ANALYSIS OF SPILLOVER EFFECT ON GREEN STOCK, COMMODITY AND CRYPTOCURRENCY MARKETS DURING COVID-19 PANDEMIC AND RUSSIAN-UKRAINE WAR

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ABSTRACT

The increasing risk of climate change is making changes to all aspects of humanity, including the financial sector. This study aims to determine the spillover effect between oil commodities, green stock markets in Indonesia and America and Bitcoin. Using the Vector Autoregression method, this study divides into several time periods, namely the overall period (April 2016 - February 2023), the period before the COVID-19 pandemic (April 2016 - December 2019), the period after the COVID-19 pandemic (January 2020 - February 2022), the Russian-Ukrainian war period (February 2022 - February 2023) and uses daily return data from Crued Oil WTI, Nasdaq OMX Green Economy, SRI-KEHATI Index and Bitcoin. The results showed that in the crisis period there was a spillover effect on all research variables. Therefore, investors should avoid these four instruments when there is a shock to one of the financial instruments. That way, investors can reduce the loss of their investment and wait for the opportunity to buy back financial assets after the crisis period is over.
Keywords: spillover; crued oil; hisa ya kijani; cryptocurrency

1. Introduction

In recent decades, the issue of sustainability has become a global conversation, due to the increasing risk of climate change. According to the Mckinsey Report (2020) found that the physical risks of climate change are already present and growing, as the planet's temperature has increased by an average of about 1.1 degrees Celsius since the 1880s. The sustainability agenda began to be widely discussed when the United Nations (UN) issued the Sustainable Development Goals (SDGs) since 2016. According to Bappenas (2023), the Sustainable Development Goals are a commitment from countries that are members of the United Nations to carry out development that maintains sustainable improvement of people's economic welfare, development that maintains the sustainability of people's social lives, development that maintains the quality of the environment and development that ensures justice and the implementation of governance that is able to maintain an improved quality of life from one generation to the next. The commitment made by various countries was strengthened by the Paris Climate Agreement in 2015 where the agreement was attended by 195 countries that agreed to reduce the risk of climate change until 2030. Indonesia itself only joined the Paris Agreement on April 22, 2016.

As the risk of climate change increases, so does the financial sector and investor behavior. One way to reduce global risks related to environmental issues in the financial sector is to issue green bonds and determine green stocks for companies that have paid attention not only to environmental issues but other aspects. This step can be taken as one of forming new financial

assets called green finance or green investing and making investors interested in environmental issues in their investments. According to Tran, et al. (2020) green investing is a process of making investment decisions based on environmental protection criteria with the aim of having a positive impact on the environment, and generating certain financial returns on investments made. One of the green assets, green bonds, are fixed income assets that finance investments with environmental or climate-related benefits (Ehlers & Packer, 2017).

On the other hand, the emergence of cryptocurrencies is also considered as a way to reduce the global risk of climate change, but this is still a matter of debate, including among academics or researches. According to the British Broadcasting Channel (BBC), academics from Cambridge estimate that Bitcoin consumes about 121.36 terawatt-hours (TWh) of electricity every year, which is more than the electricity consumption of Argentina with a population of 46 million. The increased energy required to produce Bitcoin assets could increase the risk of climate change. On the contrary, according to Badea and Mungiu-Pupazan (2021) despite its high energy consumption and adverse environmental impacts, Bitcoin continues to be an instrument used in the environmental economy for various purposes and trends regarding Bitcoin regulations in different countries show that the use of Bitcoin is gaining legitimacy, despite criticisms of this cryptocurrency.

Based on the explanation above, researchers want to see the relationship between each financial instrument, namely, green stocks, oil commodities and Bitcoin during the COVID-19 pandemic and the war conflict between Russia and Ukraine. The advantage of this research is that there has not been much research related to the relationship between green stocks in Indonesia and America with other instruments such as crude oil and Bitcoin. In addition, there have not been many studies related to the comparison of the spillover effect between the four instruments during the COVID-19 pandemic and the war between Russia and Ukraine. Di and Xu (2022) examined the spillover effects between Bitcoin assets, commodities and stocks in developed and developing countries for the period before the COVID-19 pandemic and the period after the vaccine for COVID-19. Another research from Urom, et al. (2020) examined the spillover effect on stocks, Bitcoin and oil and gold commodities using the Baynesian TVP-VAR method. The results of this study provide convincing evidence of time variation in the level of volatility spillover, and that spillover increases during extreme global market conditions. The choice of this instrument is because during the COVID-19 pandemic and war there were shocks to oil commodities. During the COVID-19 pandemic there were shocks to the demand for oil commodities, while during the Russian and Ukrainian wars there were shocks to the supply of oil commodities. Bourghelle, et al. (2021) states COVID-19 pandemic created a demand shock as reduced global demand for crued oil and triggered an economic recession. Different from COVID-19 pandemic, oil shock during Russia-Ukraine war will affect global economy via three main channels: financial sanction, commodities and supply chain disruptions (Bagchi & Paul, 2023). Oil commodities are used because although all countries are trying to switch from non-renewable energy to renewable energy, a transition in energy use is needed so that oil energy is still very much needed today. Meanwhile, the selection of green stock market financial instruments was chosen because these instruments are still rarely researched, especially in the green stock market in Indonesia. According to World Energy Investment (2020), a major shock from the COVID-19 pandemic, investment activity was disrupted by lockdown policies, especially for oil prices. However, clean energy investment is relatively stable in decline. For the selection of Bitcoin variables due to the policy regarding Bitcoin in Indonesia, it can currently be traded as a commodity, which also supports the purpose of this study to see whether Bitcoin financial assets can be used as hedging for portfolios from green stock markets in Indonesia and America.

2. Literature Review

Di and Xu (2022) examined the spillover effects between Bitcoin assets, commodities and stocks in developed and developing countries for the period before the COVID-19 pandemic and the period after the vaccine for COVID-19. This study uses the Vector Autoregression (VAR) and Generalized Forecast Error Variance Decomposition methods. The results show a higher correlation between Bitcoin and traditional financial assets such as stocks, gold and oil. However, during the COVID-19 recovery period, the correlation between Bitcoin and other financial instruments was very low after the vaccine became available. This result proves that the effect of the COVID-19 vaccine has a positive effect on the economic recovery from the Pandemic because the vaccine revives public confidence, especially investors, in the economy and financial markets despite the increase in the number of COVID-19 cases due to Omicron. Vaccination is a successful tool to aid economic recovery and reduce pressure on financial markets. The research also found that Bitcoin was a strong transmitter of volatility during COVID-19.

Meanwhile, research from Wen, et al. (2022) where this study observed that gold and Bitcoin instruments are good safe haven assets during the COVID-19 Pandemic. Using the Time-varying Parameter VAR (TVP-VAR) method, the results of this study are that the impact of oil commodities on gold and Bitcoin assets is more significant in the short term but less significant in the medium and long term. The effect of oil commodities on gold and Bitcoin was mostly negative before the COVID-19 pandemic, but there was a change in direction to positive when the pandemic began. Thus, gold and Bitcoin have a good hedging effect for oil before the COVID-19 pandemic. Meanwhile, in the period after the pandemic, for Bitcoin assets, there is a mixed positive response during the COVID-19 pandemic, indicating that Bitcoin cannot be a safe haven asset for oil assets during the COVID-19 pandemic. For gold, there was a positive response at the beginning of the COVID-19 pandemic. Therefore, gold is not a safe haven hedge for oil. After that, the time-varying response changes from positive to negative, but the negative relationship is weak and only lasts for a short time. Therefore, the safe haven properties of gold assets for oil appear short-term only.

In addition to examining the relationship between oil commodities and gold and Bitcoin assets, Wen, et al. (2022) also examined the effect of a shock in the stock market on gold and Bitcoin prices. The existence of a shock in the stock market has a more significant spillover response in the short term, but there is no spillover effect in the medium and long term. The impact of the shock in stocks on gold prices was negative throughout the period before the COVID-19 pandemic. Thus, gold has a good hedging effect against shocks in the stock market before the COVID-19 pandemic. This contrasts Bitcoin with the stock market, where Bitcoin price spillovers are always positive. This implies that Bitcoin is not a safe haven asset against stock market shocks during the COVID-19 pandemic, nor is it a hedging tool for the stock market before the COVID-19 pandemic.

Research from Urom, et al. (2020) examined the spillover effect on stocks, Bitcoin and oil and gold commodities using the Baynesian TVP-VAR method. The results of this study provide convincing evidence of time variation in the level of volatility spillover, and that spillover increases during extreme global market conditions. In contrast, stocks are relatively less responsive to volatility spillovers during extreme events. This proves that the increased spillovers found for both risks can lead to financial contagion. Second, the results from the cross-quantilogram show strong dependence and positive directional predictability between Bitcoin, stock markets in several countries and crude oil during bull market returns. However, during bear market periods, there is negative dependence and predictability from Bitcoin to stocks in Finland, the Netherlands, the US and the crude oil market only. This implies that Bitcoin can act as a hedge against stocks in Finland, the Netherlands, the US, and the crude oil market. However, the insignificant dependence and directional predictability from Bitcoin to

the remaining assets suggests that Bitcoin can act as a safe haven for these assets during bear markets.

Meriyani, et al. (2022) showed by using the Multiple Regression method, the movement of crude oil prices has a positive effect on the price of Bitcoin. This means that the volatility of crude oil prices will affect the volatility of Bitcoin prices either when crude oil prices rise or fall. As we know, trading cryptocurrency assets such as Bitcoin is traded daily so there is no period to rest so Bitcoin volatility is also very high. Based on the findings of this study, it can also be concluded that the effects of crude oil price movements will affect the price of Bitcoin in the long run and it can be assumed that there will be a role of crude oil prices from Bitcoin volatility during 2021. The study also found that the spillover effects of gold or crude oil are more crucial than other spillover effects, suggesting a link between Bitcoin assets and crude oil. Meanwhile, the effect of natural gas commodity assets on Bitcoin assets is that the price movement of natural gas commodity assets has a positive effect on the price movement of Bitcoin. This shows that the volatility of natural gas will affect the price movement of Bitcoin, for example if the price of natural gas assets increases or decreases, it will affect the volatility of Bitcoin.

The research results from Qian, et al. (2022) using TVP-VAR and Spillover Indices based on Diebold-Yilmaz, namely first, dynamic spillover analysis and robustness tests show that bitcoin, gold, and commodities have a weak hedging effect on the stock market. The ability of the studied financial instruments to act as safe haven properties ranked based on the research results are commodities, gold and then bitcoin. Second, the dynamic spillover analysis directly shows that the world stock market and developed countries act as net spillover transmitters, while bitcoin, gold, and commodities are net receivers. Third, the total dynamic average spillovers increase significantly after extreme risk events occur. More specifically, the spillover effect decreased from 50.84% to 39.37% when the European debt crisis ended, but the spillover effect increased rapidly to 48.43% during the COVID-19 outbreak, which means that risk transmission is more sensitive when a crisis occurs. Finally, the dynamic total spillover measurement reveals that the total spillover of six markets exhibits significant time-varying characteristics, ranging from nearly 20% to 80%, indicating relatively strong spillover effect information among bitcoin, gold, commodities, and stock markets.

Research from Fareed (2022) using the Rolling Window Multiple Correlation method and Polanco-Martinez (2020) found that in the bivariate case COVID-19 significantly and positively affects the carbon efficiency index, has a significant negative effect on oil prices and has a significant and asymmetric impact on bitcoin While in all tetra-variate cases, these studies found a positive and significant correlation between Bitcoin and green stocks while a significant negative impact on oil commodities. The findings of this study corroborate important policy implications for investors. Investors can also diversify their portfolios from oil commodities to Bitcoin and green stocks during pandemic-type crises. In other words, stocks of low-carbon companies and crypto markets can serve as safe haven assets for investors against the shock of the COVID-19 pandemic.

3. Research Methods

The VAR model is a multivariate model for time series analysis. In a VAR model, the dependent variable is not only affected by the lag of the variable itself, but also by the lags of other variables in the model. In general, the VAR model is expressed as:

$$y_t = c + A_1 y_{t-1} + A_2 y_{t-2} + ... + A_p y_{t-p} + e_t \quad (1)$$

where:
y_t = dependent variable at t

C = constanta
A_1, A_2 = coefficient matrix
y_{t-1}, y_{t-2} = dependent variable matrix at t
ε_t = residual matrix or error

In this study, the dependent variables used are the returns of green stocks in Indonesia and America, Bitcoin also Oil. Therefore, the research model is as follows:

$$(2) \quad \begin{bmatrix} OR \\ SR_{US} \\ SR_{ID} \\ BR \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix} \begin{bmatrix} OR \\ SR_{US} \\ SR_{ID} \\ BR \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \\ e_{4t} \end{bmatrix}$$

where:
OR = return of crued oil WTI
SR_{US} = return of American green stock
SR_{ID} = return of Indonesian green stock
BR = return of Bitcoin
α = lag operator
e = error

In the model, it is assumed that the oil commodity is the source of the shock so that it ranks first in the model. Furthermore, the shock caused by oil will have an impact on the green stock market, both in Indonesia and America as well as Bitcoin. The three financial instruments are instruments that receive or absorb shocks not as an alternative to shocks.

4. Research Findings and Discussion

An overview of the return movement during the research period can be seen through the descriptive statistics of each variable in the time period that has been classified in this study.

4.1 Descriptive Statistic

Table 1. Descriptive Statistics of All Variables Based on the Research Period

	SR_{ID}	SR_{US}	OR	BR
Mean	0.03%	0.05%	-0.14%	0.36%
Median	0.03%	0.10%	0.22%	0.23%
Max	15.87%	9.69%	37.66%	26.77%
Min	-7.86%	-11.52%	-305.9%	-38.17%
Std dev	1.30%	1.26%	8.72%	4.79%
N	1657	1657	1657	1657
Mean	0.04%	0.05%	0.06%	0.43%
Median	0.04%	0.09%	0.19%	0.29%
Max	3.77%	5.15%	14.68%	26.77%
Min	-5.40%	-5.19%	-9.03%	-21.87%
Std dev	1.06%	0.74%	2.03%	4.90%
N	889	889	889	889
Mean	-0.001%	0.09%	-0.54%	0.45%

Median	-0.03%	0.15%	0.27%	0.31%
Max	15.87%	9.69%	37.66%	21.38%
Min	-7.86%	-11.52%	-305.97%	-38.18%
Std dev	1.74%	1.68%	15.21%	4.90%
N	519	519	519	519
Mean	0.04%	-0.02%	-0.01%	-0.06%
Median	0.07%	0.03%	0.27%	-0.15%
Max	3.03%	6.10%	12.91%	13.25%
Min	-5.79%	-7.59%	-12.13%	-24.15%
Std dev	0.95%	1.69%	3.10%	4.10%
N	247	247	247	247

Based on table 1, of the return movement of each variable used and the statistical description, the four return variables experienced significant price movements during the COVID-19 pandemic. The SRI-KEHATI index decreased by 7.86% and the Nasdaq OMX Green Economy decreased by 11.52%. Likewise with Bitcoin financial assets which experienced a decline during the COVID-19 pandemic of 38.18% and oil commodities which experienced a decline of 305.97%. However, during the COVID-19 pandemic, these four assets also had the largest increase during the study period. The SRI-KEHATI index increased by 15.87%, the Nasdaq OMX Green Economy increased by 9.63%, while Bitcoin increased by 21.38% and the WTI oil commodity increased by 37.62%.

4.2 Regression Result

The following are the results of VAR estimation on each optimum lag throughout the study period.

Table 2. Regression Result Across All Period

Lag	Adjusted R^2			
	OR	SR_{US}	SR_{ID}	BR
Overall Period				
0	-	-	-	-
1	0.101	0.003	0.053	0.003
73	0.217	0.261	0.232	0.197
Before COVID-19 Period				
0	-	-	-	-
1	0.016	0.016	0.043	0.0001
19	0.129	0.109	0.131	0.094
After COVID-19 Period				
0	-	-	-	-
2	0.188	0.081	0.110	0.023
27	0.761	0.336	0.361	0.292
Russia-Ukraine War Period				
0	-	-	-	-
23	0.483	0.506	0.476	0.540

Based on the table 2, in the overall period, lag 73 has a higher adjusted R^2 value than the other lags. value that is higher than the other lags, while in the period before the COVID-19

pandemic, lag 19 has an adjusted R^2 value that is higher than the other lags. period before the COVID-19 pandemic, lag 19 has the highest adjusted R^2 value among other lags. value is higher among other optimum lags. For the period after the COVID-19 pandemic COVID-19 pandemic, lag 27 has a higher adjusted R^2 value than lag 2. than lag 2. Finally, in the period of war between Russia and Ukraine lag 23 has a higher adjusted R^2 value compared to other lags.

4.3 Result Discussion

      To discuss the research results related to the relationship between the variables used in the study and the resulting response of each variable to a shock from other variables, it is necessary to look at the results of the Impulsive Response Function and Variance Decomposition more deeply.

Table 3. Impulse Response Function Result

Impulse	Response			
	OR	SR_{US}	SR_{ID}	BR
Overall Period				
OR	0.0213	0.0002	0.0001	0.0034
SR_{US}	0.0005	0.0111	0.0019	0.0149
SR_{ID}	-0.0001	0.0005	0.0090	0.0022
BR	-0.0001	0.0037	0.0029	0.0566
Before COVID-19 Period				
OR	0.0161	0.0009	-0.0024	0.0117
SR_{US}	0.0047	0.0057	0.0009	-0.0087
SR_{ID}	-0.0016	0.0020	0.0078	0.0027
BR	0.0011	0.0022	0.0012	0.0617
After COVID-19 Period				
OR	0.1512	-0.0027	0.0003	-0.0118
SR_{US}	-0.0624	0.0138	0.0021	0.0274
SR_{ID}	0.0209	-0.0009	0.0145	0.0103
BR	-0.0084	0.0044	0.0036	0.0578
Russia-Ukraine War Period				
OR	0.0154	-0.0041	-0.0007	-0.0303
SR_{US}	-0.0081	0.0125	0.0061	0.0101
SR_{ID}	0.0019	-0.0122	0.0050	-0.0246
BR	0.0088	-0.0009	0.0017	0.0210

      Based on the results of the table above, it shows that the shock that occurs in the oil commodity variable has a positive impact on American green stocks in the overall period and before the COVID-19 pandemic, but has a negative effect during the COVID-19 pandemic period and the war period between Russia and Ukraine. This is the same experienced by the Bitcoin variable against the shock from the oil commodity, where in the overall period and before the COVID-19 pandemic the shock to the oil commodity had a positive impact on the Bitcoin variable, but in the COVID-19 pandemic period and the war period between Russia and Ukraine the shock from the oil commodity had a negative impact on the Bitcoin variable. For the Indonesian green stock variable, it has a positive response to the oil commodity shock in the overall period and the COVID-19 pandemic, but in the period before the COVID-19 pandemic and the war between Russia and Ukraine, the response of the Indonesian green stock variable to shocks to oil commodities has a positive response.

In shocks that occur in green stock variables in America, the response of oil commodity variables is positive in the overall period and the period before the COVID-19 pandemic, but has a negative response in the COVID-19 pandemic period and the period of the Russian and Ukrainian wars. While the response of Indonesian green stocks to shocks to the American green stock variable has a positive response in all periods of the study, both in the overall period, the period before the pandemic and after the COVID-19 pandemic as well as the period of the Russian and Ukrainian wars. For the response of the Bitcoin variable to shocks from the American green stock variable, it has a positive response in the overall period, after the COVID-19 pandemic and the Russian and Ukrainian wars. Only the period before the COVID-19 pandemic, where the Bitcoin variable has a positive response to shocks to the American green stock variable.

The shocks that occur in the Indonesian stock variable, the response experienced by the oil commodity variable is negative in the overall period and before the COVID-19 pandemic, but has a positive response in the period of the COVID-19 pandemic and the Russia and Ukraine war. The American green stock variable shows a positive response in the overall period and before the COVID-19 pandemic and has a negative response in the period of the COVID-19 pandemic and the Russian and Ukrainian wars. For the Bitcoin variable, it has a positive response in the overall period, before and after the COVID-19 pandemic to shocks to the Indonesian green stock variable. However, only in the period of the Russian and Ukrainian wars did the Bitcoin variable have a negative response to shocks to green stock variables in Indonesia.

Meanwhile, shocks that occur to the Bitcoin variable have a different response from the oil commodity variable, where in the overall period and the COVID-19 pandemic show a negative response. But in the period before the COVID-19 pandemic and the war in Russia and Ukraine, the oil commodity variable has a positive response to shocks in the Bitcoin variable. For the response of the green stock variable in America to Bitcoin variable shocks, it has a positive response in the overall period, before and after the COVID-19 pandemic, but has a negative response in the period of the Russian and Ukrainian wars. Finally, the response of the green stock variable in Indonesia to Bitcoin variable shocks is positive throughout the study period.

Table 3. Variance Decomposition Result

Impulse	Response			
	OR	SR_{US}	SR_{ID}	BR
Overall Period				
OR	93.8074	2.5580	2.2383	1.3962
SR_{US}	4.6778	91.3817	2.0390	1.9015
SR_{ID}	1.8752	6.2526	89.7215	2.1507
BR	0.7983	4.7073	1.7711	92.7233
Before COVID-19 Period				
OR	90.5777	4.2372	2.9708	2.2143
SR_{US}	6.1705	89.4371	1.9407	2.4517
SR_{ID}	2.2908	8.84405	87.0761	1.7890
BR	1.1626	2.5683	2.0503	94.2188
After COVID-19 Period				
OR	63.4368	13.4145	19.2330	3.9157
SR_{US}	7.4168	83.0716	5.5229	3.9888
SR_{ID}	4.2692	5.7036	85.9920	4.0351

BR	3.06001	14.4347	3.2137	79.2916
Russia-Ukraine War Period				
OR	75.0442	10.2393	8.9452	5.7713
SR_{US}	12.2699	69.8705	11.2026	6.6569
SR_{ID}	10.6089	13.7322	67.4593	8.1997
BR	15.4447	25.5268	7.9433	51.0852

Based on the results of the Variance Decomposition summary table, it shows that for oil commodity variables, the overall period is most influenced by the American green stock variable by 2.55%, where in the period before the COVID-19 pandemic the influence of American green stocks was 4.23% and increased to 13.41% in the COVID-19 pandemic period. In the period of Russia and Ukraine war, the influence of US green stocks on oil commodity variables decreased to 10.24%. For the American green stock variable, throughout the study period, the oil variable influenced the American green stock the most. However, the influence of oil commodity variables was highest in the period of the Russian and Ukrainian wars at 12.27%, followed by the COVID-19 pandemic period at 7.42% and the period before the COVID-19 pandemic at 6.17%. In the overall period, the influence of oil commodities on green stock variables in America amounted to 4.68%.

In the green stock variable in Indonesia, throughout the study period, it shows that the variable that has the most influence on the green stock variable in Indonesia is green stocks in America. The influence of the American green stock variable on the Indonesian green stock variable in the overall period is 6.25%, where in the period before the COVID-19 pandemic the influence of the American green stock variable was 8.84%. In the COVID-19 pandemic period, the influence of the green stock variable has decreased to 5.70% and there is an increase in the influence of oil commodities on the Indonesian green stock variable, which in the period before the COVID-19 pandemic the influence was 2.29% to 4.27% in the COVID-19 pandemic period. During the Russia and Ukraine war period, the influence of the green stock variable in America and the oil commodity variable was 13.73% and 10.60%.

For the Bitcoin variable, throughout the study period the influence exerted by other variables was the American green stock variable. In the overall period, the influence of the American green stock variable was 4.70%, where in the period before the COVID-19 pandemic the influence of American green stocks was 2.57%, then increased to 14.43% in the COVID-19 pandemic period. In the period of the Russia and Ukraine war, the influence of the American green stock variable increased again to 25.52%.

4.4 Economic Analysis

Based on the results of the discussion, it can be seen that there is an increase in spillover during the crisis period of both the COVID-19 pandemic and the Russian and Ukrainian wars, this is the same as the results of the research by Li, et al. (2023) which states that there is an increase in the relationship between oil commodities and Chinese green stocks during the COVID-19 pandemic, and Gkillas, et al. (2022) which states that an increase in volatility (shock) in oil commodities will increase the linkage effect between oil commodities and Bitcoin. This shows that the need for diversification for an investor in investing, especially during periods of crisis.

In addition, this study can also see the relationship between oil commodities and American stocks and Bitcoin changing from positive in the period of no crisis and negative when a crisis occurs. The Indonesian green stock variable has a dynamic relationship with oil commodities, where in the COVID-19 pandemic period it has a positive relationship in the period of the Russian and Ukrainian wars it has a negative relationship. While the relationship between Indonesian and American green stock variables has a different relationship when there

is a crisis or no crisis, where in the period before the COVID-19 pandemic has a positive relationship but when in the period of the COVID-19 pandemic and the Russian and Ukrainian wars the relationship between Indonesian green stock variables and American green stocks has a negative relationship.

Based on the Impulse Response Function and Variance Decomposition results, it can be concluded that in the crisis period there was a spillover effect on all variables. Therefore, investors should avoid these four instruments when there is a shock to one of the financial instruments. That way, investors can reduce the loss of their investment and wait for the opportunity to buy back financial assets after the crisis period is over.

5. Conclusion

This study aims to look at the spillover effect between oil commodity instruments, green stocks in Indonesia and America and Bitcoin. In this study, researchers divided into 4 research periods, namely the overall period, the period before the COVID-19 pandemic, after the COVID-19 pandemic and the period of the Russian and Ukrainian wars. The results show there is an increase in spillovers during the crisis period of both the COVID-19 pandemic and the Russian and Ukrainian wars, which can be seen from the Variance Decomposition results. Another finding from this research that the relationship between oil commodities and US stocks and Bitcoin changes from positive in the period of no crisis and negative when a crisis occurs, while the Indonesian green stock variable has a dynamic relationship with oil commodities, where in the COVID-19 pandemic period it has a positive relationship in the period of the Russian and Ukrainian wars it has a negative relationship. The last, for the green stock variable in Indonesia, there is an increasing relationship with the US green stock variable and oil commodities during the crisis period. Based on this study also suggest that investors should avoid these four instruments during crisis period since an increase in spillover effect between one instrument and another.

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