role of Bitcoin, gold, and government bonds for stock investors in Thailand. The results from dummy variable regression reveal that gold is a strong hedge and safe haven for stocks, while Bitcoin is considered to be a weak hedge and bonds diversifiers for stock.

Based on the DCC-GARCH model, the results reveal that the stock-gold correlations are generally negative, becoming more so during stock market downturns. Hence, gold behaves as a safe haven for stock. Meanwhile, despite displaying positive correlations in turbulent periods, stock-Bitcoin and stock-bond correlations are not significantly different from zero during normal periods. Therefore, Bitcoin and bonds provide hedging and diversification benefits to Thai equity investors.

When considering the linkage among asset classes through the spillover indices, the following conclusions can be drawn: (1) despite the growing attention toward Bitcoin, its influence in terms of shock spillover on other asset classes is still relatively small when compared to the others; (2) government bonds display the highest shock contribution both to and from the others. This may be because government bond yields typically reflect the monetary policy expectations and macroeconomic factors; and (3) stock and gold markets are less connected during market turbulence since spillover indices decline significantly. This striking result also confirms that gold acts as a safe haven for stock.

Based on the above conclusions, the following suggestions are presented for equity investors to achieve better asset allocation, particularly during downward movement in the Thai stock market. Consistent with traditional findings, investors could receive the highest diversification benefit from having a position in gold since it acts as a strong hedge and safe haven for stock in tranquil and turbulent periods, respectively. Bitcoin demonstrates the highest average return and is the least connected to the stock market. Moreover, correlations between Bitcoin and stock are generally close to zero, indicating that investors can gain diversification benefits by adding Bitcoin to their portfolios. Bitcoin is a useful hedging asset for stock in general; however, such appealing properties also contain considerable risks since Bitcoin exhibits the largest volatility. Contradictory to traditional flight-to-quality literature, the results of this study suggest that Thai government bonds do not provide a safe haven for stock since the stock-bond relationship is slightly positive and significant during times of crisis. Investors, especially those who are more risk averse, may introduce bonds into their portfolios to diversify risk during normal periods, even though the diversification benefit may be lower during market downturns.

**Table 7** Dummy variable regression based on the spillover index

Estimated parameters	Stock - Bitcoin	Stock - Gold	Stock - Bond
$S_{i,t} = \delta_{0,i} + \delta_{1,i}D(r_{\text{stock}q_5}) + \delta_{2,i}D(r_{\text{stock}q_{2.5}}) + \delta_{3,i}D(r_{\text{stock}q_1}) + \delta_{4,i}S_{i,t-1} + \varepsilon_{i,t}$ where $S_{i,t}$ is the spillover index from stock to other assets.			
Average spillover index ( $\delta_0$ )	0.1727* (0.0994)	0.4440*** (0.1601)	0.4983** (0.2037)
Extreme market at 5% quantile ( $\delta_1$ )	0.5301 (0.4218)	-0.3551 (0.5929)	0.0074 (0.6493)
Extreme market at 2.5% quantile ( $\delta_2$ )	0.0951 (0.8246)	0.6277 (1.1692)	-1.3039 (1.2683)
Extreme market at 1% quantile ( $\delta_3$ )	1.0977 (1.0085)	-3.0302** (1.4324)	2.4518 (1.5537)
Lagged dependent variable ( $\delta_4$ )	0.9700*** (0.0139)	0.9326*** (0.0185)	0.9545*** (0.0166)

Note: The standard errors are reported in the parenthesis. \*\*\*, \*\*, and \* denote statistical significance at 1 percent, 5 percent, and 10 percent, respectively.

One limitation of this study is that the Bitcoin data are in local currency because such have only been available since mid-2018. Specifically, Bitcoin data have been retrieved from the international exchange quoted in US dollars and then translated into Thai baht using the exchange rate (baht per US dollar). Recently, the importance of local exchange platforms has increased in terms of investors and trading volume. Hence, the properties of Bitcoin could be reinvestigated in the future when sufficient data are available from local exchange platforms. In addition, asset correlations have clearly changed during the COVID-19 pandemic: a positive correlation between stock and gold was found in the early part of 2020, contradicting the negative correlations on average over the study period. Therefore, a comprehensive study on the safe haven behavior of gold and other candidate assets during the COVID-19 pandemic should be investigated specifically in the future.

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### Conflict of Interest

The authors declare that there is no conflict of interest.

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