Article Type: Research Paper

Return connectedness of sectoral stock indices on the Indonesian stock exchange during Russian-Ukraine conflict

Fitriyah Fitriyah* and Zakia Nur Mukminatin

Abstract

Research aims: The purpose of this study is to determine the return connectedness of sectoral stock indices in Indonesia and to identify sectors that act as risk transmitters and risk recipients during the Russia-Ukraine conflict.

Design/Methodology/Approach: The study employed a quantitative method with a comparative descriptive approach using data obtained from id.investing.com in the form of daily data on the closing price of the sectoral stock index starting from the period March 16, 2021 to March 14, 2023. The sampling technique used purposive sampling method. Time varying parameter VAR is an analytical tool used to analyze the data.

Research findings: The test results found that the return connectedness of Sectoral Stock Indices increased during the Russia-Ukraine war. During the war, the sectoral indices that acted as risk transmitters were finance, industry, infrastructure, consumer cyclicals, and basic materials. Sectors that acted as risk receivers were health, transportation, energy, consumer non-cyclicals, and technology.

Theoretical contribution/Originality: This is the first study to examine return spillover in Indonesia stock sectors, specifically focusing on the Russia-Ukraine conflict. This study provides understanding about return spillover and directional spillover among 11 Indonesian stock sectors.

Practitioner/Policy implication: This article has important implications for investors to allocate their portfolios taking into account the similarities and differences in the time-varying connectivity characteristics of different asset systems. Also, for policymakers in Indonesia should adopt flexible regulatory strategies to avoid systemic risk contagion.

Keywords: Connectedness; Indonesia; Russia-Ukraine Conflict; Sectoral Stock Indices

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DOI: 10.18196/jai.v26i1.22406

CITATION:
Fitriyah, F., & Mukminatin, Z. N. (2025). Return connectedness of sectoral stock indices on the Indonesian stock exchange during Russian-Ukraine conflict . *Journal of Accounting and Investment, 26*(1), 155-172.

ARTICLE HISTORY
Received:
19 May 2024
Revised:
22 Jul 2024
22 Oct 2024
04 Dec 2024
13 Dec 2024
Accepted:
16 Dec 2024

JAI Website:

Introduction

Global power conflict posed a threat to financial stability after the COVID-19 epidemic broke out. Ukraine was attacked by Russia on February 24, 2022. The number of parties involved, their geopolitical presence, and their allies made this conflict exceptional (Caldara & Iacoviello, 2022). The Russian economy has been impacted by the extreme financial, economic, and commercial sanctions imposed by the West, which have resulted in near-complete isolation from the West and its allies. From an economic perspective, Russia and Ukraine are significant players in the global markets for food, fertilizer, grain, energy, oil, and gas. When a battle starts, it's hard to predict how long it will last and what kind of assistance each side will require. Commodity prices, inflation rates, and the state of the global economy are all impacted by this uncertainty. Today, inflation poses a serious threat to numerous economies worldwide. Rising prices,

as a result, have an impact on various sectors of the economy (Ratten et al., 2021).

One of the outcomes of the Russia-Ukraine war has been an increase in grain prices. In retaliation for Western economic sanctions, Russia would restrict wheat and fertilizer exports while also shutting the Black Sea. Russia's political attitude will imperil the global food supply and drive up food costs. Rising wheat costs would eventually affect Indonesian consumers because wheat is a raw material for foods like instant noodles and wheat. Wheat shortages or increased prices owing to the situation in Ukraine may raise the pricing of derivative items such as instant noodles, which are popular among the middle and lower classes.

Junaedi (2022) predicts that the crisis between Russia and Ukraine will probably cause the value of the rupiah to decline. This is because there is a possibility that Russia will be kicked out of the international SWIFT (Society for Worldwide Interbank Financial Telecommunication) payment system, which will affect the removal of Russian money. Exchange rate swings will result from the departure of Russian capital from the global financial system. There were two primary causes of the Ukrainian crisis: changes in currency exchange rates that led to an increase in the amount of foreign debt (Aliu et al., 2024). Meaning that there will be an increase in the loan interest rate. The loan interest rates will rise in tandem with ongoing increases in interest rates. Therefore, the rise in foreign debt as a result of the nominal interest rate increases on loans brought about by fluctuations in the US dollar's value ultimately made it harder for state-owned enterprises with high debt-to-capital ratios to resolve the Ukrainian crisis. In the meantime, the public continues to be insistent about the ways in which state-owned businesses can support price stability.

Given that the majority of open firms on the Indonesia Stock Exchange have international debt in the form of foreign currency, it is extremely likely that declining exchange rates will have an impact on capital market stock prices (Cahya et al., 2018). Tandelilin (2010) discovered that interest rates, inflation, and currency rates are macroeconomic variables that might affect stock values. As a result, the stock index's capacity to reflect a negative outlook for the Rupiah exchange rate will decline. Stock prices will be impacted by the rupiah's depreciation relative to other currencies, which is a warning flag for investors (Ang, 1997). Additionally, changes in the rupiah exchange rate and inflation may have an impact on the business's profitability and capacity to meet its short- and long-term debt. Additionally, the profitability of the company variable can be interpreted by Setiawanta et al. (2019) as a signal from the company to investors that it is doing well.

Mankiw (2000) asserts that the money market and the products market can be the channels via which prices and exchange rates are related. In macroeconomics, the Mundell-Flemming (M-F) model is utilized to comprehend the link. In tiny open economies, interest rates are determined by global rates. Once an increase in the money supply reduces domestic interest rates, capital will flow out of the economy, causing investors to pay attention to more profitable opportunities elsewhere. This capital outflow protects domestic interest rates from falling. Furthermore, when capital outflows increase the supply of domestic currency in the foreign exchange market, the exchange

rate will depreciate. A falling exchange rate makes domestic goods more expensive than foreign goods and increases net exports (Ohyama, 2007). Therefore, in a small, open economy, monetary policy affects income through the exchange rate and not through interest rates. The implication for monetary policy from this model is that the more perfect capital mobility is, the more effective monetary policy will be (Okotori & Ayunku, 2020).

Meanwhile, when an economic crisis in one country triggers an economic crisis in another country, this is called the "contagion effect"(Lee et al., 2018). The effectiveness of contagion can be explained in various ways. According to Dornbusch et al. (2000), One of the main interpretations of the contagion effect comes from the relationships that exist between market economies, such as macroeconomic similarities, trade transactions, and bank lending. After the crisis in Greece, the spillover effect spread to other countries in Europe, including Ireland, Portugal, Italy, Spain, the UK, and France. Previous contagion effects have also occurred before the European crisis, such as the subprime mortality crisis and the Asian monetary crisis of 1997-1998 (Lee, 2012).

In a study by Zhang et al. (2021), it was found that COVID-19 had a large impact on spillovers between energy and stock markets. Shigemoto & Morimoto (2022) found that the energy resources sector and the bank sector were risk receivers in the pre-COVID-19 period, but these sectors turned into risk transmitters during the COVID-19 period. Mensi et al. (2021) found that the connectedness among U.S. stock sectors was volatile during economic, energy, and geopolitical events. Similar to the previous study, Mensi's research found that there were sectors that experienced a change in role. Coupled with research by Bui et al. (2022), the Vietnamese stock market showed substantial intersectors with linkages above 60 percent from 2012 to 2021. However, the sectoral spillover effect increased to around 90 percent during the COVID-19 pandemic.

Previously, several studies focused on COVID-19 were presented. However, sectoral spillover effects during the Russia-Ukraine war are still not widely researched, specifically in Indonesia. The Russia-Ukraine conflict might have an impact on the Indonesian stock sector. Therefore, analyzing the spillover of sectoral stock during the Russia and Ukraine conflict is important for designing political policies for governments and policymakers as well as managing investment portfolios by investors. Previous research has examined sectoral spillover during the Russian-Ukrainian war other than in Indonesia, such as in Egypt (Mahran, 2023). Therefore, this research aims to examine the spillover between sectoral stock indices in Indonesia during the Russian-Ukrainian war.

This study has three contributions. First, in contrast to studies on sectoral spillovers that highlight shocks during COVID-19, this study examined sectoral spillovers during the Russia-Ukraine conflict. Second, our study is the first to examine sectoral return spillover in Indonesia’s stock indices. Third, our study identified risk-transmitted and risk-receiver sectors among 11 Indonesian sectors and discussed their behavior, especially during events such as the Russia-Ukraine war.

This article has important implications for investors to monitor how these events play out in the future and any potential drawbacks, recognize any risks, and swiftly stop losing money. Globalization of the economy, however, has rendered it impossible for any government to avoid public catastrophes. As such, investors ought to take into account relevant foreign markets in addition to the local market when making investment selections. Investors should also distribute their portfolios according to how the asset systems may differ and how they are similar in terms of time-varying connectedness. Industries with high levels of risk, such as healthcare, transportation, consumer goods, and technology, should be avoided by investors. They act as risk transmitters since the fluctuations in industrial profitability might have an impact on all four sectors. The fungible role of financial assets suggests that policymakers should adopt flexible regulatory strategies to avoid systemic risk contagion.

Literature Review and Hypotheses Development

Spillover Returns among Sectoral Stock Indices in Indonesia during the Russian-Ukrainian Conflict

According to Yang & Lim (2004), the contagion or spillover effect occurs when a financial crisis in one country causes a crisis in another country. In addition, said that the contagion effect has three definitions: First, the spread of a shock across countries or, in general, there is a significant relationship between countries that occurs outside of some fundamental intermediaries. Second, contagion in a broad sense, namely a shock that is spread across countries or the occurrence of a relationship that has mutual impacts between several countries. For example, the 1997 Asian financial crisis spread across East Asia, and Indonesia was also affected. Third, connecting contagion with a phenomenon when the correlation between countries increases during a crisis period compared to the correlation in the normal economic period. This definition is in line with this study, which compares the correlation levels before and during the research period. Back in 2011, various sectors in the S&P 500 exhibited a 95% degree of correlation, beating the former record set in 1987. The high correlation meant that they all moved basically in lockstep with each other.

In the context of the war between Russia and Ukraine, financial contagion theory proposes that this war might cause shocks and disturbances to spread throughout the interconnected global financial system (Ozili, 2024). These shocks can come from a variety of sources, including geopolitical instability, interruption in trade and supply chains, economic sanctions, and market sentiment (OECD, 2022). The interconnectedness of the equities markets in the United States, Russia, and Ukraine has substantial implications. The United States is a key global economic powerhouse, with its equity market serving as a benchmark for investors worldwide. Alternatively, Russia and Ukraine are emerging markets that underwent a variety of economic and geopolitical crises, which can potentially generate spillovers.

In the existing research, scientists have extensively focused on the spillover effects between financial markets and overseas assets (Antonakakis et al., 2020; Chen et al., 2023; Jung & Maderitsch, 2014). These studies focus on overall patterns in spillover between asset classes or financial markets, but they do not provide insights into dynamic transmission across different sectors of an economy.

Examining the spillover effects between sectors is critical because each sector is uniquely tied to the economy (Chatziantoniou et al., 2021). Scholars have recently expanded their research to include sectoral spillover effects, employing the network analysis approach. Research by Bui et al. (2022) stated that sectors in the Vietnam stock market showed a spillover relationship above 60% from 2012 to 2021. However, the spillover relationship increased to around 90% during the COVID-19 pandemic. These results are supported by Ngene (2021), who also found that the stock sector experienced an increase in spillover to 76%. Alexakis & Pappas (2018) also support the existence of high contagion in all sectors during the Global Financial Crisis (GFC) and European Sovereign Debt Crisis (ESDC). In research by Majumder & Nag (2018), spillover between sectors was found to be higher during the global financial crisis period. However, no increase was found in the context of the Eurozone debt crisis. Additionally, Mensi et al. (2021) find that spillovers among U.S. stock sectors are volatile during economic, energy, and geopolitical events. According to research by Shahzad et al. (2021), the results show evidence of increasing volatility spillovers and becoming very intense during the COVID-19 period. Based on previous research, we conclude that the correlation between stock sectors will increase during a crisis.

H_1: *There was an increase in spillover returns among sectoral stock indices in Indonesia during the Russia-Ukraine conflict.*

Research Method

Research Design

According to Iranifard & Latifnejad Roudsari (2022), researchers do comparative research by comparing a certain issue in different situations using quantitative or qualitative methods. This study used a quantitative method with a comparative descriptive approach to examine the return connectedness of sectoral stock indices in Indonesia. The type of data used in this research was secondary data. The data presented is on a numerical scale. The research uses time series data, which is organized based on a certain period.

The data in this study were obtained from id.investing.com in the form of daily data on the closing price of the sectoral stock index starting from March 16, 2021, to March 14, 2023. We split the data into two parts to compare with the separator date, which is February 21, 2022. All sectoral stock indices traded on the Indonesian stock exchange are included in the population of this study. In this study, researchers selected eleven sectoral stock indices in Indonesia to conduct return spillover testing. The sectoral stock indices include energy, basic materials, industrials, consumer cyclical and non-cyclical, healthcare, finance, technology, infrastructure, transportation, and property.

Limiting the definition of the variables to be studied was deemed necessary so that each variable in this study could be understood correctly and prevent incorrect interpretation. The sectoral stock index variable used in this study has a definition, namely, an index that measures the price performance of all stocks in each sector with reference to the IDX Industrial Classification (IDX-IC) with calculation:

$$IDX - IC = \ln (R_t/R_{t-1}) \ldots (1)$$

From equation (1), it can be seen that the return of the IDX Industrial Classification stock sector is obtained from the natural logarithm of the return, where R_t represents the closing price of the stock sector index on day *t*, and R_{t-1} represents the closing price of the stock sector index on the previous day (*t*-1).

Data Analysis

An increasingly common method for examining the dynamic behavior of macroeconomic time series is time-varying parameter vector autoregression (TVP VAR). Diebold and Yilmaz (2009, 2012, 2014) methodology lacks the advantage of the Forecast Error Variance Decomposition method by Antonakakis et al. (2020) in that it does not require the selection of a rolling-window size, resulting in more stable and strong dynamic connections captured by this method. Furthermore, the Antonakakis et al. (2020) method is appropriate for capturing dynamic linkages in small sample data sets since it does not lose observations throughout the estimate step.

Furthermore, the final size is unaffected by outliers generated by the Kalman filter, allowing for a more accurate estimation of the genuine parameter values. According to Urrea & Agramonte (2021), the kalman filter combines measurements and predictions to find the optimal state. Data analysis in this study uses the R Studio analysis tool, which aims to process data, code, present data, and tabulate data. Data analysis is useful for testing the dynamics of spillover returns. The R Studio tool was used to analyze spillover returns using Time-Varying Parameter Vector Autoregression from Antonakakis et al. (2020) that can be calculated as follows:

Total Net Connectedness is the sum of cross-variance shares, which is the fraction of *H*-step ahead in forecasting Xi due to risk in Xj can be calculated as:

$$C_t\,(H) = \frac{\sum_{i,j=1,i\neq j}^{m} \widetilde{\Phi}_{ij,t}(H)}{\sum_{i=1,j=1}^{m} \widetilde{\Phi}_{ij,t}(H)} * 100 \ldots (2)$$

Directional Connectedness to Others is a connectedness measure that captures the shock given by vector i to all vectors j, which can be calculated as:

$$C_{i\rightarrow j\,,t}\,(H) = \frac{\sum_{j=1,i\neq j}^{m} \widetilde{\Phi}_{ji,t}(H)}{\sum_{j=1}^{m} \widetilde{\Phi}_{ji,t}(H)} * 100 \ldots (3)$$

Directional Connectedness from Others is a connectedness measure that captures the shock received by vector i from all vectors j, which can be calculated as:

$$C_{i\leftarrow j,t}\,(H) = \frac{\sum_{j=1,i\neq j}^{m} \widetilde{\Phi}_{ij,t}(H)}{\sum_{i=1}^{m} \widetilde{\Phi}_{ij,t}(H)} * 100 \ldots (4)$$

Using the Directional Connectedness to and from other steps above, we can obtain Net Connectedness, which is the difference between the volatility shock TO and the volatility shock transmitted FROM all other markets. The Net Total Directional Connectedness illustrates whether variable i drives the network $\left(C_{i,t} > o\right)$ or network-driven $\left(C_{i,t} > o\right)$ can be calculated as:

$$C_{i,t} = C_{i\rightarrow j,t}(H) - \ C_{i\leftarrow j,t}(H) \ldots (5)$$

To investigate the direction of pairwise connectivity between two assets. To put it another way, the difference in the risks transmitted from asset i to asset j and from asset j to asset i can be used to define the net pairwise directional connectedness between asset i and asset j. Specifically, the difference in the risks transmitted from asset j to asset i can be defined as the net pairwise directional connectedness between asset i and asset j:

$$NPDC_{ij,t}\,(H) = \left(\frac{\widetilde{\Phi}_{ij\,,t}\,(H)}{\sum_{i=1,j=1}^{m} \widetilde{\Phi}_{ji\,,t}\,(H)} - \frac{\widetilde{\Phi}_{ji\,,t}(H)}{\sum_{i=1,j=1}^{m} \widetilde{\Phi}_{ji\,,t}\,(H)}\right) * 100 \ldots (6)$$

If $NPDC_{ij,t}$ (H) > 0 ($NPDC_{ij,t}$ (H) < 0), variable i affects (is affected by) variable j more (less) than variable j affects variable i.

Result and Discussion

Result

The descriptive statistics for price returns are reported in Table 1, which exhibits serial correlation, non-normality of distribution, and stationary of all series.

The Mean results show that most sectors have values close to zero, meaning that over the period, the returns of these sectors were relatively stable or did not experience significant changes. The energy sector recorded the highest positive return (0.000805), while the infrastructure sector experienced the largest decline (-0.000166). The Standard Deviation (Std.) shows the volatility in each sector. The transportation sector has the highest volatility (0.011), meaning there are greater fluctuations, while the Consumer Cyclicals and Property sectors have lower volatility, meaning they are more stable. Skewness and Kurtosis describe the asymmetry of the distribution of returns. The Healthcare and Transportation sectors have high positive skewness. The high kurtosis number in healthcare (15.03) indicates extreme returns and unusual volatility.

Table 1 Descriptive Statistics

	Mean	Std.	Skew	Kurtosis	JB	ADF	Q (20)	Q2 (20)
Basic Materials	-0.000125	0.005	-0.131	3.524	6.347*	-20.886***	21.028	204.153***
Consumer Cyclicals	-4.94E-06	0.004	0.041	4.195	26.554***	-21.070***	16.632	127.689***
Consumer Non Cyclicals	5.49E-05	0.004	0.103	3.925	16.596***	-16.901***	46.158***	90.398***
Energy	0.000805	0.006	0.214	4.722	58.288***	-19.471***	18.569	136.082***
Infrastructure	-0.000166	0.004	0.079	3.869	14.442***	-22.259***	26.980	185.290***
Healthcare	0.000254	0.004	1.398	15.031	28.248***	-18.061***	49.976***	132.501***
Finance	-7.15E-05	0.005	-0.146	3.887	15.918***	-21.652***	16.145	151.967***
Technology	0.000130	0.005	0.063	3.612	7.223*	-9.487***	9.314***	162.142***
Transportation	0.000451	0.011	1.896	10.843	1403.200***	-18.952***	20.331	122.365***
Property	0.000372	0.004	0.359	5.192	101.200***	-20.453***	18.133	115.595***
Industrials	0.000338	0.006	0.381	4.319	42.936***	-23.011***	22.014	118.680***

Notes: * means significant at 10%, ** means significant at 5% and *** means significant at 1%

The Jarque-Bera (JB) test reveals that most sectors, including Healthcare and Transportation, do not follow a normal distribution as indicated by significant outliers. ADF (Augmented Dickey-Fuller Test): Significant negative ADF values in all sectors indicate that the performance data in each sector does not have a unit root, meaning that the data is stationary and can identify long-term trends in each field. Ljung-Box Q (20) and Q2 (20) are used to test for serial correlation in the returns data. From Table 2, it is known that the healthcare and consumer non-cyclical sectors show serial correlations in some sectors, such as healthcare and consumer non-cyclical.

Discussion

Spillover Returns among Sectoral Stock Indices in Indonesia during the Russian-Ukrainian Conflict

Figure 1 shows the dynamics of the return linkage index among the sectoral stock indices. The higher the index, the higher the connectedness between the assets under study. It can be seen in the Total Connectedness Index graph from Figure 1 that the TCI experienced a significant decline from above 80% in early 2021 to around 50% in mid-2021. Then, it moved sideways until it increased to 70% at the beginning of the Russia-Ukraine war. Despite the decline, the TCI of the sectoral index in Indonesia peaked again in early 2023 and declined until March 2023.

Table 2 Average Dynamic Connectedness Table

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	FROM
Panel A. Before Russia-Ukraine Conflict												
(1)	31.44	7.68	8.26	7.45	7.21	7.07	3.54	9.62	2.36	4.66	10.70	68.56
(2)	8.31	29.85	11.70	5.93	8.46	7.00	2.96	11.22	2.67	3.89	8.02	70.15
(3)	8.59	10.36	31.11	7.22	8.14	6.50	2.93	10.39	1.72	5.01	8.04	68.89
(4)	7.07	6.45	7.86	39.75	5.35	6.32	3.00	6.74	4.28	4.38	8.80	60.25
(5)	8.58	7.93	9.15	6.59	34.00	5.72	5.93	10.35	3.88	2.34	6.44	66.92
(6)	7.57	7.17	7.13	6.31	5.09	37.27	1.77	9.95	2.55	4.24	10.90	62.73
(7)	6.69	4.38	5.28	5.46	9.44	2.90	53.00	4.57	1.90	3.09	3.34	47.04
(8)	9.99	9.49	10.22	6.89	8.16	8.36	2.23	28.91	2.75	4.42	8.58	71.09
(9)	5.35	4.61	2.98	7.26	2.62	4.01	3.29	2.77	56.70	3.57	6.84	43.31
(10)	6.54	5.14	6.64	6.58	2.70	5.41	2.28	4.35	2.41	50.40	7.55	49.61
(11)	10.86	8.07	8.23	7.60	4.78	8.66	1.78	8.09	3.71	5.59	32.60	67.36
TO	79.55	71.28	77.45	67.30	61.93	61.94	29.71	78.00	28.20	41.20	79.30	675.90
Inc.Own	110.90	101.10	108.60	107.00	95.00	99.20	82.70	106.90	84.90	91.60	112.00	cTCI/TCI
NET	10.98	1.13	8.56	7.05	-4.98	-0.78	-17.30	6.96	-15.10	-8.40	11.90	67.59/61.4
NP	9	6	8	6	3	5	1	6	1	3	7	
Panel B. During Russia-Ukraine Conflict												
(1)	32.31	11.52	6.10	7.8	7.64	3.91	2.68	7.96	7.64	5.43	7.01	67.69
(2)	12.35	30.50	6.47	8.92	6.08	7.17	2.82	8.30	4.71	5.21	7.47	69.51
(3)	7.12	8.20	36.79	10.9	5.08	6.69	2.64	6.87	6.09	5.84	3.78	63.21
(4)	8.68	8.73	9.51	31.61	6.30	3.82	3.44	8.37	6.62	6.38	6.53	68.39
(5)	8.83	6.18	6.37	7.46	39.16	7.47	3.08	9.36	4.08	4.11	3.90	60.84
(6)	5.91	3.70	7.38	4.15	5.11	45.10	1.51	16.00	2.82	5.18	3.15	54.89
(7)	9.31	5.36	3.06	5.28	5.01	1.52	52.50	5.98	4.42	2.70	4.91	47.54
(8)	7.66	7.57	5.62	8.02	6.39	11.51	1.92	33.79	4.66	7.60	5.26	66.21
(9)	12.10	5.67	6.96	7.62	4.86	2.92	3.45	5.74	43.30	3.39	3.94	56.66
(10)	8.64	6.08	6.64	8.60	5.90	5.33	3.08	9.96	4.67	38.10	3.05	61.94
(11)	10.56	8.76	4.48	8.50	6.29	4.75	3.49	8.23	5.30	3.01	36.60	63.37
TO	91.16	71.77	62.60	77.26	58.70	55.10	28.11	86.80	51.02	48.80	49.00	680.25
Inc.Own	123.50	102.30	99.40	109.00	97.81	100.00	80.60	120.50	94.70	86.90	85.60	cTCI/TCI
NET	23.47	2.26	-0.62	8.87	-2.19	0.21	-19.40	20.50	-5.64	-13.00	-14.00	68.03/62
NP	9	6	6	8	4	6	1	10	3	0	2	

Note: (1) = Finance; (2) = Infrastructure; (3) = Basic Materials; (4) = Consumer Non-Cyclicals; (5) = Consumer Cyclicals; (6) = Energy; (7) = Health; (8) = Industry; (9) = Technology; (10) = Transportation; (11) = Property; TO = Total Directional Connectedness to Others; FROM = Total Directional Connectedness from Others; Inc.Own = Proportion of the Index's Forecast Error Variance Explained by Its Own Shocks; NET = Net Total Directional Connectedness; NP = Net Pairwise Directional Connectedness; cTCI: Conditional Total Connectedness Index; TCI: Total Connectedness Index

The average connectedness measure between stock sectors in Indonesia is presented in Table 2, and the corresponding pairwise connectedness network is depicted in Figure 2. Based on Table 2 and Figure 2, it can be seen that healthcare was the sector that dominated the most both before and during the war. Meanwhile, property and finance dominated the entire connected system. Finance remained the highest net transmitter during the war, followed by industrials. Inc.Own is the percentage of forecast error variance for an index, explained by its own shock. The higher this number, the more self-driven the index movement compared to movement driven by impacts from other indexes. TCI/cTCI measures the average spillover contribution of shocks between one variable over another variable where TCI/cTCI is obtained from the average TO value or

FROM value. The conditional total connectedness index and total connectedness, respectively 68.03% and 62% during the Russia-Ukraine war increased from before the war, which indicates that the stock sectors in Indonesia were affected during the Russia-Ukraine war and there was high contagion among the stock sectors in Indonesia.

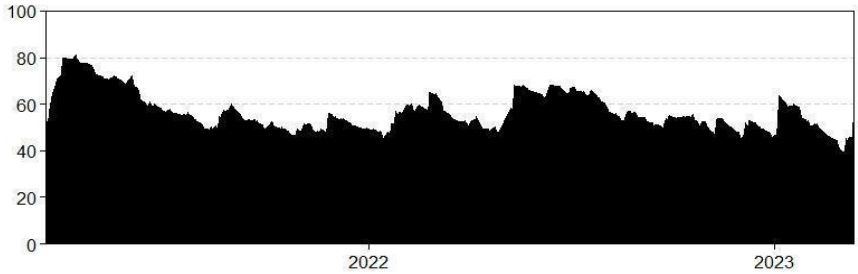

Figure 1 Total Connectedness Index From The Year 2021 to 2023

This result supports hypothesis 1, which states that there was an increase in spillover returns among sectoral stock Indices in Indonesia during the Russia-Ukraine conflict. This is also in line with the results of research by (Bui et al., 2022), which states that sectors in the Vietnamese stock market show a connectedness above 60% from 2012 to 2021. However, the connectedness increased to around 90% during the COVID-19 pandemic. Ngene (2021) also found that sectors experienced an increase during a crisis in the connectedness to 76%.

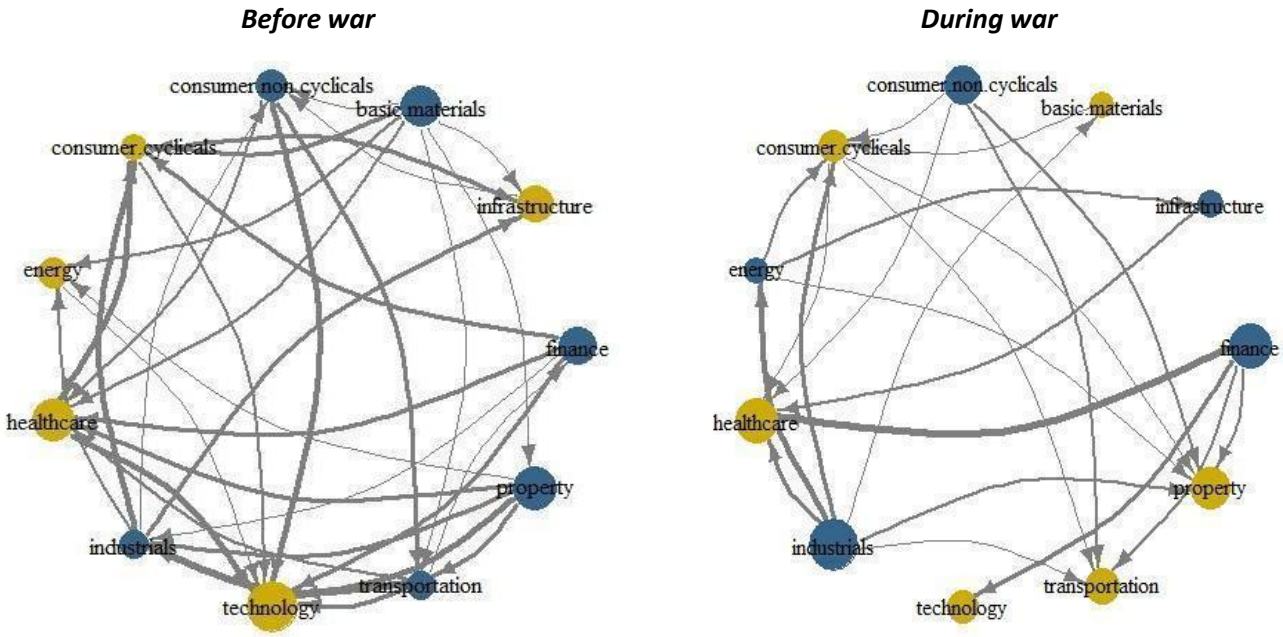

Figure 2 Network Visualization of Net Pairwise Directional Connectedness Before and During The Russia-Ukraine Conflict

Net directional connectedness shows that the financial and industrial sectors during the war dominated the whole system with values of 23.47 and 20.55, respectively. Meanwhile, the health and property sectors are the most dominant assets, with values of -19.4 and -14.4. During the battle, energy moves from net receivers to net transmitters of shocks, while basic materials and property transform from a net transmitter of shocks to a net receiver across all sectors. Financials, infrastructure, consumer non-cyclical, and industrials have increased intensity, and their role as net transmitters does not change during the conflict. Meanwhile, consumer cyclical and technology decreased in intensity, and net receivers did not change their role before and during the war. Healthcare and transportation were also net receivers, but the intensity of their role increased during the war.

Figure 2 introduces the network visualization method to illustrate the dynamics of net pairwise directional links in the Indonesian stock sector. Positive pairwise spillover from one market to another is shown by the arrow in each network graph that points from market i to market j. The strength of the net pairwise spillover is indicated by the thickness of the edge arrows. The strength of each market's overall net directional spillover to the global financial market is indicated by the node size. As a result, the node's size dictates its contribution to the net directional spillover of the particular market. A blue point indicates a sector that is dominant over the others. A yellow point indicates a sector that is under the influence of other sectors. The matching arrow widens with the increasing net pairwise connectivity index. Figure 3 displays the findings of the net pairwise directional association both before and during the crisis between Russia and Ukraine.

Comparing these figures, we may see the following. First, the structure of transfers (receipts) and pairwise net spillovers between stock sectors in Indonesia shifted dramatically following the commencement of the Russia-Ukraine crisis. Second, during the Russia-Ukraine crisis, the financial and industrial sectors were the primary sources of shocks for all stock markets in Indonesia. This is proved by the thickness of the arrows, the blue color, and the large size of the nodes. On the other side, the healthcare and real estate sectors stand to benefit the most from the shocks.

In Figure 3, the net total directional connectivity varies by index, demonstrating the net contribution of each sectoral stock index in Indonesia. A positive net total directional connectedness index implies that the asset transmits more risk to the rest of the system of spillover returns between stock sectors than it receives from all assets in the system, indicating that it is a net risk transmitter. In contrast, a negative net total directional connectedness score suggests that it is a net receiver of risk.

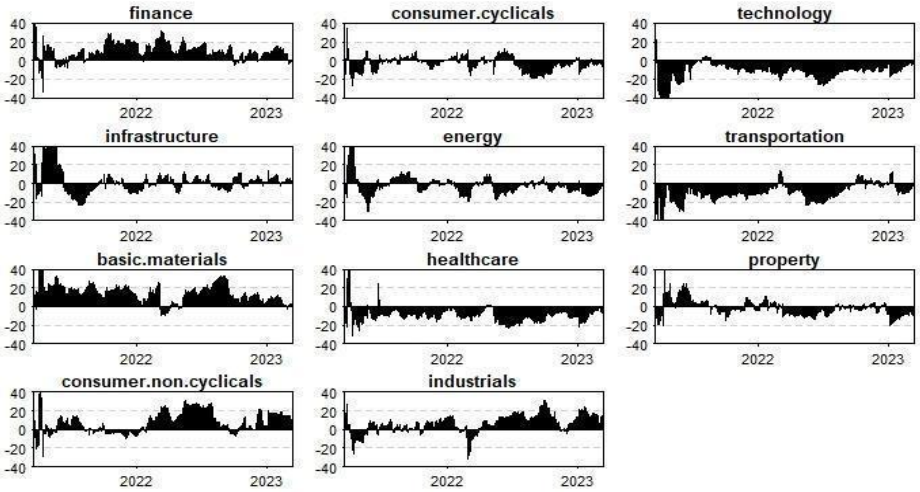

Figure 3 Net Total Connectedness Index of All Sectors From The Year 2021 To 2023

Risk Transmitters and Risk Receivers of Spillovers during the Russia-Ukraine Conflict.

Financial Sector

The banking sector remained the same as before the war as a risk transmitter until March 2023. This means that the financial sector always provides risk to the overall return spillover system between sectoral indices before and during the war, with the highest risk intensity at the beginning of the war. This is because the financial sector supports the JCI after the energy sector. Demirgüç-Kunt et al. (2021) stated that the adverse impact of the COVID-19 shock on banks was much more pronounced and long-lasting. Shortly afterward, the Russia-Ukraine war caused inflation rates to spike in many countries, and central banks had to increase benchmark interest rates. However, inflation in 2023 was optimally controlled with sufficient domestic liquidity (Limanseto, 2024). Although the performance of this sector has declined, some issuers actually recorded positive performance.

Healthcare, Transportation, and Industrial Sector

The healthcare and transportation sectors remain as risk receivers, meaning that both sectors are not much affected by the Russia-Ukraine war. And still receive risk from the sectoral index return spillover system before and during the war. So, both sectors tend to move on their own, unaffected by the sentiments that hit the JCI. The industrial sector remains a risk transmitter in the spillover system until 2023. This sector continues to experience a recovery trend amidst global economic uncertainty, especially in the utilization of the non-oil and gas processing industry, which continued to increase in 2022 (Baheramsyah, 2023).

Infrastructure Sector

During the war, the infrastructure sector shifted to become a risk transmitter in the spillover return system with high intensity from March to April 2022 and maintained this position until March 2023. This change in role during the Russia-Ukraine war is due to the increase in material costs and the rise in the benchmark interest rate, which is putting great pressure on the infrastructure sector (Nainggolan, 2022).

Basic Materials Sector

At the beginning of the war, the basic materials sector turned into a risk receiver until May 2022 and returned to being a risk transmitter. This change to a risk transmitter is due to a decrease in the index in 2022 as the amount of cash and cash equivalents decreases from 2021 to 2022. However, in early 2023, the majority of basic materials became risk receivers. This is due to the government's drive to change the economic base from commodities to a value-added product base, which is a factor affecting the basic materials sector (Purnama, 2024). Thus, the downstream and industrialization policies of a number of commodities are positive sentiments to move the shares of issuers in the raw goods sector.

Consumer Cyclicals and Consumer Non-Cyclicals Sector

The consumer cyclical sector will turn into a risk receiver until May 2022 and then turn back into a risk transmitter in the spillover system until March 2023. Meanwhile, the consumer non-cyclical sector became a risk transmitter at the beginning of the war but became a risk receiver until early 2023. Some consumer sector issuers were hindered by economic turmoil in 2022, such as inflation figures from the producer and consumer side, rising interest rates, Rupiah depreciation, and commodity price spikes that disrupted top-line financial performance (Hutagaol et al., 2022). It also increases COGS and total expenses, thus suppressing the bottom-line performance of primary consumer goods sector issuers.

The increase in inflation had a negative impact on the non-primary consumer goods sector, especially on the middle to lower market share. However, according to Kemenkeu (2024), in 2023, inflation will be under control and support people's purchasing power. In line with this, interest rate policies were normalized in line with the strengthening of the Rupiah exchange rate and maintained domestic inflation. The decline in food commodity prices will also support the financial performance of issuers in the consumer goods sector in 2023.

Energy Sector

The energy sector was the recipient of risk until 2023, with the highest intensity of risk acceptance from the entire spillover system at the beginning of the war. The energy sector is impacted by the increase in energy commodities due to the Russia-Ukraine war (Santi, 2022). Therefore, investment in the energy sector provides a high-return opportunity. The energy sector was the main driver of the JCI throughout 2022. In 2023, there was a

continuous decline in energy commodity prices, so the prospects for the energy sector in Indonesia were not as high as at the beginning of the war.

Technology Sector

The technology sector turned into a risk transmitter for the overall system spillover return until June 2022. And returns to being a risk receiver until 2023. The technology sector was projected to be the most burdened in 2022 due to the changing momentum as the US central bank starts to raise its benchmark interest rate. The decline in the sector's performance can be seen from the performance of former startup issuers, which immediately weakened after listing on the stock exchange (BEI, 2022).

Conclusion

This paper investigates the evolution of the network of relationships between stock sectors in Indonesia during the Russia-Ukraine crisis. Our empirical findings are as follows: First, there is an increase in dynamic return connectedness throughout Indonesia's stock sectors, which indicates that hypothesis 1 can be supported. Second, directional spillover results show that during the Russia-Ukraine conflict, materials and basic assets moved from net shock transmitters to net receivers during the war, while energy moved from net receivers to net shock transmitters. The financial, infrastructure, non-cyclical consumption, industrial, healthcare, and transport sectors have grown strongly, and their role has remained unchanged throughout the conflict. In particular, finance was at one time the strongest source of shock in the Indonesian stock market, while health was the subject of the strongest shock.

The implications of this paper for Indonesian authorities and investors are substantial. Investors should first monitor how these events play out in the future and any potential drawbacks, recognize any risks, and swiftly stop losing money. Globalization of the economy, however, has rendered it impossible for any government to avoid public catastrophes. As such, investors ought to take into account relevant foreign markets in addition to the local market when making investment selections. Investors should also distribute their portfolios according to how the asset systems may differ and how they are similar in terms of time-varying connectedness. Industries with high levels of risk, such as healthcare, transportation, consumer goods, and technology, should be avoided by investors. They act as risk transmitters since the fluctuations in industrial profitability might have an impact on all four sectors. The fungible role of financial assets suggests that policymakers should adopt flexible regulatory strategies to avoid systemic risk contagion. Our study shows limitations. Further research is suggested to add volatility spillover in addition to return spillover and to add robustness analysis to find out whether there are differences in patterns using different parameters.

References

Alexakis, C., & Pappas, V. (2018). Sectoral dynamics of financial contagion in Europe - The cases of the recent crises episodes. *Economic Modelling*, *73*, 222–239. https://doi.org/10.1016/j.econmod.2018.03.018

Aliu, F., Kučera, J., & Horák, J. (2024). Exchange rate instabilities during the Russia-Ukraine war: Evidence from V4 countries. *Heliyon*, *10*(3), e25476. https://doi.org/https://doi.org/10.1016/j.heliyon.2024.e25476

Ang, R. (1997). *Buku Pintar Pasar Modal Indonesia*. Mediasoft Indonesia.

Antonakakis, N., Chatziantoniou, I., & Gabauer, D. (2020). Refined Measures of Dynamic Connectedness based on Time-Varying Parameter Vector Autoregressions. *Journal of Risk and Financial Management 13*(4), 84. https://doi.org/10.3390/JRFM13040084

Baheramsyah. (2023). *Industri Pengolahan Nonmigas Berperan Penting bagi Ekonomi Nasional*. https://infopublik.id/kategori/nasional-ekonomi-bisnis/712165/industri-pengolahan-nonmigas-berperan-penting-bagi-ekonomi-nasional

BEI. (2022). *Indeks Saham*. https://www.idx.co.id/id/data-pasar/data-saham/indeks-saham/

Bui, H. Q., Tran, T., Pham, T. T., Nguyen, H. L.-P., & Vo, D. H. (2022). Market volatility and spillover across 24 sectors in Vietnam. *Cogent Economics & Finance*, *10*(1). https://doi.org/10.1080/23322039.2022.2122188

Cahya, P. F. P., Suwendra, I. W., & Yudiaatmaja, F. (2018). Pengaruh Nilai Tukar Rupiah dan Inflasi terhadap Indeks Harga Saham Sektor Properti dan Real Estate yang Tercatat di Bursa Efek Indonesia Tahun 2011-2013. *Jurnal Manajemen Indonesia*, *6*(1), 1–8. https://ejournal.undiksha.ac.id/index.php/JMI/article/view/38226

Caldara, D., & Iacoviello, M. (2022). Measuring Geopolitical Risk. *American Economic Review*, *112*(4), 1194–1225. https://doi.org/10.1257/aer.20191823

Chatziantoniou, I., Gabauer, D., & Marfatia, H. A. (2021). Dynamic connectedness and spillovers across sectors: Evidence from the Indian stock market. *Scottish Journal of Political Economy*, *69*(3), 283–300. https://doi.org/10.1111/sjpe.12291

Chen, Y. L., Mo, W. S., Qin, R. L., & Yang, J. J. (2023). Return spillover across China's financial markets. *Pacific Basin Finance Journal, Elsevier*, *80(C)*. https://doi.org/https://doi.org/10.1016/j.pacfin.2023.102057

Demirgüç-Kunt, A., Pedraza, A., & Ruiz-Ortega, C. (2021). Banking sector performance during the COVID-19 crisis. *Journal of Banking and Finance*, *133*(August). https://doi.org/10.1016/j.jbankfin.2021.106305

Diebold, F. X., & Yilmaz, K. (2009). Measuring Financial Asset Return and Volatility Spillovers, with Application to Global Equity Markets. *The Economic Journal*, *119*(534), 158–171. https://doi.org/10.1111/j.1468-0297.2008.02208.x

Diebold, F. X., & Yilmaz, K. (2012). Better to give than to receive: Predictive directional measurement of volatility spillovers. *International Journal of Forecasting*, *28*(1), 57–66. https://doi.org/10.1016/j.ijforecast.2011.02.006

Diebold, F. X., & Yılmaz, K. (2014). On the network topology of variance decompositions: Measuring the connectedness of financial firms. *Journal of Econometrics*, *182*(1), 119–134. https://doi.org/https://doi.org/10.1016/j.jeconom.2014.04.012

Dornbusch, R., Park, Y. C., & Claessens, S. (2000). Contagion: Understanding How It Spreads. *The World Bank Research Observer*, *15*(2), 177–197. https://doi.org/10.1093/wbro/15.2.177

Hutagaol, Y. R. T., Sinurat, R. P. P., & Shalahuddin, S. M. (2022). Strategi Penguatan Keuangan Negara Dalam Menghadapi Ancaman Resesi Global 2023 Melalui Green Economy. *Jurnal Pajak Dan Keuangan Negara (PKN)*, *4*(1S), 378–385. https://doi.org/10.31092/jpkn.v4i1s.1911

Iranifard, E., & Latifnejad Roudsari, R. (2022). Comparative Research: An Old Yet Unfamiliar Method. *Journal of Midwifery and Reproductive Health*, *10*(3), 3317–3318. https://doi.org/10.22038/jmrh.2022.66873.1954

Junaedi, J. (2022). The Impact of the Russia-Ukraine War on the Indonesian Economy. *Journal of Social Commerce*, *2*(2), 71–81. https://doi.org/10.56209/jommerce.v2i2.29

Jung, R. C., & Maderitsch, R. (2014). Structural breaks in volatility spillovers between international financial markets: Contagion or mere interdependence? *Journal of Banking and Finance*, *47*, 331–342. https://doi.org/10.1016/j.jbankfin.2013.12.023

Kemenkeu. (2024). *Inflasi Terkendali, Daya Beli Masyarakat Tetap Kuat di 2023*. Kementerian Keuangan Republik Indonesia. https://www.kemenkeu.go.id/informasi-publik/publikasi/berita-utama/menkeu-tanggapan-p2apbn2023-rapur# .

Lee, H. Y. (2012). Contagion in International Stock Markets during the Sub Prime Mortgage Crisis. *International Journal of Economics and Financial Issues*, *2*(1), 41–53. https://www.econjournals.com/index.php/ijefi/article/view/87

Lee, K. J., Lu, S. L., & Shih, Y. L. (2018). *Contagion Effect of Natural Disaster and Financial Crisis Events on International Stock Markets*. https://doi.org/https://doi.org/10.3390/jrfm11020016

Limanseto, H. (2024). *Inflasi Indonesia 2023 Terkendali, Kembali pada Rentang Sasaran dan Terendah dalam Dua Dekade*. Kementerian Koordinator Bidang Perekonomian Republik Indonesia. https://ekon.go.id/publikasi/detail/5578/inflasi-indonesia-2023-terkendali-kembali-pada-rentang-sasaran-dan-terendah-dalam-dua-dekade

Mahran, H. A. (2023). The impact of the Russia–Ukraine conflict (2022) on volatility connectedness between the Egyptian stock market sectors: evidence from the DCC-GARCH-CONNECTEDNESS approach. *The Journal of Risk Finance*, *24*(1), 105–121. https://doi.org/10.1108/JRF-06-2022-0163

Majumder, S. B., & Nag, R. N. (2018). Shock and Volatility Spillovers Among Equity Sectors of the National Stock Exchange in India. *Global Business Review*, *19*(1), 227–240. https://doi.org/10.1177/0972150917713290

Mankiw, N. G. (2000). *Teori Ekonomi Makro (Terjemahan)* (4th ed.). Erlangga.

Mensi, W., Nekhili, R., Vo, X. V., Suleman, T., & Kang, S. H. (2021). Asymmetric volatility connectedness among U.S. stock sectors. *The North American Journal of Economics and Finance*, *56*, 101327. https://doi.org/10.1016/j.najef.2020.101327

Nainggolan, E. U. (2022). *Ekonomi Indonesia di Tengah Ketidakpastian Global*. Kementrian Keuangan Republik Indonesia. https://www.djkn.kemenkeu.go.id/kanwil-kalbar/baca-artikel/15230/Ekonomi-Indonesia-di-Tengah-Ketidakpastian-Global.html

Ngene, G. M. (2021). What drives dynamic connectedness of the U.S equity sectors during different business cycles? *The North American Journal of Economics and Finance*, *58*, 101493. https://doi.org/10.1016/j.najef.2021.101493

OECD. (2022). *Impacts of the Russian invasion of Ukraine on financial market conditions and resilience*. https://doi.org/https://doi.org/https://doi.org/10.1787/879c9322-en

Ohyama, M. (2007). The Mundell-Fleming model revisited : a microeconomics. *Keio Economic Studies*, *44*(1), 1–18. https://cir.nii.ac.jp/crid/1050001337401660672

Okotori, T. W., & Ayunku, P. (2020). *The Mundell-Fleming Trilemma: Implications for the CBN and the financial markets*. *103880*. https://mpra.ub.uni-muenchen.de/103880/1/MPRA_paper_103880.pdf

Ozili, P. K. (2024). *Global Economic Consequences of Russian Invasion of Ukraine* (MPRA Paper). University Library of Munich, Germany. https://econpapers.repec.org/RePEc:pra:mprapa:120781

Purnama, A. (2024). *Dampak Positif Hilirisasi Industri bagi Penanaman Modal di Indonesia*. Dinas Penanaman Modal Dan Pelayanan Satu Pintu Provinsi Kepulauan Bangka Belitung.

https://dpmptsp.babelprov.go.id/content/dampak-positif-hilirisasi-industri-bagi-penanaman-modal-di-indonesia

Ratten, V., da Silva Braga, V. L., & da Encarnação Marques, C. S. (2021). Sport entrepreneurship and value co-creation in times of crisis: The covid-19 pandemic. *Journal of Business Research*, *133*, 265–274. https://doi.org/10.1016/j.jbusres.2021.05.001

Santi, A. J. T. (2022). *Sektor Energi, Jagoan 2022*. https://www.kompas.id/baca/ekonomi/2022/12/29/sektor-energi-jagoan-2022

Setiawanta, Y., Purwanto, A., & Hakim, M. A. (2019). Financial Performance and Firm Value Lesson from Mining Sub-sector Companies on the Indonesia Stock Exchange. *JDA Jurnal Dinamika Akuntansi*, *11*(1), 70–80. https://doi.org/DOI: https://doi.org/10.15294/jda.v11i1.17278

Shahzad, S. J. H., Naeem, M. A., Peng, Z., & Bouri, E. (2021). Asymmetric volatility spillover among Chinese sectors during COVID-19. *International Review of Financial Analysis*, *75*, 101754. https://doi.org/10.1016/j.irfa.2021.101754

Shigemoto, H., & Morimoto, T. (2022). Volatility Spillover among Japanese Sectors in Response to COVID-19. *Journal of Risk and Financial Management*, *15*(10), 480. https://doi.org/10.3390/jrfm15100480

Tandelilin, E. ; (2010). *Portofolio dan Investasi: Teori dan aplikasi* (1st ed.). Kanisius.

Urrea, C., & Agramonte, R. (2021). Kalman Filter: Historical Overview and Review of Its Use in Robotics 60 Years after Its Creation. *Journal of Sensors*, *2021*(1), 9674015. https://doi.org/https://doi.org/10.1155/2021/9674015

Yang, T., & Lim, J. J. (2004). Crisis, contagion, and East Asian stock markets. *Review of Pacific Basin Financial Markets and Policies*, *7*(1), 119–151. https://doi.org/10.1142/S0219091504000068

Zhang, H., Chen, J., & Shao, L. (2021). Dynamic spillovers between energy and stock markets and their implications in the context of COVID-19. *International Review of Financial Analysis*, *77*(C), 101828. https://doi.org/10.1016/j.irfa.2021.101828

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Conflicts of Interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.