IDENTIFICATION OF MARKET VOLATILITY WITH SOLID VAR AUTOREGRESSION VALIDITY IN INDONESIA CRYPTOCURRENCIES OR GOLD

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ABSTRACT

Increasing market capitalization is characterized by high volatility but doesn't have the ability and potential for monetary function, Crypto world eventually shifted into the most attractive investment in the digital economy. Numerous published studies have required some improvement in the consistent relationship between commodities and financial assets and the authors proposed an alternative assessment with demonstrating the relationship between the trading volume activity of the most traded cryptocurrency in Indonesia (i.e., Ethereum) and other investment assets in Indonesia such as market indexes, rupiah exchange rate against the dollar, and gold, and related to cryptocurrencies in Indonesia which observed in over the last three years. A Var model as a quantitative and statistical approach introduced and tested the stationary data with significance value to identify the level of acceptance model. Consistency results from previous studies where Ethereum has the largest average return but higher risk and Gold as safer investment, ultimately diversification of the investment portfolio is suggested considering the degree of risk aversion.

ABSTRAK

Kapitalisasi pasar yang meningkat ditandai dengan volatilitas yang tinggi namun tidak memiliki kemampuan dan potensi fungsi moneter, dunia Crypto akhirnya bergeser menjadi investasi paling menarik di ekonomi digital. Sejumlah penelitian yang diterbitkan memerlukan beberapa perbaikan dalam hubungan yang konsisten antara komoditas dan aset keuangan dan penulis mengusulkan penilaian alternatif dengan menunjukkan hubungan antara aktivitas volume perdagangan mata uang kripto yang paling banyak diperdagangkan di Indonesia (yaitu, Ethereum) dan aset investasi lainnya di Indonesia seperti indeks pasar, nilai tukar rupiah terhadap dolar, dan emas, serta terkait cryptocurrency di Indonesia yang diamati selama tiga tahun terakhir. Model Var sebagai pendekatan kuantitatif dan statistic memperkenalkan dan menguji data stasioner dengan nilai signifikansi untuk mengidentifikasi tingkat penerimaan model. Hasil konsistensi dari studi sebelumnya di mana Ethereum memiliki pengembalian rata-rata terbesar tetapi risiko lebih tinggi dan Emas sebagai investasi yang lebih aman, pada akhirnya diversifikasi portofolio investasi disarankan dengan mempertimbangkan tingkat penghindaran risiko.

INTRODUCTION

Cryptocurrency is a digital currency whose communication channels and information are protected by using a code (cryptography) so that it can be guaranteed that it cannot be counterfeited or duplicated. Cryptocurrencies are not issued by the authorities of any country, so they cannot be intervened by any government, all transactions are regulated through the network. Currently, the cryptocurrency with the largest market capitalization in the world is Bitcoin (BTC) with a capitalization of 448 trillion dollars and followed by Ethereum (ETH) with a capitalization of 225 trillion dollars (cryptoratesxe.com, 2022).

Cryptocurrencies have a fairly long history with quite high price volatility. The price movements of Bitcoin and Ethereum in Figure 1 seem to have increased volatility in the last two years since the Covid-19 pandemic. Ethereum has a similar pattern of price movement to Bitcoin, for a cryptocurrency that only came out long after Bitcoin was in the market but already has a considerable capitalization to be the choice of investors other than Bitcoin.

Based on a survey conducted in 2022, there are 25.1 billion people in Indonesia who own Crypto, with the largest holdings in Bitcoin followed by Dodge coin and Ethereum. The average crypto holding in Indonesia is 16% slightly higher than the global average of 15%. Owners of crypto assets in Indonesia are dominated by 39% of residents aged between 18-34 years (finder.com, 2022). Based on research by Liang (2021), Bitcoin does not have the ability and potential to assume monetary function. Crypto in Indonesia may not be used as a means of financial transactions but can be traded as an investment asset in the futures market under Badan Pengawas Perdagangan Berjangka Komoditi (Bappebti). In Indonesia alone, there are 383 crypto assets that can be chosen as investments with 25 registered crypto traders (bappebti.go.id, 2022).

The pandemic Covid-19 in early 2020 has led to increased dependence on the internet. The average internet user spends 7 hours per day using the internet through various devices, the Indonesian population even spends almost 9 hours per day. Based on data about 62% of the world's population uses the internet and 58% of them use social media actively. An average of 10,2% of internet users own cryptocurrencies, even for Indonesia, there are around 16,4% of internet users own cryptocurrencies, with an increasing pattern every year (datareportal.com, 2022). The current increase in technology and digitalization has led to changes in investor behavior.

Crypto transactions in Indonesia have increased drastically to reach 859 trillion. This is supported by a very high increase in the number of crypto investors in Indonesia, which will reach 12,4 million investors by 2022 (katadata.co.id, 2022). According to Koraus et al (2021), the bitcoin feature is very attractive to investors in the digital economy which has transparent prices and without any intervention from any party. Historically, Bitcoin has had a loose relationship with other assets (Koraus et al, 2021). Many studies want to examine the relationship between cryptocurrencies and several investment options such as stocks, gold, and oil prices to see the pattern of the relationship based on time periods. Chikli et al (2021) and Wang et al (2022) find that the movement of influence between asset markets varies with time and shows a significant pattern of increase in the event of extreme events.

Kumar & Padakandla (2022) and Syuhada et al (2022) confirm that gold is consistently a safe haven for stock market investors in the short and long term, while for Bitcoin the results have not been consistent. However, Chikli et al (2021) found that Bitcoin has steadily become a safe haven for Islamic market indices when the economy is in decline. Vardar & Aydogan (2019) and Qarni & Gulzar (2021) find a short-term relationship and weak influence between the Bitcoin market and the foreign exchange market. However, according to Dahir et al (2019), Bitcoin is the main recipient of risk volatility from the stock market which is the dominant transmission catalyst for innovations that occur, that Handika et al (2019) also concluded that cryptocurrencies are not the right variable in explaining changes that happen in financial markets in Asia.

The results of previous studies are inconsistent so that is still a need for further exploration of the relationship between cryptocurrencies and several other financial assets based on stable and extreme time periods. The purpose of this paper is to determine the relationship between the return of the most traded cryptocurrency in Indonesia and other investment assets in Indonesia such as market indexes, rupiah exchange rate against the dollar, and gold, and related to cryptocurrencies in Indonesia. This paper focuses on the Indonesian market due to the phenomenon of an increase in the number of investors and the number of cryptocurrency transactions over the last three years. In this study, cryptocurrencies such as Ethereum are used, which are one the most traded cryptocurrencies in Indonesia where there is still limited research related to Ethereum in previous studies, especially research in turmoil periods such as pandemics.

This paper is structured as follows. Section 2 exhibits a brief review of the related literature and hypothesis development. Section 3 offers the methodology, the data sources, and descriptive statistics. Section 4 describes the empirical results and provides a discussion of research findings. Section 5 draws conclusions and proposes policy implications according to the empirical analysis.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Based on previous research on the relationship of return movements between financial assets and cryptocurrencies, it has been carried out with different approaches and methods. Kaczmarek et al (2022) used Recurrant Neural Networks (RNN) to perform market volatility predictions represented by Gated Recurrent Units (GRU), to predict Realized Bipower Variation (RBV). Koraus et al (2021) use Neural Networks and Spearman Correlation to see the relationship between cryptocurrencies and gold. Martyrs et al (2022) use a two-dimensional Copula to get an idea of the high-dimensional risk relationship between several assets. Dahir et al (2020) used TVP-VAR to model the relationship between financial assets. Vardar & Aydogan (2019) uses the GARCH BEKK VAR approach to look at the integration of returns and volatility between assets. Chkili et al (2021) use DCC FIGARCH to see correlations between assets. Qarni & Gulzar (2021) uses VAR to relate the relationship between cryptocurrencies and currency exchange rates. Kumar & Padakandla (2022) use a wavelet quantile correlation approach trying to capture tail dependence across different quantiles.

Based on Qarni & Gulzar (2021), a separate N-variable VAR model provides a more accurate measure for studying the influence of positive and negative volatility spillover in financial and alternative asset markets. BEKK-MGARCH model do not provide a straightforward interpretation for the magnitude and direction of spillover and contagion due to the model's non-linear measurement properties. The DCC MGARCH model provided a single measure of spillover and contagion for the entire set of economies, making it vague with respect to identifying the direction and magnitude of spillover among individual markets.

The reason why we use market indexes, the rupiah exchange rate against the dollar, gold, and oil prices related to cryptocurrencies in the Indonesian market is because much research has shown that there is a connectedness between these assets. The real asset shows the clustering volatility, which means the periods of high volatility are followed by the period of low volatility; the volatility follows each other but in a continued expectation. Investors have preferences from various investment options and these investor preferences can change based on the economic conditions that occur.

According to Baur and Lucey (2010) hedge is when an asset is uncorrelated or negatively correlated with another asset or portfolio on average. A strict hedge is (strictly) negatively correlated with another asset or a portfolio on average. Diversifier is when an asset that is positively (but not perfectly correlated) with another asset or portfolio on average. A safe haven is a hedge that happens in times of market stress or turmoil.

RESEARCH METHOD

This quantitative research uses secondary data in the form of crypto trading price returns, namely Ethereum (RETH) then gold trading prices (RGOLD), rupiah exchange rates (RKURS), and the composite stock price index (RM) in the Indonesian stock market on a weekly basis. The data taken is sourced from the investing.com page from August 30, 2018 to September 2, 2022. All data were processed using the VAR (Vector Autoregressive) method to see the relationship of causality and response between research variables. Referring to the research of Chkili, et., al (2021) and Vardar (2019), this study was conducted to prove that the volatility of Ethereum returns has a relationship and will affect other variables.

The basic formulation of the VAR model used is $= + \_ +$ where are variables of Ethereum return, gold return, rupiah exchange rate return, and JCI return. The length of the lag is symbolized by n while $_0$ is the variable of the constant n x 1 and is the coefficient of . Variable represents a shock to each variable. The first stage in this model is to conduct a root unit test to test the stationarity of the data. Stationer data indicate distribution of data is around its mean and variety. This test is necessary to avoid regression spurious which can result in invalid statistical testing and difficult to guide. The VAR model requires stationary data at the level viewed from the probability value of the variable. This study used the Augmented Dickey-Fuller Test root unit test (Amisano and Giannini, 1997). The hypothesis used is $_0$ rejected if the probability value is less than the significance value of 5% means that the data has been stationary at the level. However, if the value is greater than the hypothesis is accepted meaning that the VAR method cannot be used.

Based on the research of Zhang, et., al (2021) and Lu, et., al (2014) the analysis continued with the Time-varying Granger Causality Test. This is done to see whether there is a relationship between variables in one-time or time-varying series research. One of the popularities of these test the fact that it is identified using reduced-form VAR models, applicable to a set of potentially jointly determined variables where normalization and economic theory guideline are not required. The equation used is as follow.

$$( ) = \frac{\sum_{=1}^{-1} {}^2(—) \frac{2}{12,}( )- {}_2( )}{2 {}_2( )} \qquad (1)$$

T is the length of the sample, k(x) is the kernel function and M = MT , $—$ 0 is the smoothing parameter. In the VAR method, each variable is an endogenous variable, this test will prove the mutual correlation that occurs between one variable and another variable in the study. Then the entire data will be regressed to form a VAR model with a simple system using two changes and one inaction. The simultaneous model formed is as follows.

$$_1( ) = {}_{11} {}_1(-1) + {}_{12} {}_2(-2) + {}_1( ) \qquad (2)$$
$$_2( ) = {}_{21} {}_2(-1) + {}_{22} {}_2(-2) + {}_2( ) \qquad (3)$$

Assuming all stationary endogenous variables and errors with standard deviations are not correlated. The two equations have a reciprocal relationship because $_1( )$ and $_2( )$ mutual influence between one another. The endogenous variables in the VAR equation consist only of different lags so that the ordinary least square estimation results in a consistent conjecture. By using the matrix, the two systems can be written as follows.

$$\begin{bmatrix} _1( ) \\ _2( ) \end{bmatrix} = \begin{bmatrix} _{11} & _{12} \\ _{21} & _{22} \end{bmatrix} \begin{bmatrix} _1(-1) \\ _2(-1) \end{bmatrix} + \begin{bmatrix} _1( ) \\ _2( ) \end{bmatrix} \qquad (4)$$

The formed VAR model was then tested using a modulus stability test using the roots of characteristic polynomials against all variables. A model is said to be stable and is a valid model if it has a modulus smaller than 1 or all points are in a circle unit. Then the test continued by conducting an impulse response function (IRF) analysis to describe the response of a variable to shock from another variable. The IRF can also give an idea of the length of time the shock of the variable before it reaches its equilibrium point

Table 1. Descriptive Statistics and Stationarity

Variabel	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis	P-Value	Stasioner
RETH	0,0099	0,0044	0,3795	-0,4423	0,1279	-0,1851	4,6601	0,0000	Yes
RGOLD	0,0048	0,0045	0,1142	-0,0931	0,0237	0,4644	9,2778	0,0000	Yes
RKURS	0,0001	-0,0010	0,0782	-0,0507	0,0145	1,2061	11,9916	0,0000	Yes
RM	-0,0014	0,0026	0,0836	-0,1452	0,0273	-1,8923	11,9668	0,0000	Yes

again. The last test was a variance decomposition analysis to see which variables had more influence on a variable in this study.

RESULT AND DISCUSSIONS

We run all data using application named Eviews. 9 to check the descriptive analysis of each research variable. The result can be seen in Table 1. From the table above, it can be seen that Ethereum provides the largest average return compared to other investment instruments but the risk, which is symbolized by Standard Deviation is also greater. It shown Ethereum is more volatile than other instruments same with the result of Mariana et.al. (2021) research. Meanwhile average return of RGOLD is the second biggest in mean return but smaller standard deviation compares than RETH and RM. This evidence indicated that gold is better and safer investment than other. Shehzad (2021) has same conclusion and state that gold investments were evinced to be more beneficial. The portfolio of investor should be diversified by the investor's degree of risk aversion (Pho et., al. 2021).

The P-Value value of each variable is below the significance value indicating that H_0 rejected. and is ready to be used for the VAR method. The Figure 2 below shows that all variables have been normally distributed but in certain degree some of them have negative skewed (RM) while RKURS have shown positive skewed.

Before forming a valid model, it is necessary to select the optimum lag to be used. The determination of the lag length is necessary because too small a lag will make the model unable to explain the relationships between variables or be judged invalid. However, the lag is too long, the degree of freedom will become greater so that it is inefficient in explaining the model. This research uses a method that is often used, namely by looking at the Akaike Information Criterion (AIC) in the test results. If the AIC value in the result gets a * sign then the lag is the optimum lag. The results of the test show the following in Table 2.
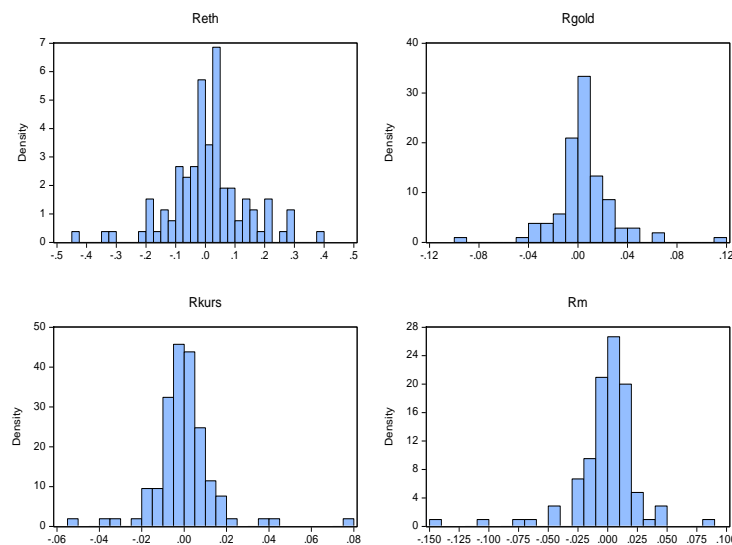

Figure 2. Normal Distribution

Table 2. Optimum Lag

Lag	LogL	LR	FPE	AIC	SC	HQ
0	743,534	NA	1,46e-12	-15,904	-15,795	-15,860
1	792,310	92,308*	7,20e-13*	-16,609*	-16,064*	-16,389*
2	806,027	24,778	7,57e-13	-16,560	-15,579	-16,164
3	819,967	23,982	7,96e-13	-16,515	-15,099	-15,944
4	825,604	9,2138	1,00e-12	-16,293	-14,441	-15,545
5	835,158	14,793	1,17e-12	-16,154	-13,866	-15,230
6	851,996	24,623	1,18e-12	-16,172	-13,449	-15,072
7	867,626	21,511	1,22e-12	-16,164	-13,005	-14,889
8	880,108	16,106	1,38e-12	-16,088	-12,494	-14,637
9	894,774	17,662	1,50e-12	-16,060	-12,029	-14,432
10	908,883	15,778	1,68e-12	-16,019	-11,553	-14,216
11	928,694	20,440	1,70e-12	-16,101	-11,199	-14,122
12	948,555	18,793	1,76e-12	-16,184	-10,846	-14,029

The test results show that the AIC value at lag 1 is marked * meaning that the optimum lag on the formed VAR model is lag 1. However, it is necessary to check further by observing the modulus values of all tests through Inverse Roots of AR. The result obtained is that all variables are marked with dots in a circle or have polynomial characteristic values below one as seen in appendix 1 below. This shows that the model formed is stable and valid.

Time-varying Granger Causality testing was performed on 104 available data using an optimum lag of 1. The significance values used are 5% and 10%, if the probability value of the test is below that value then $_0$ rejected means that the return of that variable affects the return on the other variable. The test results show a summary as presented in Table 3 below.

From the table above, the probability value RETH to RGOLD, RKURS and RM are smaller than significant value (RGOLD = 0,0676; RKURS = 0,0326; RM = 0,0457). It is mean $_0$ rejected and concluded that RETH is influenced by RGOLD, RKURS and RM. The result is against Mariana et., al (2021) that concluded uncorrelated between cryptho currency and market but has same result with Chkili (2021). On the contrary, RETH is only able to affect RKURS and the result is in line with Chkili (2021) and Vardar and Aydogan (2019).

Following previous studies, we continue to examine the pattern of relationships between variables. We formed a VAR model to see that positive relationships show that the movement of returns between these variables is unidirectional and cannot be safe haven for others. Whereas a negative relationship indicates that the variable acts as a hedge. The results can be seen in Table 4 where a negative relationship is formed between RETH and RGOLD which shows the movement of the two in opposite directions. If an investor has a portfolio containing both then when the Etherum return decreases, gold will compensate through an increase in its return or the so-called hedge. This negative relationship is also reflected in the results of the research of Chliki (2021), Baur and Lucey (2010). But this relationship pattern only goes one way because RGOLD/RETH has no relationship. This shows that if the price of gold decrease, then Ethereum cannot be a hedge for investors.

Table 3. Granger Causality

	RETH	RGOLD	RKURS	RM
RETH		0.1323	0.0678**	0.8101
RGOLD	0.0676**		0.0006*	7.00E-06*
RKURS	0.0326*	0.2683		3.00E-10*
RM	0.0457*	0.0208*	0.8072	

Description: * significant at 5% alpha and ** significant pad alpha at 10%

Table 4. Coefficient of VAR Method

	RETH	RGOLD	RKURS	RM
RETH	0.159942	0.02737	-0.01097	-0.03435
RGOLD	-0.71037	-0.31367	0.000147	-0.2304
RKURS	1.395124	0.529004	0.197187	-0.05715
RM	0.143339	0.329836	-0.29042	0.082324

Unidirectional relationship patterns are also seen in RETH/RM, RKURS/RGOLD, and RM/RKURS but with positive values. This shows that if the return of one of the instruments that is an endogenous factor decreases then the return of the exogenous factor also falls. Investors who diversify should pay attention to this to maximize the hedging function (Baur and Lucey, 2021).

The two-way relationship is seen in RGOLD/RM and RM/RGOLD as well as RETH/RKURS and RKURS/RETH which indicates that the relationship affects each other strongly between the two. The positive relationship between Etherum and exchange rates strengthens the research of Qarni and Gulzar (2021) which shows that crypto currency has a negative and positive effect on several currencies of the countries studied. But these results show that both cannot act as hedging instruments at the time of the shock.

Investors need to look at the movement of an instrument in the event of a shock and the VAR model provides these tools through the Impulse Responses Test. The results can be useful for supporting the above results as well as predicting the movement of the instrument in several periods. This study used these tools to predict volatility up to the 15th period. The results can be seen in figure 3 below.
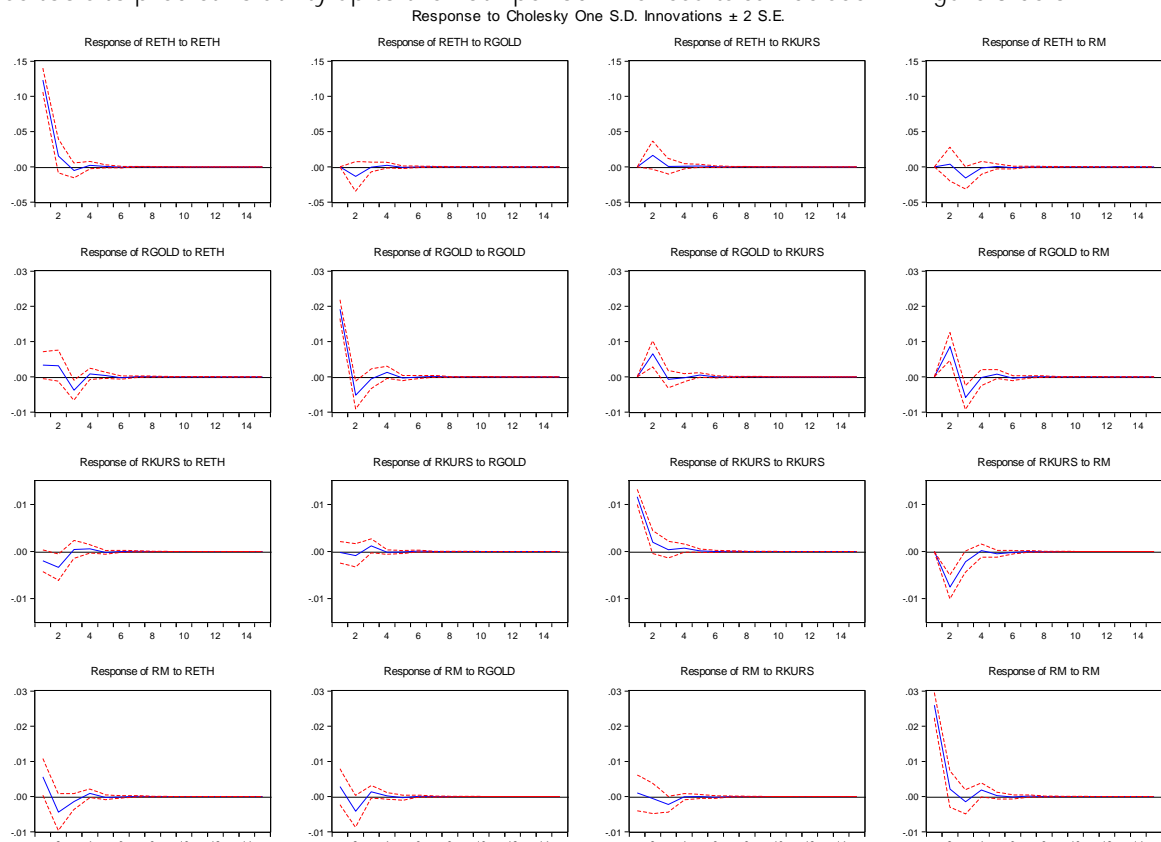

Figure 3. Impulse responses of market information on IRF Test. All impulse responses have similar results, so only some are shown
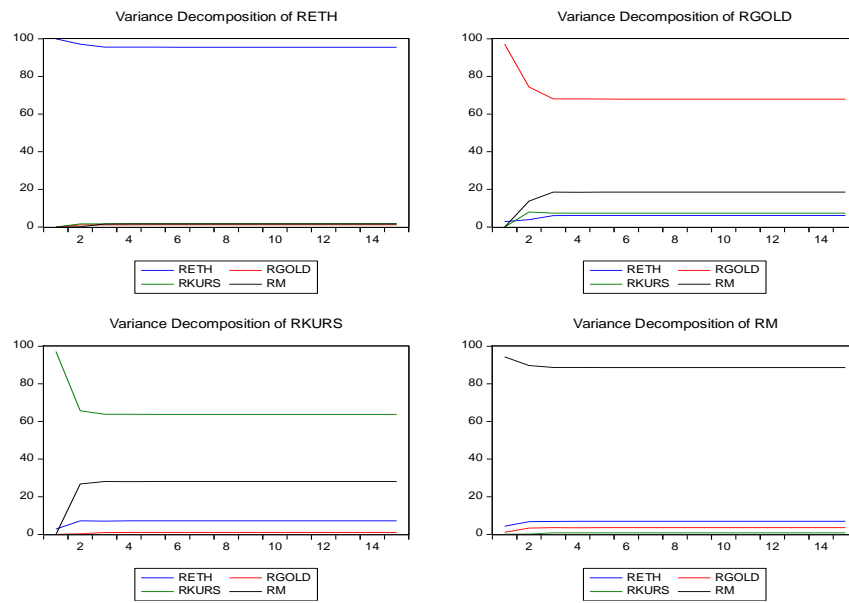
Figure. 4 Variance Decomposition

The figure above shows that on average the endogenous instrument is only influenced by its exogenous up to the period 4 to 6 after which its movement will return to its equilibrium. In addition, there is a variance decomposition test tool that can see which research variables have the most influence on endogenous variables. We run the existing data based on the formed VAR method. The results can be seen in Figure 4 below and find that the movement of Ethereum is more influenced by itself compared to other variables. This result also clarifies the results in previous tests that showed a unidirectional and two-way relationship occurred.

Figure 4 also shows that the movement of RKURS is influenced by itself by 63%, market return by 28% and other variables for the rest. It is in line with the significant positive relation between market return and Kurs return in VAR Model. Meanwhile, market return only influences gold return at 18.5% because the movement of gold is influenced by itself by 67% and 14.5% by other factors.

These empirical assessments have important implications for the dynamic domestic pricing of securities, for hedging and other trading strategies, and for regulatory policies within those four financial commodities markets. Accepting that volatility is caused by the same factors in these markets then we need to assess the impact of these factors for our understanding of the degree of co-integration in the pricing of securities within the regional context.

CONCLUSION

The proposed tests are here used to examine time-varying causal relationships among domestic cryptocurrencies and several investment commodities and currencies product, i.e., gold; and U$ to Indonesian Rupiah Kurs are considered. The results show that most information spillover among RETH (Cryptocurrencies of Ethereum) markets vary over time, which indicates the presence of evolving market linkages among domestic markets commodities. Ethereum shock will decrease the return of the market and gold but increase the market return in the opposite. The conclusion is reflecting investors' behavior that asks for more return for additional investment risk. The use of the dollar as a trading instrument of crypto transaction explains the reason for increased returns on currencies. The outline of the research shows that the Ethereum movement is influenced by itself meanwhile influencing other instruments in short term. In further, we suggest that other researchers are using other cryptocurrencies variables and

other tools of data processing to compare the result with ours. It will enrich results of research about the movement of investigation instruments that useful for investors' insight

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