

Exploring the Relationship Between Cryptocurrencies and Sharia Stocks in Indonesia

Eksplorasi Hubungan Antara Mata Uang Kripto dan Saham Syariah di Indonesia

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ABSTRACT

This study aims to determine a correlation between cryptocurrency and the ISSI Index. This research uses a quantitative approach with secondary data sources and type of time series data. The data used is the daily return data of the ISSI Index and cryptocurrency in the period January 02, 2018 to December 30, 2022 obtained through TICMI and Bloomberg. The analysis technique in this study uses CCC-MGARCH and DCC-MGARCH which are processed using Oxmetrics Version 7.0 software. The results showed that cryptocurrency correlates with the ISSI Index but the strength of the correlation is still very low, which is below 10%. This research has implications for portfolio managers and investors in managing their portfolio assets to be well diversified. In addition, this research adds to empirical research in the field of capital markets, especially Islamic capital markets related to financial market integration.

Keywords: ISSI Index, Cryptocurrency, CCC-MGARCH, DCC-MGARCH

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ABSTRAK

Penelitian ini bertujuan untuk mengetahui korelasi antara cryptocurrency dan Indeks ISSI. Penelitian ini menggunakan pendekatan kuantitatif dengan sumber data sekunder dan jenis data time series. Data yang digunakan merupakan data return harian Indeks ISSI dan cryptocurrency pada periode 02 Januari 2018 hingga 30 Desember 2022 yang diperoleh melalui TICMI dan Bloomberg. Teknik analisis dalam penelitian ini menggunakan CCC-MGARCH dan DCC-MGARCH yang diolah menggunakan perangkat lunak Oxmetrics Versi 7.0. Hasil penelitian menunjukkan bahwa cryptocurrency berkorelasi dengan Indeks ISSI namun kekuatan korelasinya masih sangat rendah yakni dibawah 10%. Penelitian ini berimplikasi kepada manajer portofolio dan investor dalam mengelola aset portofolionya agar terdiversifikasi dengan baik. Selain itu, penelitian ini menambah penelitian empiris dibidang pasar modal khususnya pasar modal syariah terkait integrasi pasar keuangan.

Kata Kunci: Indeks ISSI, Cryptocurrency, CCC-MGARCH, DCC-MGARCH

I. INTRODUCTION

Cryptocurrency is currently attracting a lot of interest among the public as an option for investing and trading. The Commodity Futures Trading Supervisory Agency (Bappebti) recorded the number of registered crypto asset users at 18.25 million as of November 2023. Every month, the average user growth has reached 437.9 thousand users since February 2021 (Indonesian Ministry of Trade, 2023). The Chainalysis report reveals that the crypto assets most widely used by investors in Indonesia are Bitcoin, Ethereum, and other coins or tokens. However, it is not explained in detail what percentage of the use of the three tokens is (Olavia, 2022). The current best cryptocurrency besides Bitcoin, Ethereum, Binance Coin is also included in the types of cryptocurrency that are popular in Indonesia (Kristianto, 2022).

According to a report by We Are Social and Hootsuite, Indonesia is one of the largest cryptocurrency-owning countries in the world and ranks sixth. Reportedly, about 20.1 percent of users aged 16-24 in Indonesia owned cryptocurrencies as of January 2023. The following are the 10 countries with the largest percentage of cryptocurrency users as of January 2023 (Simon Kemp, 2023). However, the popularity of cryptocurrency as a currency has not been recognized in Indonesia. Bank Indonesia does not recognize cryptocurrencies as legal tender as stated in the Bank Indonesia Regulation in PBI 18/40/PBI/2016 on the Implementation of Payment Transaction Processing and in PBI 19/12/PBI/2017 on the Implementation of Financial Technology (Musfirotin, 2020).

Cryptocurrencies offer investors some interesting opportunities that can affect stock market performance. Stock prices can not only be influenced from one aspect, but there is an influence of other investment products that have high returns, one of which is cryptocurrency (Du et al., 2019). This issue becomes important as market integration between traditional financial assets and cryptocurrencies increases (Bouri et al., 2018). However, the popularity of cryptocurrency as a currency has not been recognized in Indonesia. Bank Indonesia does not recognize cryptocurrencies as legal tender as stated in the Bank Indonesia Regulation in PBI 18/40/PBI/2016 on the Implementation of Payment Transaction Processing and in PBI 19/12/PBI/2017 on the Implementation of Financial Technology (Musfirotin, 2020).

In a sharia perspective, the Indonesian Ulema Council (2021) made a decision regarding the legality of cryptocurrency in a meeting of the 7th Ijtima Ulama Commission of the Indonesian Ulema Council on November 9-11, 2021 by agreeing on 17 discussion points, one of which is the law of cryptocurrency, namely the use of cryptocurrency as a currency is haram, because it contains gharar, dharar and contradicts Law Number 7 of 2011 and Bank Indonesia Regulation number 17 of 2015. In this case, it means that crypto is not a means of payment for buying and selling transactions, because what is used as legal tender is the rupiah

Most Islamic financial tools have been developed to attract funds from investors who are looking for a sharia-compliant investment universe. The Islamic stock market attracts investors through five key principles: no usury, risk sharing, limited trading, specific contracts, and Shariah-compliant operations. Commodities that comply with these rules provide interest-free transactions and serve as an important portfolio diversification tool. M. E. Arouri et al., in (Mensi et al., 2020) concluded that Islamic stock markets experienced lower volatility and fewer spillovers during the last financial crisis. Stricter Islamic legal norms lead to lower corporate interest expenses due to lower leverage. Smaller amounts of receivables provide less opportunity to incur bad debts on the balance sheet Hoque et al., in (Mensi et al., 2020). The safe-haven and diversification capabilities of Islamic stocks as well as the high return potential of cryptocurrencies are characteristics that encourage institutional and individual investors to include any of these assets as part of their portfolio (Ahmed, 2021)..

According to Gil-Alana et al., (2020) investors should diversify their portfolio by incorporating cryptocurrencies into their investments. Investors match negatively correlated securities in their portfolios. As a result, precious metals, such as gold and silver, which are negatively correlated with stock market returns, have become a popular diversification tool for risk-averse investors. In addition, Islamic equity markets have gained attention as a way to recover from the global financial crisis of 2008 and become an effective diversification tool in the financial markets. Recently, cryptocurrencies have also emerged as a financial tool to minimize portfolio risk (Gil-Alana et al., 2020). The safe-haven and diversification capabilities of Islamic stocks as well as the high return potential of cryptocurrencies are characteristics that encourage institutional and individual investors to include any of these assets as part of their portfolio (Ahmed, 2021). Most Islamic financial tools have been developed to attract investor funds seeking a Sharia-compliant investment universe.

In Walid M.A. Ahmed's (2021) research entitled "How do Islamic equity markets respond to good and bad volatility of cryptocurrencies? The case of Bitcoin" says that empirical literature on the interdependence structure of cryptocurrencies and Islamic equities is sparse, despite their high portfolio diversification potential. In addition, in the study of Saeed Sazzad Jeris et al., (2022) also said that there is very little research related to the relationship by considering Islamic stock markets. Modeling the dynamic volatility of cryptocurrencies and other assets is an important and new subject to study due to recent developments in increased integration between financial markets (Ghorbel & Jeribi, 2021).

Research Gap

In Walid M.A. Ahmed's research (2021) entitled "How do Islamic equity markets respond to good and bad volatility of cryptocurrencies? The case of Bitcoin" says that empirical literature on the interdependence structure of cryptocurrencies and Islamic equities is very rare, despite its high portfolio diversification potential. The results show that the relationship between bitcoin and Islamic stocks in the US, Switzerland and Japan shows that Bitcoin is positively, but very weakly, correlated with Shariah-compliant and sustainable stocks. For developed markets, the results show that upward volatility tends to have an equal and lagged negative effect on Islamic stocks in bearish market conditions than in bullish market conditions, while downside volatility has a positive impact on returns when Shariah-compliant equities are in bearish and bullish market conditions.

Similarly, another study by Walid Mensia, et al. (2020) with the title "Does Bitcoin Co-Move and Share Risk with Sukuk and World and Regional Islamic Stock Markets? Evidence Using a Time-Frequency Approach" found that there is a dependence on the frequency of co-movement between Bitcoin and Islamic equity returns. Movements are stronger and unidirectional at low frequencies, suggesting that diversification benefits are relatively less important to long-term investors than short-term investors. Research by Joseph et al., (2024) entitled "The Implication of Cryptocurrency Volatility on Five Largest African Financial System Stability" shows that there is significant volatility and shock effects from cryptocurrencies to African markets. In addition, there is a low to moderate positive correlation between the volatility of Bitcoin, Ethereum, and Ripple cryptocurrencies and financial markets in Africa.

Research by Imen Omri (2023) with the title "Directional Predictability and Volatility Spillover Effect from Stock Market Indexes to Bitcoin: Evidence from Developed and Emerging Markets" shows a significant unidirectional volatility spillover effect from emerging markets to Bitcoin and only six stock markets are strong predictors of Bitcoin returns in the short term. In addition, there is no difference between developed and emerging markets regarding directional predictability but there is a difference in the reaction of Bitcoin returns to shocks in emerging markets compared to developed markets. Ghorbel & Jeribi (2021) in their research entitled "Investigating The Relationship Between Volatilities of Cryptocurrencies and Other Financial Assets" said that modeling the dynamic volatility of cryptocurrencies and other assets is an important and new subject to study due to recent developments in increased integration between financial markets, The results showed that during the stability period, the crypto market had a low dynamic correlation with financial assets. However, it increased in 2020 between crypto markets, American indices and oil.

In contrast to research by Yarovaya et al. (2021) entitled "Determinants of Spillovers between Islamic and Conventional Financial Markets: Exploring the Safe Haven Assets during the COVID-19 pandemic" revealed that COVID-19, gold, and oil are important predictors of traditional-Islamic markets, and Bitcoin is not an important determinant. The study also shows that while traditional-Islamic assets are largely determined by a few factors, such as the price of oil and gold during the pandemic, this can change significantly as there are other most significant factors. However, Bitcoin fails to affect both traditional and Islamic markets. Research by Gil-Alana et al. (2020) which examined the relationship between cryptocurrencies and the stock index in the US and the results showed that all cryptocurrencies are not related in the long run to the stock market index, so it can be a portfolio diversification tool.

Research by Narayan et al. (2019) entitled "Bitcoin Price Growth and Indonesia's Monetary System" found that Bitcoin can replace conventional money, this not only changes the role of money but also reduces money circulation. This phenomenon leads to the demise of the quantitative theory of money. This theory suggests that Islamic stocks may behave differently in the face of cryptocurrency than conventional stocks.

Thus, based on the background and research gaps that have been described, the authors are interested in conducting research with the title "Study of the Relationship between Cryptocurrency and Islamic Stocks in Indonesia".

Research Objective

1. Knowing the correlation between Bitcoin and the ISSI Index
2. Knowing the correlation between Ethereum and the ISSI Index
3. Knowing the correlation between Binance Coin and the ISSI Index

II. LITERATURE REVIEW

Portfolio Theory

Markowitz portfolio theory was developed by Sharpe (1964), Lintner (1965), and Jan Mossin (1996). Sharpe (1963) developed Markowitz's theory, known as the Single Index Model, which suggests a linear relationship of actual returns of securities with general macroeconomic elements. King (1966) later developed another model, known as the Multi-Index Model, which measures the impact of common movements between securities affected by market effects and market values. Furthermore, the Markowitz 10 model was created by Sharpe (1964), which analyzes the relationship between the equilibrium expected return and risky assets. This model is known as the Capital Asset Pricing Model (CAPM) (Financial Services Authority, 2019). This theory suggests that by combining or adding a number of assets into multiple portfolios, risk can be statistically reduced. However, the returns of each asset or security in the portfolio are not perfectly positively correlated. In other words, asset diversification can be used to reduce risk (Financial Services Authority, 2019).

Return

The expected rate of return on an investment in a particular stock or group of stocks is called return. Investors always expect a return that matches their expectations. "Return" is a term used to describe the value generated from an investment. (Br Hasibuan et al., 2023). Returns can be in the form of profits (dividends and capital gains) or losses. Dividends are profit sharing provided by the company and come from the profits generated by the company. Meanwhile, capital gain is the difference between the purchase price and the selling price (Sani Akbar, 2021).

Islamic Perspective of Cryptocurrency

Rizvi and Ali (2022) found that Indonesian investors stepped in and made cryptocurrency investments to mitigate equity sector risk during the pandemic. However, cryptocurrencies are also not free from drawbacks. The drawback of cryptocurrencies is the very high price fluctuations. In addition, cryptocurrencies in general are also not secured by specific tangible assets. From an Islamic perspective, common cryptocurrencies such as Bitcoin, Ethereum, Binance are considered to contain elements of gambling (maysir) and uncertainty (gharar) (Meera, 2018). The price of cryptocurrencies fluctuates so much that it invites various opinions of the Ulama. In Islam, the category of property has at least four elements including

1. Has a material substance that can be held or touched.
2. Can be stored for a long time and does not change.
3. Has the principle of benefit and does not have masfadat.
4. Some people view it as treasure like gold, silver, cars, stocks, and others.

In addition, transactions using electronic money must avoid, namely:

- a. Usury is a transaction by taking additional money, both in selling and buying transactions and borrowing and lending illegally or contrary to Islamic teachings (Musfirotin, 2020).
- b. Maysir is a transaction that contains elements of gambling, high profit or speculation. The implementation of electronic money must be based on the need for payment transactions that demand a faster and more efficient payment system, transactions that do not contain maysir (Musfirotin, 2020). Gambling is prohibited in Islam, this is in QS. al-Maidah : 90 which reads:

يَا أَيُّهَا الَّذِينَ آمَنُوا إِنَّمَا الْخَمْرُ وَالْمَيْسِرُ وَالْأَنْصَابُ وَالْأَزْلامُ رِجْسٌ مِّنْ عَمَلِ الشَّيْطَانِ فَاجْتَنِبُوهُ لَعَلَّكُمْ تُفْلِحُونَ

The intention to benefit from the speculation of other cryptocurrency prices that are very volatile and the gambling that is carried out makes cryptocurrency there is an element of Maysir (Nur, 2020).

- c. Gharar or uncertainty in a contract regarding the quality or quantity of the contract object or regarding its delivery. According to Jurisprudence, Gharar is a characteristic in muamalah that causes some of

its pillars to be uncertain (mastur al-aqibah) (Nur, 2020). Gharar is prohibited in Islamic Sharia, therefore making transactions or providing conditions in contracts that contain elements of gharar is not permissible, as the Hadith of the Prophet Muhammad in the Abu Hurairah hadith which reads:

نَهَى رَسُولُ اللَّهِ صَلَّى اللَّهُ عَلَيْهِ وَسَلَّمَ عَنْ بَيْعِ الْخَصَاةِ وَعَنْ بَيْعِ الْغَرَرِ

Translation: "The Messenger of Allah (SAW) forbade buying and selling that contains Gharar".

Ijon sale is prohibited by the Prophet because of its high degree of Gharar. Although the seller and buyer do it on the basis of mutual consent. However, the existence of mutual consent is not enough, because the problem is not the coercion of the perpetrators of the contract, but the unclear object of the transaction such as the sale and purchase of cryptocurrency.

- d. Tadlis is the act of concealing defects in the object of the contract carried out by the seller to trick the buyer as if the object of the contract is not defective.
- e. Risywah is a purchase that aims to take something that is not its right, justify what is false and make something false into something true.
- f. Israf is the excessive spending of wealth

Cryptocurrency

Cryptocurrency is a virtual coin so it has no physical form. The only proof of cryptocurrency ownership is the transactions recorded on the blockchain. A blockchain is a public record (or electronic ledger). Cryptocurrencies are usually governed by a set of protocols that determine how many coins can be created, how they are created, and how the integrity of the ledger is protected. These protocols are intended to be equivalent to government regulations and laws that support fiat money, and their strength will affect trust in digital currencies (Siswanto et al., 2020).

The initiation of a new cryptocurrency usually occurs when a company plans to launch a new product and seeks funding to develop it. The company creates its own virtual currency and issues new coins or tokens created through an initial coin offering. Different labels have been used to describe the different types of tokens or coins issued. The first cryptocurrency was Bitcoin. Bitcoin has no function or purpose other than as a medium of exchange (or store of value) (Siswanto et al., 2020).

Bitcoin

Nakamoto (2008) states that Bitcoin uses peer-to-peer technology to operate without a central authority or bank, managing transactions and issuing bitcoins collectively by the network. Bitcoin is open source; its design is public, no one owns or controls Bitcoin and everyone can take part (Hidajat et al., 2021). The main core of bitcoin is a global ledger or balance sheet, called the blockchain. This general ledger records all transactions made using bitcoin since bitcoin was mined all transactions are recorded, so this is what makes bitcoin not easily counterfeited (Fitria, 2021). Indonesia has 10.9 million Bitcoin holders. Meanwhile, TripleA notes that with Indonesia's population touching 227 million, there are 4.55% of the population who own cryptocurrencies so that the number of crypto ownership in Indonesia is 12.6 million. The percentage of bitcoin ownership in Indonesia is 4% in comparison to all countries in the world. In a recent development, the Indonesian government has announced that PT Bursa Komoditi Nusantara or Commodity Future Exchange (CFX), as Indonesia's crypto asset exchange by the end of July 2023 (Bendiksen, 2023).

Ethereum

Vitalik Buterin first introduced Ethereum in late 2013. This Ethereum has the aim of building decentralized applications (Indodax, 2023). Formal development of the ethereum software project began in early 2014 through a Swiss Company. Ethereum is a programmable blockchain that works using ETH as the base cryptocurrency for using the system. Ether is used as payment of fees for information stored or processed. Ethereum is used as the basis for many blockchain applications (Laily, 2021). According to the Ethernodes page, the United States is the largest ether producing country in the world. A total of 2,112 production points out of 4546 Ethereum production in the world are in the US, or about 46%. Meanwhile, in second place is Germany which has 567 Ethereum validation points or accounts for around 12.47%. In position, Singapore produces 210 or accounts for about 4.26%. Ethernodes page detects 4 Ethereum nodes in Indonesia, this is only 0.06% of the total global network

Binance

According to Binance Academy, Binance is a crypto asset issued by Binance Exchange and traded under the symbol BNB. The BNB coin is a BEP-20 token type that runs on the Binance Smart Chain.

Binance uses BNB to facilitate transactions on its platform and provide benefits to its users. BNB is also used as a means of payment for services provided by Binance, such as Binance DEX, Binance Chain, and Binance Labs (Academy Binance, 2020). BNB is also available on several other cryptocurrency exchanges such as Bittrex, Upbit, and HitBTC (Academy Binance, 2023). BNB was issued in 2017 through an Initial Coin Offering (ICO) that raised \$15 million within 24 hours. The total number of BNB issued was 200 million coins, with 40% offered through the ICO (Yudha, 2022).

Islamic Stock

Shares according to Fatwa DSN-40/DSN-MUI/X/2003 are defined as proof of ownership of a company that meets sharia criteria and does not include shares that have special rights. Shariah shares are certificates that show proof of ownership of a company issued by issuers whose business activities and management methods do not conflict with shariah principles. Reporting from the Financial Services Authority page (2023) A share can be categorized as a sharia share if the share is issued by:

1. Issuers and Public Companies that clearly state in their articles of association that the business activities of Issuers and Public Companies do not conflict with sharia principles.
2. Issuers and Public Companies that do not state in their articles of association that the business activities of the Issuers and Public Companies are not contrary to sharia principles, but fulfill the following criteria:
 - a. business activities are not contrary to sharia principles as stipulated in regulation IX.A.13, namely not conducting business activities:
 1. gambling and games classified as gambling
 2. trading that is not accompanied by the delivery of goods/services;
 3. trading with false supply/demand;
 4. interest-based banks
 5. interest-based financing companies;
 6. sale and purchase of risks that contain elements of uncertainty (gharar) and/or gambling (maisir), including conventional insurance;
 7. producing, distributing, trading and/or providing goods or services that are haram in substance (haram li-dzatihi), goods or services that are haram not because of their substance (haram li-ghairihi) as determined by DSN-MUI; and/or, goods or services that damage morals and are mudarat;
 8. conduct transactions that contain elements of bribery (risywah);
 - b. the ratio of total interest-based debt to total equity is not more than 82%, and
 - c. the ratio of total interest income and total other non-halal income compared to total operating income and total other income is not more than 10%.

Indonesia Sharia Stock Index (ISSI)

A stock price index is a leading indicator that develops stock price movements. In the capital market an index is expected to have five functions, namely:

1. As an indicator of stock trends,
2. As an indicator of the rate of return,
3. As a benchmark for the performance of a portfolio,
4. Facilitates portfolio formation with a passive strategy,
5. Facilitate the development of derivative products.

The Indonesian Sharia Stock Index (ISSI) is an indicator of the performance of the Indonesian sharia stock market. The index was launched by IDX on May 12, 2011. According to the Indonesia Stock Exchange (2023), the ISSI Index is a stock index that reflects all sharia stocks listed on the IDX and listed on the Sharia Securities List (DES). ISSI constituents are reviewed every 6 months (May and November) and published at the beginning of the following month. ISSI constituents are also adjusted if there are new Islamic stocks listed or removed from the DES. The ISSI index calculation method uses a weighted average of market capitalization. The list of sharia securities for the October 2023 period includes 556 stocks of issuers and public companies, as well as other sharia securities. The data sources used as review materials in the preparation of the Sharia Securities List come from the financial statements ending on December 31, 2022 and other supporting data (Indonesia Stock Exchange, 2023).

Hypotheses

Based on the research objectives that have been prepared, the hypotheses proposed in this study are as follows:

- H1: There is a correlation between Bitcoin and the ISSI Index
H2: There is a correlation between Ethereum and the ISSI Index
H3: There is a correlation between Binance Coin and the ISSI Index

III. RESEARCH METHODS

This study will test and analyze the relationship between Bitcoin, Ethereum, Binance Coin returns and Islamic stock returns in Indonesia using the ISSI Index. This research is a type of quantitative research. John W. Creswell (2009) defines quantitative research as an interrogative statement that raises questions about the relationship between variables that the researcher wants to answer. These variables can be measured, usually through instruments so that data in the form of numbers can be analyzed using statistical procedures. Quantitative methods involve the process of collecting, analyzing, interpreting, and writing research results.

The type of data used in this research is secondary data in the form of time series. Secondary data is data obtained not directly from the object of research. Researchers get data that has been collected by other parties in various ways or methods both commercially and non-commercially (Nuryadi, 2017). This study uses secondary data sources obtained through Bloomberg and TICMI (The Indonesian Capital Market Institute). The type of data used in this study is time series data. In this study, the observation period is set between January 2, 2018 and December 30, 2022.

Empirical Model

In this study, the variables used are Bitcoin, Ethereum, Binance Coin, and the ISSI Index.

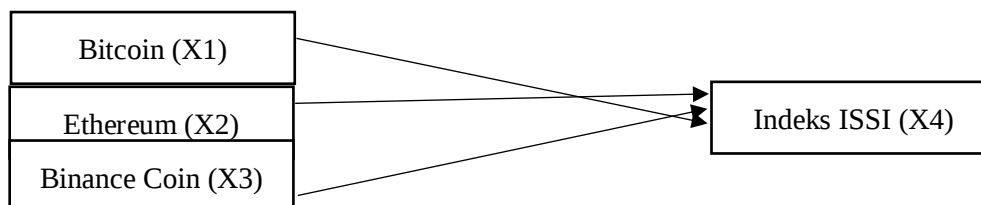


Figure 1. Empirical Model

Statistics Descriptive

Descriptive statistics are statistics that describe existing events or characteristics. Descriptive statistical analysis aims to describe and summarize data systematically. The main purpose of descriptive statistical analysis is to provide an overview of the observed data without generalizing to a wider population.

Unit Root Test

In a time series data, stationarity means that the basic properties of the time series such as the average variance remain constant over time. In this study to test stationarity using the Augmented Dickey Fuller (ADF) test. By using the ADF test, it is possible to test the stationarity of the data against the mean.

Heterokedasticity Test

Heteroscedasticity is a condition where the data has a non-constant error variance. To check the presence of heteroscedasticity effects in the data used, this study uses the ARCH-LM test. The ARCH-LM test was introduced by Engle (1982) to see the effect of conditional heteroscedasticity. If the significant value < 0.05 then heteroscedasticity occurs. However, if the significant value > 0.05 then there is no heteroscedasticity.

Model Analysis CCC-MGARCH and DCC-MGARCH

The multivariate GARCH (Generalized Autoregressive Conditional Heteroscedasticity) model with constant conditional correlation of Bollerslev (1990) and the multivariate GARCH model with dynamic conditional correlation were introduced by Engle (2001) of Bollerslev (1990) to examine the variable correlation between the volatility of returns on assets. Correlation is a method that can assess the co-movement of assets in financial markets. High correlation means high co-movement and more integrated CCC-MGARCH model introduced by Bollerslev (1990), where the correlation is independent of time. This restriction reduces the number of parameters and simplifies estimation. The conditional covariance matrix is expressed as follows:

$$H_t = D_t R D_t \dots\dots\dots (1)$$

H_t is matriks $n \times n$ from *conditional covariance* η_t on t periode R is matriks *conditional correlation* from

η_t t period. D_t is $diag(H_{1t}^2, H_{2t}^2, \dots, H_{nt}^2)$ or *conditional variance*.

This model assumes that the conditional variance of $h_{ii,t}$ follows a univariate GARCH model, this is shown in the following equation:

$$h_{ii,t} = \delta + \sum_{i=1}^p \alpha_{ij} \varepsilon_{i,t-j}^2 + \sum_{j=1}^q \beta_{ij} h_{ii,t-j} \dots \dots \dots (2)$$

The CCC-MGARCH equation is as follows

$$(\rho_{ij} \sqrt{h_{ii,t} h_{jj,t}})$$

ρ_{ij} = CCC-MGARCH correlation

$h_{ii,t}$ = Univariate GARCH Model

The DCC-GARCH model is more accurate and flexible for investment optimization and financial risk management. The DCC-GARCH method has also been used in the literature such as (Joseph et al., 2024) and (Ghorbel & Jeribi, 2021) to estimate the relationship between cryptocurrencies and other assets. DCC-GARCH is a convergent correlation and variance model, the difference is that DCC-GARCH is modeled with dynamic interactions of its variables (Gürbüz & Şahbaz, 2022). This study uses DCC-GARCH to examine the correlation between cryptocurrency returns and ISSI Index returns. The multivariate GARCH (Generalized Autoregressive Conditional Heteroscedasticity) model with constant conditional correlation of Bollerslev (1990) and multivariate GARCH model with dynamic conditional correlation were introduced by Engle (2001) Bollerslev (1990) to test the correlation of variables between the volatility of returns on assets. Correlation is a method that can assess the co-movement of assets in financial markets. A high correlation means the co-movement is high and more integrated. This research uses DCC-GARCH(1,1) to examine the dynamic conditional correlation of cryptocurrency variables and the ISSI Index. The estimation of the DCC-MGARCH(1,1) model is as follows:

$$r_t = \mu_t + \eta_t \dots \dots \dots (1)$$

$$\eta_t = H_t^{\frac{1}{2}} z_t$$

Where r_t is an $n \times 1$ vector of daily returns in period t for each market. μ_t is an $n \times 1$ vector of expected returns from the conditional value of r_t and η_t is a $b \times 1$ vector of mean-corrector returns in period t .

$$H_t = D_t R_t D_t \dots \dots \dots (2)$$

H_t is the $n \times n$ matrix of conditional covariance of η_t at period t . R_t is the conditional correlation matrix of η_t at time t . D_t is the $diag(H_{1t}^2, H_{2t}^2, \dots, H_{nt}^2)$ or *conditional variance*.

$$R_t = \begin{bmatrix} 1 & q_{12,t} \\ q_{21,t} & 1 \end{bmatrix} \dots \dots \dots (3)$$

$$R_t = Q_t^{*-1} Q_t Q_t^{*-1} \dots \dots \dots (4)$$

Q_t is a positive definite matrix containing the conditional variance-covariance of the η_t . Q_t^{*-1} is an inverted diagonal matrix with the square root of the diagonal element

$$Q_t = \begin{bmatrix} 1/\sqrt{q_{11,t}} & 0 \\ 0 & 1/\sqrt{q_{22,t}} \end{bmatrix} \dots \dots \dots (5)$$

Engle (2002) proposed a different dynamic conditional correlation model. Engle's DCC model assumes that the covariance matrix is described as follows:

$$Q_t = (1 - \theta_1 - \theta_2) \bar{Q} + \theta_1 \eta_{t-1} \eta_{t-1}' + \theta_2 Q_{t-1} \dots \dots \dots (6)$$

$$\bar{Q} = \text{Cov}(\eta_{t-1} \eta_{t-1}') = E(\eta_{t-1} \eta_{t-1}')$$

Q_t adalah matriks kovarian tidak bersyarat dari standar error η_t .

θ_1 and θ_2 are parameter of DCC. $\theta_1 + \theta_2 < 1$, The DCC estimation shows that θ_1 indicates the short-term volatility effect of cryptocurrencies on the ISSI Index and θ_2 captures the long-term volatility effect of cryptocurrencies on the ISSI Index (Joseph et al., 2024). The parameter θ_1 is the conditional variance that shows significant changes over time. The θ_2 parameter captures the dynamics of the conditional correlation matrix that varies over time.

The DCC-MGARCH equation is as follows:

$$\rho_{12,t} = \frac{q_{12,t}}{\sqrt{q_{11,t} q_{22,t}}}$$

IV. RESULTS AND DISCUSSION

Statistics Descriptive

Table 1. Statistics Descriptive

	ISSI	Bitcoin	Ethereum	Binance Coin
Mean	0.000113	0.001652	0.000274	0.002739
Median	0.000252	0.000524	0.000893	0.001542
Maximum	0.086920	0.200785	0.326811	0.530574
Minimum	-0.065601	-0.497278	-0.589639	-0.581158
Std. Dev.	0.010811	0.048339	0.062889	0.069357
Skewness	-0.049586	-1.395597	-0.938318	-0.343429
Kurtosis	10.63985	15.69335	12.26156	15.45925
Jarque-Bera	2965.075	8579.313	4535.607	7908.498
Prob.	0.000000	0.000000	0.000000	0.000000
Observations	1219	1219	1219	1219

Based on table 1 shows that cryptocurrency has a high rate of return compared to the ISSI Index. In terms of risk of financial instruments based on standard deviation, cryptocurrency is a riskier instrument than the ISSI Index, especially Binance Coin, which is 0.069357. The volatility level of the ISSI Index and cryptocurrency shows that there is a considerable difference between the minimum and maximum values which indicates volatility in returns. Jarque-Bera statistics show that there are no normally distributed variables.

Unit Root Test

The ADF (Augmented Dickey Fuller) test is used in testing the stationarity of the data used. The ADF results show that all variables are stationary at the level.

Table 2. Unit Root Test

Variable	ADF Test	Prob.
ISSI	-19.17232	0.0000
Bitcoin	-36.41346	0.0000
Ethereum	-36.63202	0.0000
Binance Coin	-35.99211	0.0000

Table 2 is the result of correlation with constant time using the CCC-MGARCH model. ρ is the correlation parameter of CCC. σ is the variance or average volatility of each variable. α captures the structural impact of previous shocks (ARCH effect), the ARCH effect incorporates the short-term volatility impact of cryptocurrencies. β captures the effect of prior volatility (GARCH effect). The GARCH effect captures the spillover effect of long-term volatility from cryptocurrencies to the ISSI Index.

Heteroscedasticity Test

ARCH-LM was used to test the heteroscedasticity effect of all the variables used. The results show that there is significant heteroscedasticity in all variables. The ARCH effect indicates that there is heteroscedasticity in the variables so that the CCC-MGARCH and DCC-GARCH models can be applied.

Table 3. Heteroscedasticity Test

Variable	ARCH-LM	Prob.
ISSI	63.100	0.0000
Bitcoin	4.5162	0.0004
Ethereum	5.4084	0.0001
Binance Coin	9.6743	0.0000

Model CCC-MGARCH(1,1) and DCC-MGARCH(1,1)

Table 4. Result of CCC-MGARCH(1,1)

Result of Estimasi Model CCC-MGARCH				
	ISSI	Bitcoin	Ethereum	Binance Coin
σ	0.00012	0.00241	0.00395	0.00481
α	0.1556 (0.0230)**	0.01238 (0.0109)**	0.1278 (0.0528)*	0.1311 (0.0831)*
β	0.7487 (0.0000)***	0.7483 (0.0000)***	0.7360 (0.0000)***	0.8107 (0.0000)***
ρ		0.07848 (0.0464)**	0.06841 (0.0880)*	0.0893 (0.0255)**

Note: *** = 1%, ** = 5%, and * = 10% is level significant

Table 5. Result of DCC-MGARCH(1,1)

	Hasil Estimasi Model DCC-MGARCH			
	ISSI	Bitcoin	Ethereum	Binance Coin
σ	0.00012	0.00241	0.00395	0.00481
α	0.1556 (0.0230)**	0.01238 (0.0109)**	0.1278 (0.0528)*	0.1311 (0.0831)*
β	0.7487 (0.0000)***	0.7483 (0.0000)***	0.7360 (0.0000)***	0.8107 (0.0000)***
DCC(θ_1)	0.0300 (0.0000)***			
DCC(θ_2)	0.9497 (0.0000)***			

Note: *** = 1%, ** = 5%, and * = 10% is level significant

Table 6. Dynamic Correlation Average Indeks ISSI, Bitcoin, Ethereum, and Binance Coin

	Dynamic Correlation Average		
	Bitcoin	Ethereum	Binance Coin
ISSI	0.079	0.069	0.091

The dynamic correlation by estimating the DCC-GARCH Model is presented in figure 2, 3, and 4. Based on the DCC-GARCH framework, which estimates the dynamic correlation between the cryptocurrencies Bitcoin, Ethereum, Binance Coin and the ISSI Index in the period January 2, 2018 - December 30, 2022. σ is the average volatility of each variable. α captures the structural impact of previous shocks (ARCH effect). The ARCH effect incorporates the short-term volatility impact of cryptocurrencies and β captures the prior volatility effect (GARCH effect). The GARCH effect captures the long-term volatility spillover effect of cryptocurrencies to the ISSI Index (Joseph et al., 2024). The parameters θ_1 and θ_2 are DCC parameters. Parameter θ_1 is a significant conditional variance which indicates that the conditional variance changes significantly over time. This implies that asset volatility is relatively unstable over time. The θ_2 parameter captures the dynamics of the time-varying conditional correlation matrix, and its significance indicates that the multivariate correlation structure changes over time (Shakeel et al., 2023).

In the univariate GARCH (1,1) estimation results, σ values indicate the average volatility of each variable. The estimation results show that Binance Coin has a high volatility when compared to Bitcoin, Ethereum and the ISSI Index which is 0.00481. When compared to the ISSI Index, cryptocurrencies have a higher level of volatility. The value in the estimation results shows that the ISSI Index has the lowest level of risk during the study period. Furthermore, the α and β values in all variables, namely the ISSI Index, Bitcoin, Ethereum, and Binance Coin, are significant at the 5% and 10% levels so that it can be interpreted that large changes in the returns of the ISSI Index and Cryptocurrency are followed by other large changes (Irwaningtyas et al., 2023).

The estimation results with the CCC-MGARCH model show that all correlations between cryptocurrencies (Bitcoin, Ethereum, Binance Coin) and the ISSI Index are significant at the 5% and 10% levels and the correlation coefficient is still very low, namely the correlation between Bitcoin-ISSI of 0.0784, the Ethereum-ISSI correlation of 0.06841 and the Binance Coin-ISSI correlation of 0.0893. While the DCC-MGARCH model results show that $\theta_1 + \theta_2 < 1$ is significant. The significant θ_1 parameter indicates that the conditional variance changes significantly over time. The significant θ_2 parameter indicates that cryptocurrencies (Bitcoin, Ethereum, Binance Coin) and the ISSI Index in multivariate are highly correlated where the correlation structure changes over time. The correlation can be interpreted that there is integration between variables, namely cryptocurrency to the ISSI Index.

Figure 1 illustrates the volatility of the ISSI Index and Cryptocurrencies. Based on the graph in the figure, it can be seen that all ISSI Index cryptocurrencies generally present high volatility compared to the ISSI Index. However, there is a similarity that occurred in 2020, the volatility of the ISSI Index, and cryptocurrencies experienced the highest volatility during the study period. This can be caused by the COVID-19 outbreak that has hit the global economy, one of which is in Indonesia, so that it can affect investor sentiment.

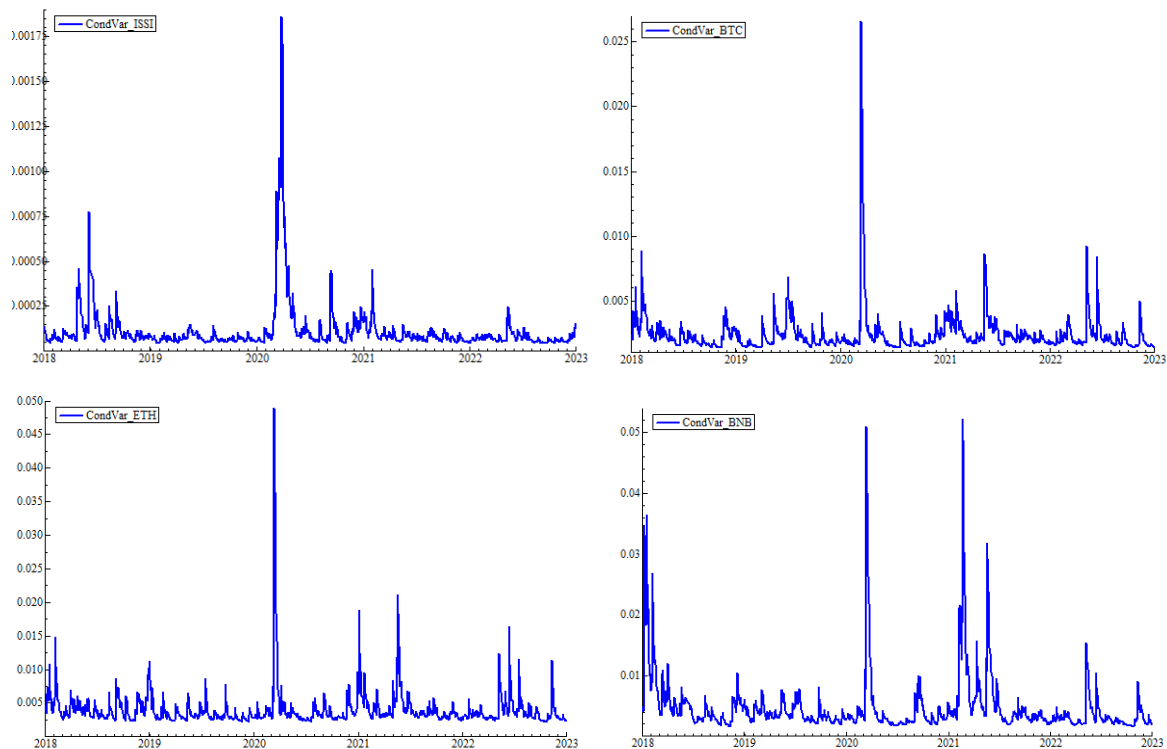


Figure 2: Conditional Variance Indeks ISSI, Bitcoin, Ethereum, and Binance Coin periode 2 Januari 2018 – 30 Desember 2022

Discussing the results of the research

a. Correlation between Bitcoin and the ISSI Index

Based on table 2 the CCC-MGARCH estimation results show that the correlation with constant time shown in ρ between Bitcoin and the ISSI Index is significant with a coefficient of 0.0784. This means that with a correlation independent of time (constant) the strength of the correlation between Bitcoin and the ISSI Index is 7.8% or it can be said that the correlation is still very low.

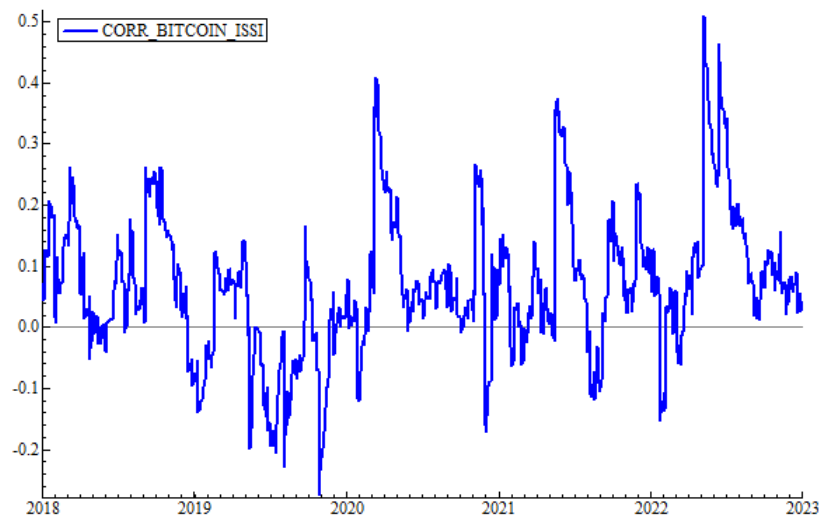


Figure 3. Dynamic Correlation Bitcoin and Indeks ISSI

Table 3 shows the average dynamic correlation between Bitcoin and the ISSI Index during the study period which shows a value of 0.079 (7.9%) or it can be said that the strength of the correlation is still very low. However, when viewed in Figure 2 the dynamic correlation that changes from time to time shows a correlation that changes to positive and negative values. Positive values indicate a unidirectional relationship while negative values indicate an unidirectional relationship. In line with Ahmed's research (2021) which shows the results that bitcoin is positively correlated, but very weak, with sharia-compliant and sustainable stocks. Similarly, research by Joseph et al. (2024) which shows that there is a moderate to low correlation between cryptocurrencies and stock markets in Africa. Mensi et al. (2020) also showed a dependence

on the frequency of co-movement between Bitcoin and Islamic equity returns. The movement is stronger and unidirectional at low frequencies. In contrast to the research of Ghorbel & Jeribi (2021) which examines the dynamic correlation between cryptocurrencies, one of which is Bitcoin and the S&P and Nasdaq Indices, the results show that the dynamic correlation tends to be negative.

Based on the research results which show a significant correlation in the CCC-MGARCH and DCC-MGARCH models between Bitcoin and the ISSI Index, it can be concluded that Hypothesis 1 is accepted because there is a correlation between Bitcoin and the ISSI Index, although the strength of each correlation is very low.

Correlation between Ethereum and the ISSI Index

Based on table 4 the CCC-MGARCH estimation results show that the correlation with constant time shown in ρ between Ethereum and the ISSI Index is significant with a coefficient of 0.0684. This means that if time is constant, the correlation between Ethereum and the ISSI Index is 6.8% or it can be said that the correlation is still very low. It is the same with the bitcoin correlation with the ISSI index.

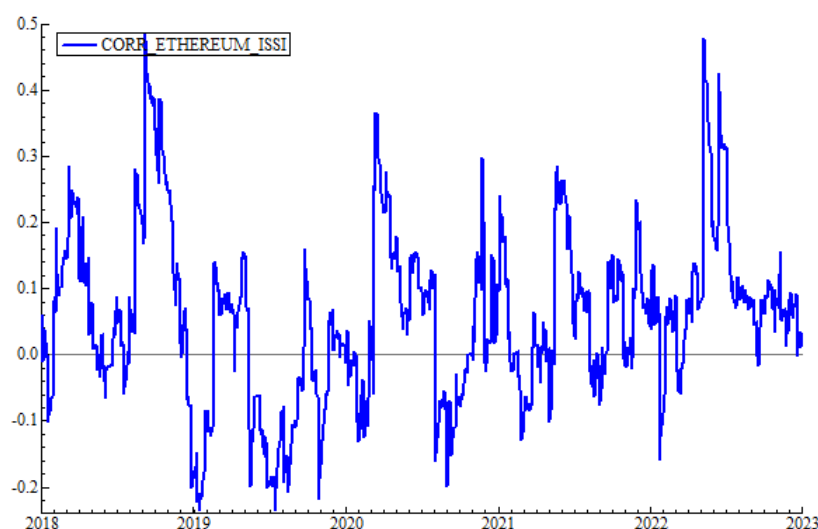


Figure 4. Dynamic Correlation Ethereum and Indeks ISSI

The average dynamic correlation between Ethereum and the ISSI Index in table 4 shows a value of 0.069 (6.9%) or it can be concluded that the correlation between the two is still very low. However, when viewed in Figure 3 the dynamic correlation that changes over time shows a correlation that changes in positive and negative values. In line with the research of Ghorbel & Jeribi (2021) which examines the dynamic correlation between cryptocurrencies, one of which is Ethereum and the S&P and Nasdaq indices, the results show that the dynamic correlation is still low. Meanwhile, in research (Joseph et al., 2024) the results of the dynamic correlation between Ethereum and the stock market in Africa show moderate to low correlation results.

Based on the research results which show a significant correlation in the CCC-MGARCH and DCC-MGARCH Models between Ethereum and the ISSI Index, it can be concluded that Hypothesis 2 is accepted because there is a correlation between Ethereum and the ISSI Index, although the strength of each correlation is very low.

Correlation between Binance Coin and the ISSI Index

Based on table 2 the CCC-MGARCH estimation results show that the correlation with constant time shown in ρ between Binance Coin and the ISSI Index is significant with a coefficient of 0.0893. This means that if time is constant, the correlation between Binance Coin and the ISSI Index is 8.9% or it can be said that the correlation is still low. It is the same with the correlation of bitcoin and ethereum with the ISSI index.

Table 4 which shows the average dynamic correlation between Binance Coin and the ISSI Index shows a value of 0.091 (9.1%) or can be said to be still very low. Similar to the correlation between Bitcoin-ISSI and Ethereum-ISSI. The dynamic correlation that changes over time between Binance Coin and the ISSI Index also changes to positive and negative values. Positive values indicate a unidirectional relationship while negative values indicate an unidirectional relationship. Based on the research results which show a significant correlation in both the CCC-MGARCH and DCC-MGARCH Models between Binance Coin and the ISSI Index, it can be concluded that Hypothesis 3 is accepted because there is a correlation between Binance Coin and the ISSI Index, although the strength of each correlation is very low.

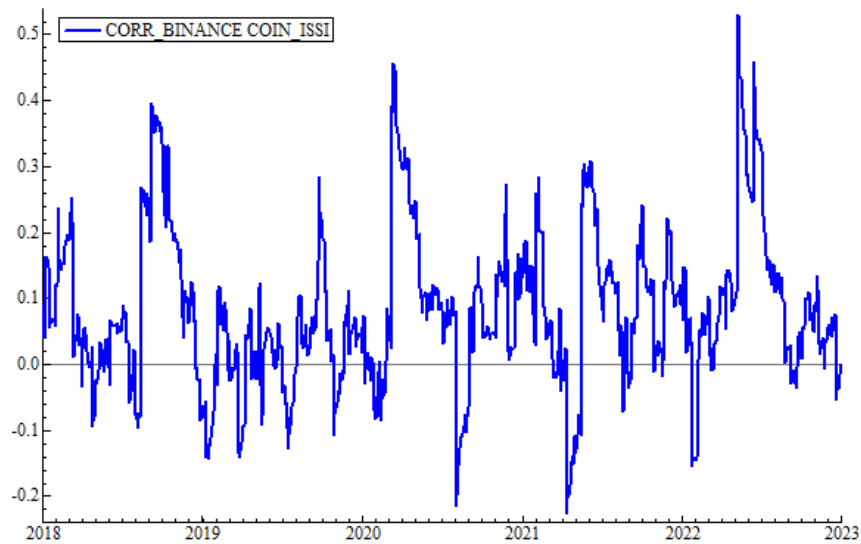


Figure 5. Dynamic Correlation Binance Coin and Indeks ISSI

Robustness Test

In testing the resilience of the results of the study (Herwartz & Roestel, 2022) by dividing the period when the problem or shock occurred in the study period. This study divided the period to test the resilience of the research results, namely the period before the occurrence of Covid-19 on January 2, 2018 – February 28, 2020 and when the occurrence of COVID-19 on March 2, 2020 – December 30, 2022.

Before the Covid-19 Pandemic

Table 5. Robustness Test CCC-MGARCH

Result of CCC-MGARCH Model				
	ISSI	Bitcoin	Ethereum	Binance Coin
σ	0.00009	0.00229	0.00342	0.00475
α	0.0493 (0.1094)	0.1625 (0.1868)	0.0993 (0.0549)*	0.0378 (0.1077)
β	0.9326 (0.0000)***	0.6824 (0.0010)***	0.6611 (0.0003)***	0.9335 (0.0000)***
ρ		-0.0129 (0.8086)	-0.00894 (0.8813)	0.0235 (0.6387)

Note: *** = 1%, ** = 5%, and * = 10% is level significant

Table 6. Robustness Test DCC-MGARCH

Result of DCC-MGARCH Model				
	ISSI	Bitcoin	Ethereum	Binance Coin
σ	0.00009	0.00229	0.00342	0.00475
α	0.0493 (0.1094)	0.1625 (0.1868)	0.0993 (0.0549)*	0.0378 (0.1077)
β	0.9326 (0.0000)***	0.6824 (0.0010)***	0.6611 (0.0003)***	0.9335 (0.0000)***
DCC(θ_1)	0.0347 (0.0025)***			
DCC(θ_2)	0.9388 (0.0000)***			

Note: *** = 1%, ** = 5%, and * = 10% is level significant

The estimation results of the CCC-MGARCH model correlation in cryptocurrency and the ISSI Index during the period before the pandemic were not significant in all cryptocurrencies. So that there is no correlation between all cryptocurrencies and the ISSI Index. Meanwhile, the estimation results of the DCC-MGARCH model in the period before the Covid-19 Pandemic show that the dynamic correlation between ISSI and Ethereum with a value of $\theta_1 + \theta_2 < 1$ is significant. The θ_1 parameter is a conditional variance that shows significant changes over time. The θ_2 parameter captures the dynamics

of the time-varying conditional correlation matrix, and its significance indicates that the multivariate correlation structure changes over time. In other words, the assets in the multivariate time series are highly correlated, and the strength of the correlation changes over time.

Pandemi Covid-19

Tabel 7. Robustness Test CCC-MGARCH Pandemi Covid-19

Hasil Estimasi CCC-MGARCH Model				
	ISSI	Bitcoin	Ethereum	Binance Coin
σ	0.00014	0.00251	0.00434	0.00485
α	0.1661 (0.0153)**	0.0693 (0.6884)	0.1514 (0.2033)	0.1717 (0.1283)
β	0.7514 (0.0000)***	0.8356 (0.0076)***	0.7775 (0.0000)***	0.7614 (0.0000)***
ρ		0.1339 (0.0062)***	0.1080 (0.0319)**	0.1348 (0.0156)**

Note: *** = 1%, ** = 5%, and * = 10% is level significant

Table 8. Robustness Test DCC-MGARCH Pandemi Covid-19

Hasil Estimasi DCC-MGARCH Model				
	ISSI	Bitcoin	Ethereum	Binance Coin
σ	0.00014	0.00251	0.00434	0.00485
α	0.1661 (0.0153)**	0.0693 (0.6884)	0.1514 (0.2033)	0.1717 (0.1283)
β	0.7514 (0.0000)***	0.8356 (0.0076)***	0.7775 (0.0000)***	0.7614 (0.0000)***
DCC(θ_1)	0.0192 (0.0000)***			
DCC(θ_2)	0.9713 (0.0000)***			

Note: *** = 1%, ** = 5%, and * = 10% is level significant

In the period during the Covid-19 Pandemic, the CCC-MGARCH Model shows that all correlations are significant between cryptocurrency and the ISSI Index so it is concluded that there is a correlation between Bitcoin and the ISSI Index, Ethereum and the ISSI Index and Binance Coin and the ISSI Index. Furthermore, the DCC-MGARCH estimation model shows that the robustness test results in all variables with a value of $\theta_1 + \theta_2 < 1$ are significant in all correlations between variables. The θ_1 parameter is a conditional variance that shows significant changes over time. The θ_2 parameter captures the dynamics of the time-varying conditional correlation matrix, and its significance indicates that the multivariate correlation structure changes over time. In other words, the assets in the multivariate time series are highly correlated, and the strength of the correlation changes over time.

V. CONCLUSION

Based on the results described in the previous chapter, it can be concluded in this study, Bitcoin correlates with the ISSI Index, the CCC-MGARCH estimation results show that the correlation strength is still low at 7.8%. Furthermore, in the DCC-MGARCH estimation results, the average dynamic correlation between Bitcoin and the ISSI Index is 7.9%.

Ethereum correlates with the ISSI Index, the CCC-MGARCH estimation results show that the strength of the correlation is still low at 6.8%. In the DCC-MGARCH results, the average dynamic correlation between Ethereum and the ISSI Index is 6.9%.

Binance Coin correlates with the ISSI Index, ISSI Index, the CCC-MGARCH estimation results show that the strength of the correlation is still low at 8.9%. Then in the DCC-MGARCH results, the average dynamic correlation between Binance Coin and the ISSI Index is 9.1%.

AUTHOR CONTRIBUTIONS

Conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing – original draft preparation, writing – review and editing, visualization: Nadya Noer Cahyani; Supervision: B.F.

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INFORMED CONSENT STATEMENT

Not applicable (studies not involving humans)

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author, [NNC].

CONFLICTS OF INTEREST

The authors declare no conflicts of interest

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