

The Effectiveness of Cryptocurrency as a Hedging Tool for Capital Market Indices in Indonesia

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ABSTRACT

This study investigates the effectiveness of cryptocurrency, specifically Bitcoin, as a hedging tool against the Indonesian stock market index (LQ-45) during periods of economic uncertainty, particularly those influenced by the COVID-19 pandemic. Utilizing a dataset spanning from January 2015 to December 2024, the research employs K-Means clustering to classify periods into normal and crisis phases based on macroeconomic indicators. The DCC-GARCH model is then applied to assess the dynamic correlations between Bitcoin, the S&P 500, and gold with the LQ-45 index. Findings reveal that Bitcoin serves as both a hedging and safe-haven asset during crises, with an effectiveness of 36.61% in protecting portfolios. Conversely, the S&P 500 and gold exhibit limited effectiveness as hedging tools and do not function as safe havens during market turmoil. This study contributes to the understanding of alternative investment strategies for managing risk within emerging markets.

KEYWORDS Cryptocurrency; Bitcoin; Hedging; Safe-Haven



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INTRODUCTION

Indonesia's economy was tested again in early 2020, when the COVID-19 pandemic began to spread to various countries (Hasan, 2020; Malahayati et al., 2021; Tambunan, 2021). Although it was not caused by crises related to financial markets – unlike the Asian Financial Crisis in 1998 or the Mortgage Crisis in 2008 – the protracted health crisis also had a negative impact on the economies and finances of countries affected by the pandemic. BPS recorded negative economic growth of 2.07% compared to the previous year, and the unemployment rate (*Tingkat Pengangguran Terbuka*) increased significantly by 2.67 million people, rising from 5.23% to 7.07%. The deteriorating macroeconomic parameters certainly affected the performance of the capital markets of countries affected by the crisis, including Indonesia. As Baker et al. (2020) noted, significant economic shocks due to the COVID-19 pandemic triggered an increase in market volatility and had great potential to reduce overall stock prices.

On one hand, the COVID-19 pandemic, which represented a crisis period, brought economic uncertainty. However, economic uncertainty does not always start with a crisis; it can occur at any time, both before and after a crisis period when things appear stable. As expressed in the Financial Instability Hypothesis by Minsky (1986), the capitalist

financial system inherently experiences cycles of stability and instability, in which periods of economic expansion are often followed by increased risk-taking that ultimately triggers uncertainty and potential crises. Therefore, our role in observing the early warning signs of stability cycles and economic uncertainty is important, especially to prepare for crisis phases. According to Bloom (2009), economic uncertainty can essentially affect investment and consumption decisions, even without an actual crisis.

The decline in capital market performance and the pressure of uncertainty due to the pandemic have made investors re-diversify their portfolios to minimize potential risks (Elton et al., 2009). Asset classes that are suitable for diversifying investment portfolios are those categorized as hedging or safe-haven assets. Baur & Lucey (2010) define an asset as a weak hedge if it does not have a negative correlation with other assets on average under normal market conditions, and as a strong hedge if it has a negative correlation with other assets. Meanwhile, safe-haven instruments have similar correlation provisions to hedging assets but apply when the market is in crisis conditions (Gurdgiev & Petrovskiy, 2024).

Table 1. Criteria for Assets as Hedging and Safe-haven Instruments

Category/Instruments	<i>Hedging</i>	<i>Safe-haven</i>
Correlation	(+) Weak or (-) Negative with the market	(+) Weak or (-) Negative with the market
Market Conditions	Usual	Crisis

Source: Baur and Lucey (2010)

One of the asset classes that will be the main focus as a hedging and safe-haven instrument is the first cryptocurrency, namely Bitcoin. Initially introduced in Nakamoto's (2008) whitepaper, Bitcoin has a unique function because it is a peer-to-peer electronic money system without the intervention of banks or governments. Bitcoin itself has, in its development until today, become legal tender in 2 countries: El Salvador and the Central African Republic. As for most countries such as the United States, Japan, and Indonesia in particular, cryptocurrencies have been regulated as commodity assets.

Based on *coinmarketcap.com* data, it is recorded that by early 2025, Bitcoin reached an all-time high of around US\$109,000. The significant growth in Bitcoin's valuation is inseparable from the adoption by various corporations and countries of the technology that serves as the support system for cryptocurrency, namely Blockchain technology—in addition to public trust and institutional investors in Bitcoin's value itself (Corporate Finance Institute, 2021). The innovation of Blockchain technology in various cryptocurrency ecosystems, such as Smart Contracts and Decentralized Apps (*DApps*) (Buterin, 2014), has encouraged cryptocurrency adoption to be more widely accepted. Although specific to this study, the focus of the cryptocurrency studied is only on Bitcoin because of its originality as the main driver of the crypto market and its provision of the most significant portion of the Internal Rate of Return since it was first launched: 196.84% from the initial price of US\$0.003 per *BTC* in March 2010. Other instruments were also analyzed, namely the S&P 500 Index as a hedge instrument whose correlation

is generally non-linear with Indonesian market conditions. Gold, as a commodity that has long been known as a safe-haven instrument, will also be tested in this study.

This research period spans 10 years from January 2015 to December 2024. Researchers attempt to take a longer time span to examine economic uncertainty in years that are not only based on the COVID-19 period. Instead of only classifying the COVID-19 pandemic period as a crisis or period of uncertainty, researchers want to further test the possibility of anomalies in other macro indicators besides GDP growth. Time clustering testing for normal and uncertain conditions will be based on a classification model using the K-Means method. The results of the time classification over normal periods will serve as a reference for Bitcoin, S&P 500, and gold instruments to function as hedging tools or not. Meanwhile, the results of the time classification of crisis periods will classify these assets in effectiveness tests as safe havens.

The test method used to determine whether an instrument can function as a hedging or safe-haven tool is DCC-GARCH. Gujarati and Porter (2009) explain that the GARCH model is needed to model volatility that changes over time, as well as to address heteroscedasticity effects in the time series of financial data. Another study by Engle (2002) introduced DCC-GARCH as a solution to model volatility and dynamic correlations between financial assets. Specifically, this study will examine which of the three instruments used as hedging variables—Bitcoin, S&P 500, and gold—has the most significant impact on the Stock Exchange Index in Indonesia, represented by *LQ-45*. The tests will be conducted with the DCC-GARCH Bivariate model, so each test will be performed in pairs to assess the highest effectiveness (*LQ-45*–Bitcoin, *LQ-45*–S&P 500, & *LQ-45*–Gold).

METHOD

The population in this study consists of daily data on *LQ-45*, Bitcoin, S&P 500, and gold from the range of 2015–2024. However, before going into detail in the population analysis, as previously explained, this study will cluster the research period into 2 periods: the normal period and the uncertainty period. For this reason, clustering is carried out with the K-Means method. The assumption is that using K-Means acknowledges that in a span of 10 years, there is a possibility that periods outside the COVID-19 pandemic could be periods of economic uncertainty. Therefore, to cluster the periods, more than one macro variable is used: GDP growth, inflation, *USD/IDR* exchange rate, and the Business Confidence Index. Goedegebuure (2021) in his manuscript explains that K-Means clustering is needed when it is assumed that a cluster is not known to us as a result of the grouping. It is important to find out whether a period that is considered "normal" based on GDP growth can actually be an anomaly when referring to other macro variables. The following are the operationalization variables for clustering:

$$\arg \min_c = \sum_{i=1}^k \sum_{x \in C_i} \|x - \mu_i\|^2$$

Where

K: number of clusters (two clusters, normal period and uncertainty)

C_i : Datasets in Kluster I

μ_i : centroid (average vector) of the cluster C_i

x : data point, where $PDB_t, Inflasi_t, Nilai Tukar IDR/USD_t, Indeks Kepercayaan Bisnis_t$

$\|x - \mu_i\|^2$: the square Euclidean distance between the data point and its centroid

By implementing these four variables, the observation of economic data (data from quarter 1 2015 – quarter 4 2024) will be mapped in a four-dimensional space. K-Means will try to group the time period into 2 clusters based on the similarity of economic characteristics: whether the period is characterized by high growth, low inflation, stable exchange rates, and high CPI (indicating business confidence), or vice versa.

Once the period clustering has been obtained, conduct a bivariate GARCH DCC test where LQ-45 as the hedge value target will be tested with Bitcoin, S&P 500, and gold. For a normal period, if one of the three alternative assets functions as a hedge then it can be categorized as a hedging tool. Meanwhile, in the crisis period, these alternative assets will be classified as safe-havens. The following are the operational variables as well as the security

$$Q_t = (1 - a - b)\bar{Q} + az_{t-1}z_{t-1} + bQ_{t-1}$$

Where

Q_t : a dynamic covariance matrix of standard residuals that reflects the dynamics of the volatility relationship between two assets (LQ-45 – Bitcoin, LQ-45 – S&P 500, LQ-45 – Gold)

$\bar{Q}$: The average historical covariance matrix of the standard residual (z-score), calculated as the average of the during the observation period. $z_t z_t^T$

a, b : DCC parameter, with the condition $a+b < 1$

From the non-standard dynamic covariance matrix equation, convert the formula that is still covariance to a standard correlation matrix, with the equation: Q_t

$$R_t = \text{diag}(Q_t)^{-1/2} Q_t \text{diag}(Q_t)^{-1/2}$$

R_t : A standard residual dynamic correlation matrix at time t, obtained by normalizing $.Q_t$

$\text{diag}(Q_t)^{-1/2}$: A diagonal vector of , which represents the individual variance of each asset. $.Q_t$

This operation ensures that the value of the diagonal = 1 and the other elements are the dynamic correlation between the assets (for example, the correlation of LQ-45 with Bitcoin, S&P 500, or Gold at time t). R_t

After obtaining the correlation of the value of the 3 equations (LQ-45 – Bitcoin, LQ-45 – S&P 500, LQ-45 – Gold), calculate the effectiveness of hedging with the following equation:

$$HE = 1 - \frac{Var(r_p)}{Var(r_u)}$$

Where

r_p : portfolio return without hedging, i.e. only returns from LQ-45

r_u : return portfolio dengan hedging, $= r_{uLQ-45} - h_t \times r_{Bitcoin/S\&P\ 500/Gold}$

The data collection method is carried out by observation using secondary data, where the research span will take 10 years, to see if there are anomalies in the Indonesian economy other than the Covid-19 period. In addition, a long time span is important to enlarge the sample size when performing the clustering stage. In connection with the macroeconomic data that will normally be released on a quarterly basis, the number of clustered samples amounts to 40 samples (from Q1 2015 – Q4 2024). Malhotra (2020) stated the need for a minimum sample size so that data does not occur *underfit*. In this case the minimum acceptable sample size is 30 samples. (Scott, 2007)

Once the clustering calculation is complete, the testing of alternative assets as a hedge will take a range of daily periods. The samples collected are estimated to reach more than 2300 samples, and it is expected that the use of daily data will be able to capture the effects of changes in the volatility correlation between assets. The search for macroeconomic data will be searched through Trading Economics Indonesia, while for the LQ-45, Bitcoin, S&P 500, and gold price asset variables will be searched through Investing.com and calculated through the daily return of each asset. Finally, the statistical data analysis will use Python version 3.11

RESULTS AND DISCUSSION

The results of clustering with K-Means provide the following result simulation:

Table 2. The results of clustering with K-Means

	Normal period	Crisis Period
Total Quarters	35	5
Time Range	Q1 2015 – Q4 2019 & Q2 2021 – Q4 2024	Q1 2020 – Q1 2021

Based on the classification of cluster with K-Means, it was found that although in the 1st quarter of 2020 GDP growth remained positive, there was a decline compared to the average economic growth in general, which was 2.97%. So that the period along with 4 other quarters in which negative GDP growth is classified as a period of economic uncertainty. In addition, there is also a deteriorating Business Confidence Index figure in the right period when GDP growth has decreased. Meanwhile, inflation data, although smaller during periods of uncertainty due to weak purchasing power, does not provide additional predictors to classify new periods of uncertainty outside the pandemic. Then the exchange rate, which is also slightly higher than the average during the period of uncertainty, also does not provide a new dimension for testing the K-Means cluster outside of the Covid-19 pandemic. The following is a comparison of the average scores between the four macroeconomic indicator data.

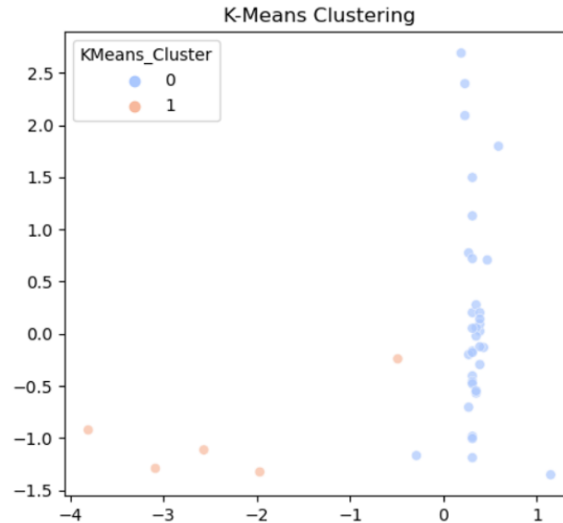


Figure 1. the four macroeconomic indicator data

Source: processed data, python

Table 3. Macroeconomic Variable Average Data

Variable Macroeconomics	Mean during periods of Uncertainty	Average (mean) during the Normal period
GDP growth	-0.0174	0.0508
Inflation	0.0188	0.0352
IDR/USD Exchange Rate	0.0128	0.0041
Business Trust Index	-0.604	1.0126

Based on the attached graph, there are 5 data points that are classified as anomaly, in this case it is a period of uncertainty (orange), while for blue data points it is a period of normal conditions.

After successfully determining the results of the cluster period, what is needed is then to conduct a fit test on the results of the K-Means classification above. According to Han, Kamber & Pei (2012) the results of the K-Means test require a representation of the Silhouette Score with the following conditions:

Table 4. the results of the K-Means test

Silhouette Score	Cluster Quality
0.71 – 1.00	Excellent
0.51 – 0.70	Good
0.26 – 0.50	Keep
0.00 – 0.25	Weak
< 0.00	Bad

In the test results, a Silhouette score of 0.604 was obtained, which indicates that the clusters are quite well separated, and also indicates that the number of clusters selected – as many as 2 – is appropriate. So it can be said that the clustering of normal periods and periods of economic uncertainty is valid to be used and can be continued for the DCC GARCH Bivariate test.

The results of the GARCH DCC correlation test are attached as shown in the following table:

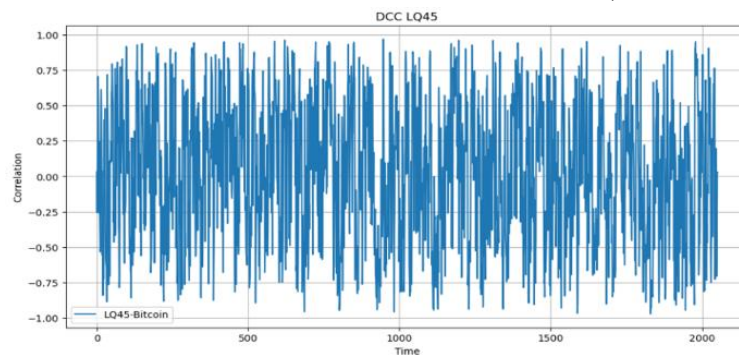
Table 5. The results of the GARCH DCC correlation test

Normal period	LQ-45	Bitcoin	S&P 500	Gold
LQ-45	1.0000			
Bitcoin	0.0290	1.0000		
S&P 500	0.1311	0.1764	1.0000	
Gold	0.0095	0.0593	-0.0054	1.0000

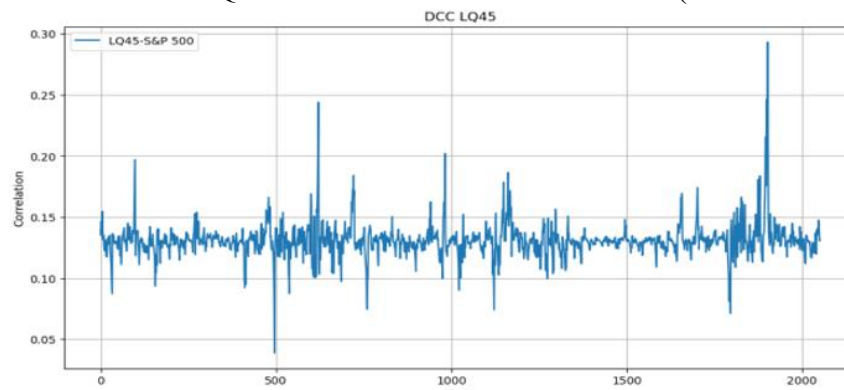
Source: processed data, python

As the data in the attached table shows, each of the LQ-45 Index's correlations with alternative assets is small. None of the alternative assets have a negative value against the others. As stated by Wijaya and Ulpah (2022), a small correlation usually shows a hedging indicator but is of a weaker value, as well as the results of the research of Mariana, Ekaputra, and Husodo (2021). However, in these studies, in-depth testing was not carried out on how effective the hedging of each alternative asset was. So in this study, although the correlation of the DCC GARCH bivariate tends to be weakly correlated, there is sufficient probability to conclude that the effectiveness of hedging is still quite sufficient, especially in normal periods (Q1 2015 – Q4 2019 & Q2 2021 – Q4 2024).

DCC GARCH LQ-45 & Bitcoin Correlation Chart (Normal Period)

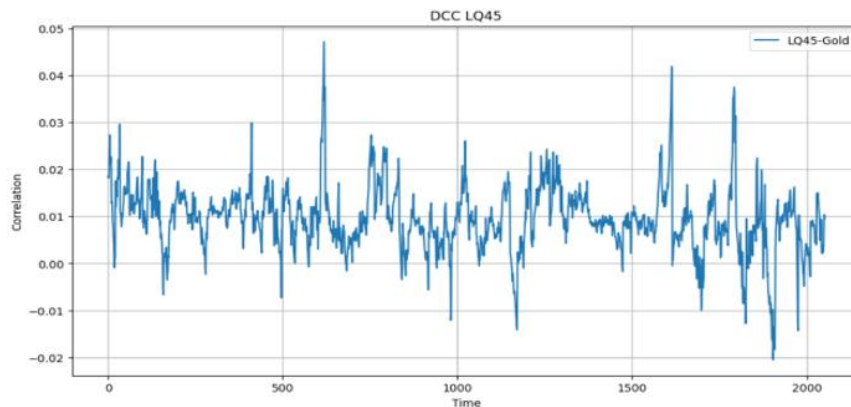


DCC GARCH LQ-45 & S&P 500 Correlation Chart (Normal Period)



DCC GARCH LQ-45 & Gold Correlation Chart (Normal Period)

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For the effectiveness of hedging attached is the following explanatory table:

Table 6. the effectiveness of hedging attached

Aset Alternative	The Value of Hedging Effectiveness
Bitcoin	15.84%
S&P 500	18.12%
Gold	0.45%

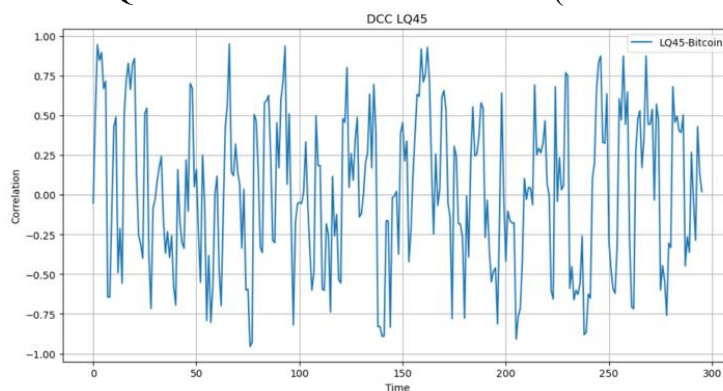
As attached, correlations with a small positive value still have a hedging impact, even though they are not the dominant hedging. Bitcoin simply functions as a hedge with an effectiveness of 15.84%. But on the other hand, gold, which usually has a considerable impact, is only 0.45% effective. Next, let's further dissect the bivariate GARCH DCC for alternative assets in the period of economic uncertainty that lasted for 5 quarters from Q1 2020 – Q1 2021.

The results of the DCC GARCH correlation test in the period of inefficiency are attached as shown in the following table:

Table 7. The results of the DCC GARCH correlation test

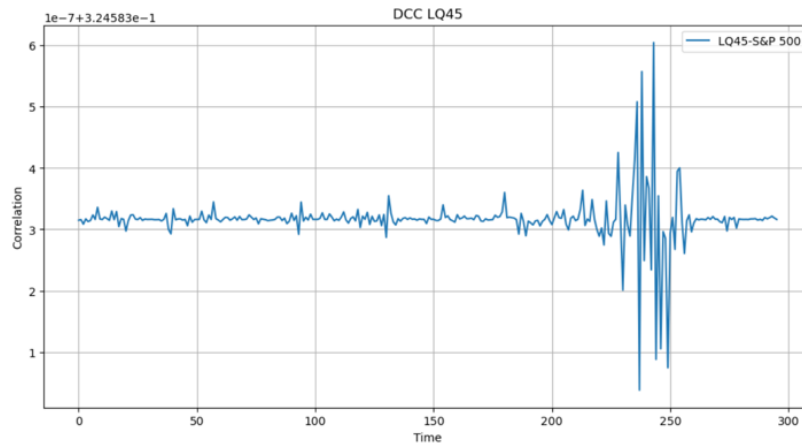
Normal period	LQ-45	Bitcoin	S&P 500	Gold
LQ-45	1.0000			
Bitcoin	0.0208	1.0000		
S&P 500	0.3246	0.3897	1.0000	
Gold	0.0473	0.2135	0.1288	1.0000

DCC GARCH LQ-45 & Bitcoin Correlation Chart (Period of Uncertainty)

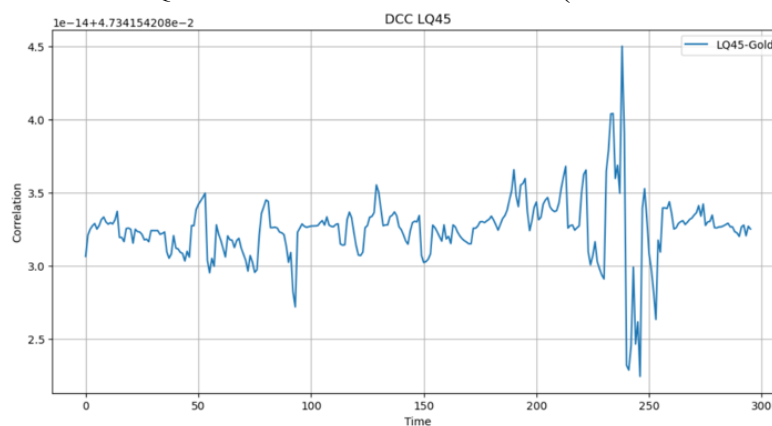


DCC GARCH LQ-45 & S&P 500 Correlation Chart (Period of Uncertainty)

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DCC GARCH LQ-45 & Gold Correlation Chart (Period of Uncertainty)



Interestingly for the correlation in periods of uncertainty, Bitcoin still provides a similar correlation of 0.208 (0.290 in normal periods) while there is a difference in the DCC correlation between the S&P 500 and gold, especially the S&P which this time has a correlation of more than 0.3. This incident may be caused because at the beginning of the pandemic, capital markets in various parts of the world tended to experience turmoil. As for the price of gold, although it remains slightly correlated, there is an increase to 0.0473 (previously 0.0095). This can certainly affect the effectiveness of hedging even if the correlation remains of weak value.

If we compare the effectiveness results, there are several changes compared to the normal period as shown in the table below:

Table 8. the effectiveness results

Aset Alternative	The Value of Hedging Effectiveness
Bitcoin	36.61%
S&P 500	-71.01%
Gold	-14.31%

Bitcoin's effectiveness during the crisis period is actually seen more significant at 36.61%. Opposite to the other 2 alternatives that are not effective as safe-havens. The adoption and awareness of the existence of an alternative asset called Bitcoin actually became a turning-point during the Covid-19 pandemic.

The results in the attached tables are in line with the research of Wijaya and Ulpah (2022) who stated that Bitcoin can act as a hedging and safe-haven at the same time, as

well as He, et al. (2024), although in his research Bitcoin functions more as a short-term hedge. So that the null hypothesis is rejected and Hypotheses 1a and 1b where bitcoin functions as a hedging and safe-haven are acceptable. For the S&P 500 as found by Natsir et al. (2019) and Mariana, Ekaputra, and Husodo (2021) can function as a hedge even in normal periods. In this study, the S&P 500 does not function as a safe-haven for the LQ-45 index due to the similarity in asset characteristics between the two. So H2a is appropriate where S&P can act as a hedging, although in the 2b hypothesis H0 is not rejected, so the alternative is not accepted. This can be due to the correlation between the S&P 500 and the LQ-45 which tends to be closer than during the normal period, so that safe-haven characteristics are not formed and the capital market both experience shock effects when hit by the initial period of Covid-19.

Finally, for gold, in this study only functions minimally as a hedging and does not have effectiveness as a safe-haven, as their function is in general. So for hypothesis 3a it is still acceptable to assume that gold is not a better hedging instrument than Bitcoin and the S&P 500 against the LQ-45. However, for hypothesis 3b, H0 is not rejected so that gold does not function as a safe-haven. This is different from the results of Baur and Lucey (2010) and Wijaya and Ulpah (2022) where gold in general can function both as a hedging and safe-haven. The analysis of K-Means clustering and the implementation of the GARCH Bivariate DCC can be the reason why the safe-haven nature of gold does not function as it should, - it can be due to different period ranges -. In the future, it is necessary to implement more comprehensive data on clustering factors that may be able to change the results of the research.

CONCLUSION

Based on the results of testing the role of Bitcoin, the S&P 500, and gold against the *LQ-45* index, it can be concluded that Bitcoin has a role as both a hedging instrument and a safe haven, so that it is able to protect investors' portfolios in both normal market conditions and times of uncertainty. Meanwhile, the S&P 500 and gold only function as hedging instruments, so their effectiveness is limited to normal market conditions and does not provide consistent protection in the event of a crisis or market turmoil. This conclusion is in line with the purpose of the study to evaluate the effectiveness of the three assets in risk management strategies for the Indonesian stock market.

REFERENCES

- Baur, D. G., & Lucey, B. M. (2010). Is Gold a Hedge or a Safe Haven? An Analysis of Stocks, Bonds and Gold. In *The Financial Review* (Vol. 45). <http://www.merriam-webster.com/>.
- Bloom, N. (2009). The Impact of Uncertainty Shocks. *Econometrica*, 77(3), 623–685.
- Buterin, Vitalik (2014). Ethereum: A next generation smart contract and decentralized application platform.
- Corporate Finance Institute. (2021). Understanding Cryptocurrency

- Gujarati, Damodar & Dawn C. Porter (2009). Basic Econometrics. McGraw Hill Education
- Gurdgiev, C., & Petrovskiy, A. (2024). Hedging and safe haven assets dynamics in developed and developing markets: Are different markets that much different? *International Review of Financial Analysis*, 92, 103059. <https://doi.org/10.1016/j.irfa.2023.103059>
- Goedegebuure, Robert (2021). K-Means Clustering. https://bookdown.org/robert_statmind/kmeans_ebook/
- Hasan, Z. (2020). The Impact Of Covid-19 On Islamic Banking In Indonesia During The Pandemic Era. *Journal of Entrepreneurship and Business*, 8(2), 19–32. <https://doi.org/10.17687/jeb.v8i2.850>
- Malahayati, M., Masui, T., & Anggraeni, L. (2021). An assessment of the short-term impact of COVID-19 on economics and the environment: A case study of Indonesia. *Economia*, 22(3), 291–313. <https://doi.org/10.1016/j.econ.2021.12.003>
- Malhotra, Naresh K. (2020). Marketing Research, An Applied Orientation. Pearson Education Limited.
- Mariana, C. D., Ekaputra, I. A., & Husodo, Z. A. (2021). Are Bitcoin and Ethereum safe havens for stocks during the COVID-19 pandemic? *Finance Research Letters*, 38.
- Nakamoto, Satoshi (2008). Bitcoin: A Peer-to-Peer Electronic Cash System
- Natsir, Khairina, Yusbardini, & Nurainun Bangun. Analisis Kausalitas antara IHSG, Indeks Dow Jones Industrial Average dan Nilai Tukar Rupiah/US\$. *Jurnal Muara Ilmu Ekonomi dan Bisnis* Vol. 3, No. 2, Oktober 2019 : hlm 229-239
- Scott R. Baker Nicholas Bloom Steven J. Davis Stephen J. Terry. Covid-induces economic uncertainty. Working Paper 26983 National Bureau of Economics Research. 1050 Massachusetts Avenue Cambridge, MA 02138 April 2020
- Tambunan, T. T. H. (2021). Covid-19 Pandemic and Severity of Economic Impacts: The Indonesian Case. *Global Economics Science*, 1–15. <https://doi.org/10.37256/ges.232021898>
- Wijaya, Carla A. and Ulpah, Maria (2022) "The Analysis of the Roles of Bitcoin, Ethereum, and Gold as Hedge and Safe-Haven Assets on the Indonesian Stock Market before and during the COVID-19 Pandemic," *The Indonesian Capital Market Review*: Vol. 14: No. 1, Article 4.