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Dynamic Correlation of Commodities, Stock Market and Exchange Rate in Period of Russia-Ukraine War

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Abstrak
Tujuan penelitian ini adalah untuk menentukan korelasi dinamis antara JCI (*Jakarta Composite Index*) dan beberapa komoditas seperti emas, minyak, dan nilai tukar USD/IDR. Metode yang digunakan dalam penelitian ini adalah pendekatan kuantitatif dengan teknik analisis data runtut waktu dengan *Dynamic Conditional Correlation-Generalized Autoregressive Conditioned Heteroscedasticity* (DCC-GARCH). Data dalam penelitian ini adalah data harian JCI dari Bursa Efek Indonesia, harga emas, harga minyak, dan nilai tukar Dolar terhadap Rupiah (USD/IDR) mulai dari masa pandemi Covid-19 hingga selama perang Rusia-Ukraina. Hasil penelitian ini menemukan bahwa perubahan harga emas dan minyak, baik Brent maupun WTI, memiliki pengaruh signifikan terhadap volatilitas JCI selama periode perang Rusia-Ukraina pada tahun 2022. Namun, terdapat korelasi yang berbeda antara JCI dan nilai tukar USD/IDR di mana nilai tukar Dolar terhadap Rupiah tidak berpengaruh signifikan terhadap JCI atau dapat dikatakan memiliki korelasi yang lemah selama periode perang Rusia-Ukraina.

Kata kunci: DCC-GARCH, nilai tukar, emas, JCI, minyak

Abstract
The purpose of this study is to determine the dynamic correlation between JCI (Jakarta Composite Index) and some commodities such as gold, oil and the exchange rate of USD/IDR. The method used in the study is a quantitative approach with the time series analysis technique Dynamic Conditional Correlation-Generalized Autoregressive Conditioned Heteroscedasticity (DCC-GARCH). The data in this study are daily JCI data from the Indonesia Stock Exchange, gold prices, oil prices, Dollar to Rupiah (USD/IDR) exchange rate starting from during the Covid-19 pandemic to December 30, 2023 during the Russia-Ukraine war. The results of this study found that changes in gold and oil prices both Brent and WTI have a significant effect on the volatility of the JCI during the Russia-Ukraine war period in 2022. However, there is a different correlation between JCI and USD/IDR Exchange Rate where the Dollar to Rupiah Exchange Rate does not significantly affect JCI or can be said to have a weak correlation during the Russia-Ukraine war period.

Keywords: DCC-GARCH, exchange rate, gold, JCI, oil

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INTRODUCTION

In early 2020 Indonesia was faced with a less stable economy due to the Covid-19 outbreak, which affected global economic conditions (QingXu et al., 2022). The Covid-19 virus has disrupted the global supply chain, resulting in reduced aggregate demand. As a result, not only energy is affected, but also the consumption of commodity goods, especially the price of oil which is destroyed, even minus so that there is a decline in the price of crude oil in the international market during the first four months of 2020 (Mahmood et al., 2022). However, something different happened during the Russia-Ukraine war, where world crude oil prices tended to increase, even in early March 2022 it was estimated that the price of crude oil commodities reached a price of $120 per barrel (Ruchuan Ma et al., 2021). Along with the raising of another commodities price.

Over time with the conflict between Russia and Ukraine in 2022, the world oil price increased (Kumari et al., 2023). On the other hand, during the Covid-19 pandemic, oil prices decreased while gold prices tended to increase. This is one of the causes of destruction for the world economy from the impact of Covid-19 which occurred in early 2020 (Amar et al., 2023).

Different things happened during the post-pandemic period, where gold prices tended to rise. In addition, during the recovery period of economic conditions from the effects of the Covid-19 pandemic, in early 2022 there was a dispute between Russia and Ukraine which caused a major conflict in the European part of the world (Ustaoglu, 2023). Where the Russia Ukraine war itself is one of the many new global events and not only causes human suffering, but also endangers the global economy. The war event will also have an impact on stock market returns and volatility (Mahmood et al., 2022). Where stock market volatility can be seen from the JCI for Indonesian context.

During the Covid-19 pandemic the JCI decreased drastically, which means that stock prices on the IDX (Indonesia Stock Exchange) were weakening, or it can be concluded that investors tended to sell their assets during the pandemic. On the other hand, during the Russia-Ukraine war, the JCI moves upward. This shows that, during the Russia-Ukraine war, investors actually tended to invest by increasing the amount of assets they owned. Global and national risks due to the Russia-Ukraine war also cause changes in commodity prices to impact the value of a country's currency in the international market, this can happen because the foreign exchange rate is a measure of the economy and the relative level of financial health of a country (Sokhanwar & Bouri, 2023).

Research conducted by Syahri & Robiyanto (2020); Churchill et al (2019); Arisandhi & Robiyanto (2022); Sokhanwar & Bouri (2023); and Dharma et al. (2024) found that there is a significant dynamic correlation between gold prices, oil against JCI and exchange rates during the Covid-19 pandemic period. In another study conducted by Asaad (2020) in Iraq, stated that there was no significant dynamic correlation with changes in oil prices, gold prices, and exchange rates against the JCI before the Covid-19 outbreak. Based on previous studies that use dynamic correlations between the variables studied in this research, there are still very limited studies that conduct research in the Covid 19 pandemic period or until the Russia-Ukraine war period using the DCC GARCH method. Therefore, this study will fill the literature gap by examining whether there is a dynamic correlation between variables significantly during the Russian-Ukrainian war period using the analysis method, namely DCC GARCH.

LITERATURE REVIEW

Gold is the most traditional and widely recognized safe haven asset. Gold itself became one of the first forms of money and is a very important precious metal, besides that gold also has a very high hedge (Ming et al., 2023). In the history of mankind, gold has become a precious metal that is highly admired and is also used as a medium of exchange and a sign of wealth (Kumar et al., 2022). Gold has a negative relationship with stock prices, so in the context of a safe haven when stock prices fall, different things happen to gold prices, where gold prices increase. This happens because investors move their assets from stocks to gold. Gold prices that increase from year to year and tend to be less risky can affect the movement of the JCI. Previous research has been conducted by Chkili (2016); Choudhry et al. (2015); Kumar (2014); Shabbir & Kousar (2020) which states that, gold prices have a negative relationship with stock price volatility.

Crude oil is an important component of international staple commodities. Therefore, crude oil plays an important role in global economic development (Zhang & Qin, 2022). The extreme volatility of crude oil prices has led to increased interest among investors, academics, and policymakers in seeking assets that are potentially hedged against the crude oil market (Ming et al., 2023). During the Covid-19 pandemic and the Russia Ukraine conflict, both the global market and the international crude oil market experienced significant volatility, requiring appropriate instruments to address these potential risks (Gharib et al., 2021). Supply shocks due to the Russia-Ukraine conflict have disrupted global demand supply as Russia requires payment in Rouble (Singh et al., 2022).

Evidence of the dynamic relationship between oil prices and JCI in academic studies has been inconsistent. For example, Alkhateeb and Sultan (2019) suggest that there is a negative correlation between oil prices and stock market volatility in importing and consuming countries. However, Bjorland (2008) observed that an increase in oil prices in export destination countries is responded positively by the stock market because it is considered to increase investment spending, increase state revenues so as to create greater productivity and reduce unemployment. In terms of volatility impact, there is a positive relationship between JCI and Oil prices (Jawadi et al., 2016; Zolfaghari et al., 2020). Furthermore, recent studies provide significant evidence of a nonlinear and asymmetric relationship between these two assets, especially during the oil crisis period (Ming et al., 2023).

An exchange rate is the value of a particular foreign currency in units of domestic currency. Exchange rates often experience changes in both supply and demand in the foreign exchange market. Changes in the exchange rate of the domestic currency against foreign currencies (USD/IDR) will harm the capital market. This is because if the foreign exchange rate appreciates, the domestic currency exchange rate will depreciate. In addition, the price of imported raw materials will increase and the company's production costs will also increase. Therefore, changes in exchange rates will affect the competitiveness of the company which will affect the stock price and the products produced by the company (Yunita & Robiyanto, 2018). Exchange rates are one of the macroeconomic factors that have the potential to affect stock returns. This is because the depreciation of the domestic currency against foreign currencies will increase the number of Rupiah used to pay foreign debt and will also increase the price of imported raw materials. Furthermore, it will have an impact on the price and stock return of a company.

Changes in exchange rates are expected to affect changes in stock prices. Commodity prices such as oil, gold, and exchange rates are important benchmarks in describing fluctuations in international financial markets (Zhang & Qin, 2022). Research that has been conducted by Arfaoui & Rejeb (2017); Arifin et al. (2024); Rahman et al. (2021); Wayan & Masithah (2016) found that there is a negative correlation between exchange rates and stock price changes. Likewise, previous research conducted by Aditya et al, (2018); Patel (2019);

Wahyudi et al. (2016); Yunita & Robiyanto (2018) stated the same thing that changes in exchange rates have a negative impact on JCI returns.

METHOD

This study was conducted using a quantitative approach using secondary data collected from id.investing.com. The data consists of daily JCI data from the Indonesia Stock Exchange, gold prices, oil prices, exchange rates from Dollar to Rupiah (USD/IDR) starting from during the Covid-19 pandemic to December 30, 2023 during the Russia-Ukraine war. The dependent variable in this case is the JCI stock return, while the independent variables are changes in the price of gold, oil, and the exchange rate from Dollar to Rupiah.

Definition of Operational Variables. The JCI return calculation can be calculated using the equation:

$$\Delta JCI_t = \frac{JCI_t - JCI_{t-1}}{JCI_{t-1}}$$

Where:

JCI_t = JCI on day t
JCI_{t-1} = JCI on day t-1

The change in gold price against the Dollar exchange rate can be calculated with the equation:

$$\Delta GOLDUSD_t = \frac{GOLDUSD_t - GOLDUSD_{t-1}}{GOLDUSD_{t-1}}$$

Where:

$\Delta GOLDUSD_t$ = gold price change against the dollar on the day
$GOLDUSD_{t-1}$ = change in gold price against the dollar on day t-1

The change in oil price against the Dollar exchange rate can be calculated with the equation:

$$\Delta OILUSD_t = \frac{OILUSD_t - OILUSD_{t-1}}{OILUSD_{t-1}}$$

Where:

$OILUSD_t$ = gold price change against the dollar on the day
$OILUSD_{t-1}$ = change in gold price against the dollar on day t-1

The change in exchange rate from Dollar to Rupiah (USD/IDR) can be calculated using the equation:

$$\Delta USDIDR_t = \frac{USDIDR_t - USDIDR_{t-1}}{USDIDR_{t-1}}$$

Where:

$OILUSD_t$ = gold price change against the dollar on the day
$OILUSD_{t-1}$ = change in gold price against the dollar on day t-1

Technique of Analysis. To analyze the dynamic relationship between the variables studied in this study, this study uses the Dynamic Conditional Correlation-Generalized Autoregressive Conditional Heteroscedasticity (DCC-GARCH) approach proposed by Engle (2002) with the following formula:

$r_t| =_{t-1} \sim N(0 D_t R_t D_t)$,

$D_t^2 = diag\ \{\omega_i\} + \text{diag}\ \{k_i\}^{o} r_{t-1} r'_{t-1} + diag\{\lambda_i\}^{o} D_{t-1}^2$,

$$\varepsilon_t = D_t^{-1} r_t$$
$$Q_t = S^{\circ}(l\ l' - A - B) + A^{\circ}\varepsilon_{t-1}\varepsilon'_{t-1} + B^{\circ}Q_{t-1},$$
$$R_t = \text{diag}\,\{Q_i\}^{-1} Q_t\ \text{diag}\ \{Q_i\}^{-1}$$

Where:

$r_t|$ = conditional correlation matrix describing the relationship at time t
D_t^2 = a dynamic conditional matrix that captures changes
ε_t = standard error
Q_t = covariance matrix without standardized residual conditions
R_t = conditional correlation matrix

This DCC-GARCH model has been carried out by Yuliana & Robiyanto (2022), Robiyanto et al. (2020), and Zakiyah & Windasari (2022) in studying the dynamic correlation between world oil and gold prices and the stock market. This DCC-GARCH calculation will be tested using Eviews software.

RESULT AND DISCUSSION

Descriptive statistics are used to determine the average value, maximum value, minimum value, and standard deviation value of the data. Descriptive statistics in this study are contained in Table 1. Table 1 shows that the average JCI is 7.0861 with a standard deviation value of 0.0105, while the average gold variable is -0.0004 and the standard deviation is 0.0718. Then the average of USD variable is -0.3313 and the standard deviation is 0.0103. Next, the average WTI variable is -0.0031 with a standard deviation value of 0.1105. And the average Brent variable shows 0.0004 with a standard deviation value of 0.0300.

As shown in Table 2, the average value of JCI during the Covid-19 pandemic period is 7.9867 with a standard deviation value of 0.0116, then the average value of the gold variable is 4.5717 with a standard deviation value of 0.0098, while the USD variable shows an average value of -9.5677 and the standard deviation is 0.0046, then the average value of the WTI and Brent variables is -0.0044 and 0.0007 respectively and the standard deviation values are 0.1314 and 0.0308.

Table 3 shows that the average JCI in the Russia-Ukraine war period is 5.0640 with a standard deviation value of 0.0078, gold with an average value of -0.0015 and a standard deviation value of 0.0114, then USD with an average value and standard deviation of 0.0002 and 0.0034, and WTI where the average has a value of -0.0005 and a standard deviation value of 0.0300, and the last is Brent which has an average value of -0.0003 and a standard deviation value of 0.0283.

Table 1. Descriptive Statistics of JCI, Gold, USD, WTI, and Brent 2019-2023

Variable	N	Minimum	Maksimum	Mean	Dev. St
JCI	1006	-0.0657	0.1019	7.0861	0.0105
Gold	1006	-0.0561	0.0524	-0.0004	0.0103
USD	1006	-0.0274	0.0456	4.4267	0.0043
WTI	1006	-3.0596	0.3766	-0.0031	0.1105
Brent	1006	-0.2440	0.2101	0.0004	0.0300

Source: id.investing.com, processed.

Table 2. Descriptive Statistics of JCI, Gold, USD, WTI, and Brent for the Covid-19 period

Variable	N	Minimum	Maksimum	Mean	Dev. St
JCI	696	-0.0658	0.1019	7.9867	0.0116
Gold	696	-0.0305	0.0525	4.5717	0.0098
USD	696	-3.0597	0.0457	-9.5677	0.0046
WTI	696	0.0046	0.3766	-0.0044	0.1314
Brent	696	-0.2440	0.2102	0.0007	0.0308

Source: id.investing.com, processed.

Table 3. Descriptive Statistics of JCI, Gold, USD, WTI, and Brent during the Russia-Ukraine war period

Variable	N	Minimum	Maksimum	Mean	Dev. St
JCI	310	-0.0442	0.0224	5.0640	0.0078
Gold	310	-0.0561	0.0485	-0.0015	0.0114
USD	310	-0.0128	0.0107	0.0002	0.0034
WTI	310	-0.1213	0.1291	-0.0005	0.0300
Brent	310	-0.1316	0.0879	-0.0003	0.0283

Source: id.investing.com, processed.

The Stationary test in this study uses the Augmented Dickey-Fuller test and has a significant value. The test results can be seen from Table 4. Table 4 shows that the JCI, Gold, USD, and Oil (WTI and Brent) variables are stationary.

Table 4. Augmented Dickey-Fuller Test Results

Variable	Augmented Dickey-Fuller test statistic	Probability	Results
JCI	-15.7253	0.0000	Stationary
Gold	-32.1269	0.0000	Stationary
USD	-17.5242	0.0000	Stationary
WTI	-15.5411	0.0000	Stationary
Brent	-29.3320	0.0000	Stationary

Source: id.investing.com, processed.

The DCC GARCH test in this study aims to determine whether or not there is a dynamic correlation between variables in the Covid-19 period and the Russian-Ukrainian war and is limited by the emergence of Hamas-Israel aggression. Table 6 shows the DCC value between JCI-Gold in the Covid-19 period is -0.0361 with a standard deviation value of 0.0264, then the DCC value of JCI-Brent has a value of 0.0846, followed by the DCC value of JCI-WTI which is 0.0644 where the standard deviation value is 0.0638, and the DCC value of JCI-USD/IDR is -0.3570 with a standard deviation value of 0.0543. It can be seen in Table 5 that the average value of DCC during the two periods was negative, this also occurred during the Covid-19 pandemic period where the average value of DCC was also negative, this can be interpreted that the JCI variable with USD/IDR has a dynamic correlation.

Table 5. DCC GARCH between variables for various times

Variable	Mean	Maximum	Minimum	Std. Dev
JCI-Gold	0.0299	0.1686	-0.3239	0.0718
JCI-Brent	0.1194	0.6946	-0.5453	0.0751
JCI-WTI	0.0917	0.8457	-0.4776	0.0619
JCI-USD/IDR	-0.3312	-0.1866	-0.4804	0.0438

Source: id.investing.com, processed.

Table 6. DCC GARCH of Covid-19 period

Variabel	Mean	Maximum	Minimum	Std. Dev
JCI-Gold	-0.0361	0.1241	-0.1538	0.0264
JCI-Brent	0.0846	0.6996	-0.5766	0.0889
JCI-WTI	0.0644	0.4042	-0.3013	0.0638
JCI-USD/IDR	-0.3570	-0.1661	-0.5287	0.0543

Source: id.investing.com, processed.

Table 7 illustrates the average DCC in the Russia-Ukraine war period from all variables, from several variables only USD/IDR has a dynamic correlation with the return value of JCI, this happens because the average value of DCC at various times shows the same results as the average value of DCC that occurred during the Russia-Ukraine war period, where the value of both is negative. Therefore, the JCI and USD can be said to have a dynamic correlation.

Table 7. DCC GARCH of Russia-Ukraine War Period

Variable	Mean	Maximum	Minimum	Std. Dev
JCI-Gold	-0.0623	0.1385	-0.4534	0.0865
JCI-Brent	0.1564	0.3542	-0.1679	0.0571
JCI-WTI	0.2193	0.3897	0.0651	0.0673
JCI-USD/IDR	-0.2613	-0.1481	-0.3553	0.0162

Source: id.investing.com, processed.

Figure 1 shows the result of dynamic correlation analysis between JCI and Brent oil price using DCC GARCH. The results show that the highest DCC value of JCI with Brent oil during the study period was 0.6946 in March 2023 and the lowest DCC value was -0.5453 in April 2023. Table 5 shows the average value of DDC is 0.1194 which means that the dynamic correlation of JCI with Brent Oil is positive. Figure 2 shows the results of the dynamic correlation analysis between JCI and WTI Oil tested using the DCC GARCH method. The results show that the highest value of DCC between JCI and WTI oil occurs in June 2022 and March 2023 which is 0.8457 and the lowest value is in April 2023 which is -0.4776. However, if seen in Table 5 where the average value of DCC is positive, it is 0.0917. This means that the dynamic correlation between JCI and WTI Oil is positive. Figure 3 shows the results of the dynamic correlation analysis between JCI and Gold through DCC GARCH, where the results range from 0.1686 to -0.3239. The highest DCC is seen at the end of December 2022 while the lowest result occurs at the end of March 2022. It can be seen in Table 5 that the average value of DCC is 0.0299 which means the dynamic correlation between JCI and gold variables is positive.

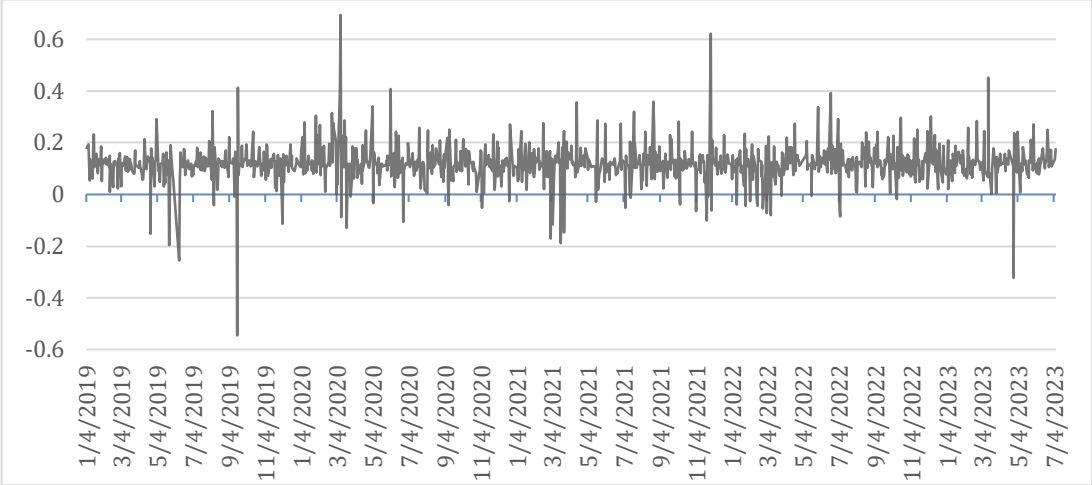


Figure 1. Dynamic Correlation JCI-Brent
Source: id.investing.com, processed.

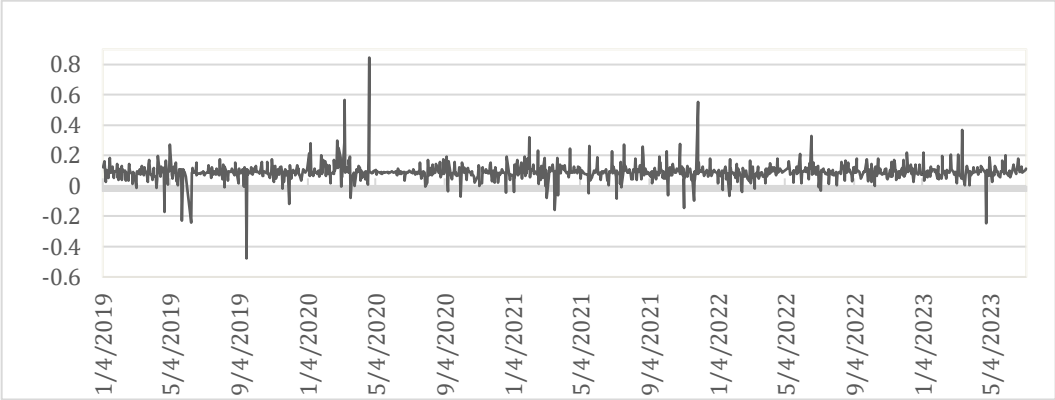


Figure 2. Dynamic Correlation JCI-WTI
Source: id.investing.com, processed.

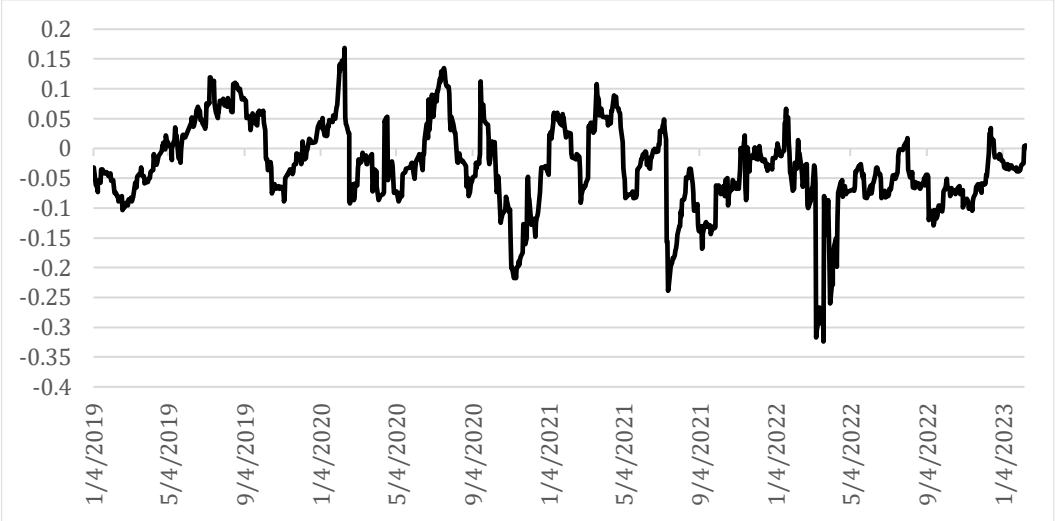


Figure 3. Dynamic Correlation JCI-Gold
Source: id.investing.com, processed.

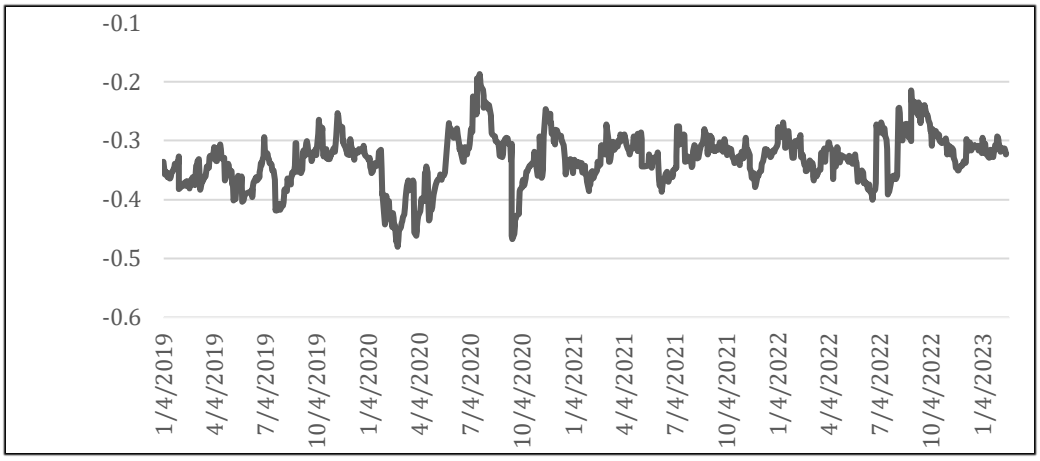


Figure 4. Dynamic Correlation JCI-USD/IDR
Source: id.investing.com, processed.

Figure 4 illustrates the DCC GARCH results between JCI and USD/IDR where the highest result is -0.1866 at the beginning of September 2022 and the lowest value is shown in June 2022 which is -0.4804. Based on Table 5, it is known that the average value of DCC is -0.3312. This indicates that the dynamic correlation between JCI and USD/IDR Exchange Rate is negative and relatively weak.

According to the hypotheses that have been developed, it can be concluded that only the first hypothesis is rejected where JCI has a negative relationship with gold prices. While the calculation results that have been done using the DCC GARCH method show that the dynamic correlation between JCI and Gold is positive. The gold commodity provides evidence that the higher the return on gold, the higher the volatility of JCI. It is suspected that investors doubt the significance of changes in gold prices, so investors tend not to choose gold as an asset to invest in. It is also not uncommon for people to believe that gold is the safest asset to invest in. The results of this study are supported by Choudhry et al. (2015); Ingalhalli et al. (2016); Raza et al. (2016).

Another analysis shows that changes in both Brent and WTI oil prices have a positive dynamic correlation. However, on the other hand, there is no dynamic correlation between JCI and USD/IDR exchange rate or in other words the dynamic correlation between JCI and USD/IDR exchange rate is negative. As can be seen in Table 5, this is in line with research conducted by Syahri & Robiyanto, (2020).

CONCLUSION

This study aims to determine whether or not there is a dynamic correlation between the JCI and Gold, Oil (Brent & WTI), and the USD/IDR Exchange Rate. The results of this study found that changes in gold and oil prices both Brent and WTI have a significant effect on the volatility of the JCI during the Russia-Ukraine war period in 2022. However, there is a different correlation between JCI and USD/IDR Exchange Rate where the Dollar to Rupiah Exchange Rate does not significantly affect JCI or can be said to have a weak correlation during the Russia-Ukraine war period.

This study was conducted using multivariate analysis method through DCC GARCH on the relationship between JCI, oil, gold, and USD/IDR exchange rate which took daily data as samples during the period of Russia-Ukraine war on February 24, 2022 until the start of Hamas-Israel war on October 7, 2023. Future research is recommended to use the period

from the start of the Hamas-Israel war. So that further findings can be obtained regarding the correlation of JCI, oil, gold, and the USD/IDR exchange rate.

This research can be study as a reference for investors in observing the variables of gold, oil and exchange rates that will be chosen to invest in the stock market. The limitation of this study is the lack of similarity of research studies with the Covid-19 pandemic period to the Russian-Ukrainian war, so there are difficulties in comparing the proof of hypotheses in this study. In addition, the lack of studies with the same approach is also one of the obstacles in the process of validating and verifying data effectively. Since too many geopolitical events have been happened after the Russian-Ukraine war, so the future study should consider these events in their studies, newer and more sophisticated method should be employed.

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