

# Impact of Russia–Ukraine conflict on Russian financial market: Evidence from TVP-VAR and quantile-VAR analysis

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## Abstract

This study aims to analyze the repercussions of the Russia–Ukraine conflict on the Russian financial market, focusing on the main stock market and sectorial stock indices. High-frequency hourly data from September 12, 2021, to April 29, 2022, covering the period before and after the outbreak of conflict, is utilized for analysis. The empirical investigation employs the TVP-VAR and Quantile-VAR connectedness approaches. Our findings indicate a significant impact of the conflict on the Russian stock market, leading to increased market risk during the event period. Notably, certain sectors, including oil and gas, utilities, metals & mining, financials, consumer goods, and services exerted more influence on other sectors, while chemicals, transport, and telecoms were influenced by other sectors. These insights are crucial for comprehending the financial implications of the ongoing conflict on the local economy, providing valuable guidance to portfolio managers, investors, and policymakers in devising effective financial strategies.

*Keywords:* Russia–Ukraine conflict, stock market index, sectorial index, TVP-VAR, quantile network connectedness estimations

*JEL classification:* C31, G11, G14.

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## 1. Introduction

The ongoing Russia–Ukraine conflict negatively impacts global stock markets. Sanctions imposed against Russia create economic setbacks, affecting local stock market. The conflict disrupts global trade relations, especially with the EU, leading to uncertainty for investors. Volatility in Russian markets further exacerbates negative impacts on listed firms, contributing to stock market fluctuations. In this study, we

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empirically examine the impact of the Russia–Ukraine conflict in 2022 on the Russian main and sectorial stock indices.

The impact of wars and conflicts on the stock market is well-documented in various research studies. For example, Abbassi et al. (2023), Jin et al. (2022), Qureshi et al. (2022) have investigated the adverse effects of such situations. Others, like Yousaf et al. (2022a), examined the substantial effect on the stock markets of G-20 economies, while Bounou and Yatié (2022) focused on countries sharing borders with Ukraine and Russia. However, there is limited literature on the impact of the conflict on the Russian stock market, particularly on financial conditions and exchange rates like the ruble to the dollar.

Consequently, this study aims to analyze the impact of the ongoing conflict on the Russian stock market, along with the connectedness of major sectorial indices in several ways. *Firstly*, we present evidence on the time-varying parametric connectedness network model of major indices, a novel approach compared to other studies that have examined cross-commodity effects and connectedness return using diverse methods (Adekoya et al., 2022; Farid et al., 2022; Kilinc-Ata et al., 2023). Additionally, there is a lack of research exploring extreme connectedness and dependency structure of return spillovers among different commodity groups. Specifically, we examine the connectedness of major sectorial indices such as oil and gas, electric utilities, telecom, materials & mining, financials, consumer goods & services, chemicals, and transportation due to the current ongoing conflict between Russia and Ukraine. *Secondly*, we demonstrate the influence of the current conflict on the tail-dependency network of Russian main stock indices, including MOEX Russia Index, RTS Index, MOEX Blue Chip Index, and MOEX Broad Market Index. The vulnerable situation triggered extreme uncertainty in regional financial markets, especially in Russia, leading to an anxiety trading environment and severe economic losses. Consequently, concerns remain regarding effective risk management strategies and alternative portfolios as shields during this vulnerable situation. *Thirdly*, we utilize hourly intervals of intraday data, enabling examination of small changes in stock returns and facilitating more effective investment decisions for portfolio managers. While some research has explored associations among different commodity groups during the current conflict (Liadze et al., 2022), our study presents the influence of the outbreak on the extreme return connectedness network of multiple indices and groups of indices representing commodities used in households' daily routines.

In this way, our study offers valuable insights for policymakers, fund managers, and investors to make informed decisions on investment options during ongoing war-crisis periods. Our key findings reveal significant changes in the Russian stock market's connectedness and increased market risk during the conflict. Specifically, the oil and gas, electric utilities, metals & mining, financials, consumer goods, and services sectors act as net transmitters of spillovers, while chemicals, transport, and telecoms are net receivers. Following the invasion, the Russian economy experienced a substantial economic slowdown in the short term. The Russian stock market faced closures, with MOEX being shut for over a month, and many companies with shares listed abroad witnessing all-time low equity values and delisting. Additionally, the Russian ruble plummeted against the US dollar as the conflict started, further impacted by sanctions and fears of import bans (14% decline in offshore trading).

Russia's economy could contract in the short term as well as in the long term, as documented by recent studies (Liadze et al., 2022). The international view expects the economic impact of sanctions to be comparable to, or worse than, the slowdowns experienced during the 2008–2009 financial crisis or the COVID-19 pandemic. The country's economy is facing multiple challenges, with multinational corporations withdrawing their operations and cutting ties with Russian entities like Sberbank, Gazprom, and others, leading to significant disruptions in major stocks and banking assets with business linkages to the US banking system. Furthermore, USA has frozen the financial assets of Russian multinational companies in the US financial system and restricted their access to US bond and equity markets (Boungou and Yatié, 2022). Another significant challenge is the removal of the Russian banking sector from SWIFT, hindering cross-border trade and creating difficulties in signing Letters of Credit for international trade.

Typically, in a war situation, both countries' economies suffer adverse effects. However, in the case of Russia, the actual impact may differ from economists' and opponents' expectations (Rutland, 2015). This study aims to explore whether the Russian economy is effectively managing crisis or experiencing a certain economic slowdown. The analysis includes a discussion of the real-time economic situation of Russia's main indices, such as the MOEX Russia Index, RTS Index, MOEX Blue Chip Index, MOEX Broad Market Index, and sectoral indices, including oil and gas, electric utilities, telecom, materials & mining, financials, consumer goods & services, chemicals, and transportation.

The paper is structured as follows. Section 2 provides a literature review relevant to our study. The subsequent section outlines the methodology, tools, and procedures utilized. Section 4 presents the empirical results and subsequent discussion. The final section concludes the study.

## 2. Review of literature

A growing body of literature has extensively documented the diverse impacts of international conflicts on the financial market, subsequently affecting the overall health of the economy. Most studies reveal the aggregate negative and long-term effects of war and conflict on the stock market. For instance, Frey and Kucher (2000) examined how the crisis influenced European bond market prices, posing macro-level challenges for policymakers in terms of investor trust in the bond market. Schneider and Troeger (2006) qualitatively observed the conflict between Israel and the Gulf region, while Tosun (2021) reported the destructive impact of terrorist events like 9/11, which initiated contemporary crises. Similarly, Hassan depicted varying impacts on different sectoral indices during the Indo-China border conflict (Hassan et al., 2022). Kumari et al. (2022) employed the event study model to explore the Indian stock market's response to Indo-China conflicts from 2019 to 2022. Empirical evidence demonstrates heterogeneity in effects, although the overall impact tends to be negative.

### 2.1. *The impact of the Russia–Ukraine conflict on sectorial indices*

Consistent with previous studies, the ongoing conflict between Russia and Ukraine bears resemblance to the 2014 conflict, which negatively impacted not only

the Russian and Ukrainian economies but also affected the entire region, including the European Union. Jin et al. (2022) have highlighted the novel and detrimental impact of the current ongoing conflict on the financial market. In light of this impact, Adekoya et al. (2022) examined the oil's connectedness with financial assets such as bonds, bitcoin, US Gold, and stocks during the Russia–Ukraine conflict using intraday data and the TVP-VAR model. They found stronger connectedness during the conflict with oil becoming a net transmitter.

Furthermore, Chortane and Pandey (2022) explored the impact of the Russia–Ukraine conflict on the global currency value against the US dollar. Using event and market model estimations, they confirmed a negative influence on the global currency value, with varying effects across regions. The ongoing geopolitical tension not only increases the risk of equity markets but also affects energy product supply and the tourism sector. Pandey and Kumar (2023) examined the impact of the Russia–Ukraine conflict on the global tourism sector using the event study model and found abnormal returns in the EU, Middle East, Pacific, and Africa.

Singh et al. (2022) investigated the effect of the conflict between Russia and Ukraine on investors' perception of the energy, aerospace and defense, and environment, social, and governance sectors. They found increased attention towards the energy, aerospace, and defense sectors due to their growing sustainability role. Regarding the response of global financial markets to the Russia–Ukraine conflict, Umar et al. (2022b) depicted that EU equities and Russian bonds are the net transmitters of shocks. Overall, this conflict has significant impact on the regional economy and the stability of the financial and economic system. Various studies have explored the correlation between domestic and regional stock markets in times of crises and conflicts, examining capital markets with other variables such as the Asia currency crisis and foreign exchange markets (Karanasos et al., 2022; Kubiczek and Tuskiewicz, 2022). Additionally, previous research focused on examining the relationships of Asian stock markets before and during the GFC 2007-08 (Manopimoke et al., 2018).

## 2.2. Trade sanctions

In addition to the literature mentioned earlier, it is crucial to consider the trade boycott against Russia and its financial ramifications on the Russian economy. Western countries imposed sanctions and recalled multinational corporations operating in Russia, leading to a stagnant downgrade of the financial market. Consequently, the EU and other allies sought gradual independence from Russian energy products. Heilmann (2016) found significant negative effects of such regional boycotts, but response heterogeneity exists due to factors such as the lack of alternatives or high import costs for energy products. These boycotts have ultimately impacted the stock market, leading to negative price and return effects. Tosun and Eshraghi (2022) evaluated the response of firms remaining in Russia during these sanctions and boycotts, finding that investors' portfolios underperformed leavers and the market benchmark, with investors applying a strong market fine on the companies with operations in Russia.

The impacts of the ongoing situation on stock markets have been widely investigated by policymakers, academics, investment institutions, and individuals. Kollias et al. (2011) analyzed the impact of political risk and war threat on the debt

and stock market, highlighting significant contagion effects on the stock and trading markets. Similarly, Bloom (2009) studied the exogenous impact of events like the GFC, 9/11 attack, and crude oil price shocks on the EU stock market, considering micro and macroeconomic variables at different uncertainty levels. Ahmad et al. (2013) examined the impact of the GFC 2007-08 on the European capital market, finding risk transmission to emerging market countries. In our study, we expect a similar risk transmission to European countries from Russia due to trading and investment partnerships among the countries. Several other studies have examined the economic situations during crises and their response on the stock market, such as Heiberger (2014) studying the impact of war crises and economic uncertainty on the stock index.

Yousaf et al. (2022b) conducted an analysis of the impact of the Russia–Ukraine conflict on the G20 and selected stock markets using the event study technique. The results show a significant and negative impact of the conflict on the event day and the post-event day. Regional analysis further confirms the negative effect on the EU and Asian regions, with variations observed across different countries. Similarly, Alam et al. (2022) investigated the impact of the Russian invasion crisis on five commodities in BRIC and G7 countries. Applying the TVP-VAR approach, the authors documented a strong connectedness among all commodities and markets. Furthermore, Patel et al. (2023) examined the spillover between green-dirty cryptocurrencies and socially responsible investment during the Ukraine conflict and identified significant variations in the connectedness between the pre- and during-conflict periods.

### *2.3. Market uncertainty and high risk*

Based on the existing literature, we observe a common theme of risk as a key factor in financial markets. Shocks in the market transmit associated risks, influencing the volatility and behavior of the stock market. In the context of the Russia–Ukraine tension, the Russian stock market faced heightened risk, leading to a herding effect amid the ongoing crisis. This study predicts that the Russian stock market may experience contagion and collapse if external shocks persist. Therefore, policymakers and financial market supervisors should prioritize risk assessment during crises. Scholars have empirically examined factors causing systemic financial risk. Bounou and Yatié (2022) studied the spillover effect of systemic risk on financial institutions, while Sohail et al. (2021) explored the scale of financial assets' impact on systemic risk. Acemoglu et al. (2015) found that closely associated financial markets can increase constancy for small shocks but become a significant source of systematic risk beyond a certain threshold.

### *2.4. Impact of COVID-19 on stock market and other assets*

The financial world has witnessed global outbreaks like the COVID-19 pandemic, impacting the stock market with high-frequency shocks that affect the economy. Researchers have investigated the impact of the COVID-19 outbreak on the stock market. For instance, Abosedra et al. (2021) studied consumer expenditure and sentiment in the US during COVID-19 and found significant changes in consumer behavior with sentiment impact during each sub-period. Arfaoui et al. (2022)

evaluated Sukuk and stock association in GCC economies during COVID-19 and observed asymmetries in shocks effects and spillover. Corbet et al. (2021) examined volatility spillover in Chinese financial markets during COVID-19. Similarly, Pandey and Kumari (2021) analyzed the impact of COVID-19 on 49 stock markets of developed and emerging countries and found a significant impact. Other studies also explored COVID-19's influence on the US, Chinese, and Russian stock markets, as well as on IT sectors, portfolio diversification, and volatility spillover.

### *2.5. Impact of crisis on global and regional economy*

During the crisis, excessive credit expansion was observed, leading to macro-economic imbalances. Current crisis has several features unique to the Russian stock market, such as the herding effect in stock market, negative externalities in commodity market, and information mismatch regarding the economic policy uncertainty has contributed more uncertainty in the uprising of the systemic financial risks and risk contagion in the economy. Scholars are employing new econometric methods to investigate financial issues, including the network connectivity of different markets. The transmission of information during crises is closely related to increased uncertainty in the stock market. Researchers have studied information transmission and its impact on various markets like commodities, currency, bonds, and stocks. Studies on the network connectedness of major stock markets during global crises, such as the 2008–2009 financial crisis, China–India's unique strategies, and the Russia–Ukraine tension, have been explored. The complex network estimations and high-dimensional dataset analysis are applied to examine the effects of crises on stock markets. Studies have shown that the effects of global financial crises vary significantly among different stock markets due to event characteristics. Risk assessment during crises is crucial for policymakers at the macro level, considering the strong correlations among financial assets and commodities. However, previous research focused more on pairwise correlation, neglecting the overall interconnectedness network and interaction correlation of financial risk with other markets, including commodity, metal, energy, and agriculture.

The global financial crisis has severely impacted financial markets worldwide, prompting numerous studies to examine the dynamic relationships across different financial markets. Researchers have investigated the dynamic relations between the US and Asia stock markets, as well as the interconnections among bond, gold, and stock markets, which vary over time and respond to market conditions, particularly during crises. Regional crises, such as the Asian currency exchange and European sovereign debt crises, have also caused financial instability and collapses of financial institutions. The ongoing conflict between Russia and Ukraine has further exacerbated the situation, leading to significant damage to the regional economy. Scholars have explored systemic risk in European countries, examining the dynamic return and cross-connectedness for financial assets and commodities, and observing volatility spillovers between US treasury bonds and emerging markets during crisis periods. This study contributes to the literature by elucidating the impact of the Russia–Ukraine conflict on the relationship between local stock markets. The empirical findings have important implications for various stakeholders, including market participants, corporations, and individuals interested

in investing in Russia's stock markets during current situation. Given Russia's significant role as a major exporter of agricultural commodities, such as wheat, and its substantial contribution to global exports in conjunction with Ukraine, it is evident that conflicts and wars have detrimental effects on the economy's health and development process, especially in the stock market.

### 3. Material and methods

#### 3.1. TVP-VAR estimation model

Previous studies utilized the event study estimation approach to conduct similar analyses (Umar et al., 2022a). However, the event study approach estimation solely provides the event's impact during the event window. In this study, we examine the response of the Russian economy to the crisis that arose after the start of conflict with Ukraine. For this purpose, we adopted the Time-Varying Parameter Vector Autoregressive (TVP VAR) model proposed by Antonakakis and Gabauer (2017), which extends the work of Diebold and Yilmaz (2009, 2014). The TVP VAR model offers several advantages over other methodologies. Firstly, it is less susceptible to outliers, ensuring more robust estimations. Secondly, it avoids parameter estimation bias caused by arbitrary window size selection. Additionally, this estimation method does not result in data loss since it employs the Kalman filter method for determining variance and covariance matrices. Lastly, the TVP VAR model introduces a novel approach that enables the investigation of high-frequency data, such as intraday and daily data (Antonakakis et al., 2020). Below, we present the equations that define the TVP VAR model. Let  $W_t$  be a vector with  $(n \times 1)$  elements, representing  $n$  sectors. We can express the TVP VAR model as follows:

$$W_t = X_t W_{t-1} + \varepsilon_t \quad \text{where } \varepsilon_t \sim n(0, P_t), \quad (1)$$

$$X_t = X_{t-1} + \theta_t \quad \text{where } \theta_t \sim n(0, Q_t), \quad (2)$$

where  $W_{t-1}$  denotes the lag of the dependent variable, and  $X_t$  represents the time-varying  $n \times n$  element coefficient matrix, where  $\varepsilon_t$  and  $\theta_t$  are disturbances explained by the  $(n \times 1)$  and  $(n^2 \times n)$  vectors respectively. On the other hand,  $P_t$  and  $Q_t$  are  $(n \times n)$ , and  $(n^2 \times n^2)$  matrices, respectively, representing the time-varying variance and covariance matrices of the disturbance terms  $\varepsilon_t$  and  $\theta_t$ .

To facilitate analysis, we use the World representation theorem to transform the TVP VAR model into TVP VMA (Time-Varying Vector Moving Average), enabling the application of generalized forecast error and variance decomposition (hereafter referred to as GFEVD). By doing so, variance decomposition can provide insights into the transformation of forecast errors using a moving average representation.

Furthermore, the H-step-ahead forecast partitions the error variation of a variable into distinct components represented by shocks in the system. This approach is captured by the following equation:

$$W_t = \sum_{i=1}^p X_{it} W_{t-i} + \varepsilon_t = \sum_{i=0}^{\infty} \alpha_{jt} + \varepsilon_{t-j}. \quad (3)$$

Using the GFEVD approach, we can develop four different connectedness procedures, i.e., total connectedness TO others, total connectedness from others, net connectedness, and average connectedness (interconnectedness). In the below equations,  $i$  and  $j$  represent variables,  $\delta_{ij,t}^g(h)$  shows spillover impact from variable  $i$  to  $j$  and vice versa in the case of  $\delta_{ij,t}^g(h)$ .

$$To_{jt}; C_{i \rightarrow j,t}^g(h) = \sum_{i=1, i \neq j}^N \delta_{ij,t}^g(h), \tag{4}$$

$$From_{jt}; C_{i \leftarrow j,t}^g(h) = \sum_{i=1, i \neq j}^N \delta_{ji,t}^g(h), \tag{5}$$

$$Net; To_{jt} - From_{jt}; = \sum_{i=1, i \neq j}^N \delta_{ij,t}^g(h) - \sum_{i=1, i \neq j}^N \delta_{ji,t}^g(h), \tag{6}$$

$$Ac_i; = N^{-1} \sum_{j=1}^N To_{jt} = N^{-1} \sum_{j=1}^N From_{jt}. \tag{7}$$

Similarly, graphic visualization is also provided to the structural connectedness tables where different sectors indices show nodes while the arrows show pairwise connectedness among indices.

### 3.2. Quantile VAR estimation model

One of the main advantages of the quantile model is that it can provide output at different levels (quantile  $\tau$ ) of  $Y_t$  conditional on  $X_t$  (Furno and Vistocco, 2018; Koenker and Bassett, 1978). It can be written as:

$$q_\tau(Y_t \text{ conditional on } X_t) = X_t \alpha(\tau). \tag{8}$$

where  $q_\tau$  shows the  $\tau^{\text{th}}$  conditional quantile of  $Y_t$  having a range between 0 and 1 while  $X_t$  shows independent variables, similarly,  $\alpha(\tau)$  denotes dependency between  $X_t$  and  $\tau^{\text{th}}$  conditional quantile of  $Y_t$ , which can be stated as:

$$\hat{\alpha}(\tau) = \underset{\alpha(\tau)}{\operatorname{argmin}} \sum_{t=1}^T (\tau - 1_{[Y_t < X_t \alpha(\tau)]}) |(Y_t < X_t \alpha(\tau))|. \tag{9}$$

Thus the  $p^{\text{th}}$  order of the  $n$ -variable quantile VAR procedure is:

$$Y_t = k(\tau) + \sum_{i=1}^p \alpha_i(\tau) Y_{t-i} + \varepsilon_t(\tau) \quad \text{where } t = 1, 2, 3, \dots, T, \tag{10}$$

were  $Y_t$  is the dependent variable;  $k(\tau)$  denotes the  $n$ -vector of constant;  $\varepsilon_t(\tau)$  represents quantile ( $\tau$ ) of the error term;  $\alpha_i(\tau)$  is the lagged coefficients of the dependent variable at quantile ( $\tau$ ) having  $i = 1, 2, \dots, p$ . The coefficients of  $\hat{\alpha}(\tau)$  and  $k(\tau)$  are computed given that the error terms are in line with population quantile constraint, i.e.

$$q_\tau(\varepsilon_t(\tau) | Y_{t-p}, \dots, Y_{t-1}) = 0. \tag{11}$$

The  $\tau^{\text{th}}$  conditional quantile of dependent variable  $Y_t$  is provided below, which may be computed following equation by equation sequence at every quantile ( $\tau$ ).

$$q_\tau(Y_t | Y_{t-p}, \dots, Y_{t-1}) = k(\tau) + \sum_{i=1}^p \hat{\alpha}_i(\tau) Y_{t-i}. \tag{12}$$



### 3.3. Data and variables

This study aims to investigate the Russian main and sectorial stock market indices, utilizing high-frequency hourly data collected between September 12, 2021 and April 29, 2022. This time frame was chosen to encompass both the period before the conflict and the period after its outbreak, allowing us to analyze the impact of the conflict on the Russian economy. The intraday hourly stock data, comprising a total of 2786 observations, were sourced from Bloomberg. We meticulously adopted the approach of utilizing the squares of return values as a proxy for volatility by following the seminal work of Hanif et al. (2023).

### 3.4. Summary statistics

Table 1 presents the summary statistics of the Russian stock markets, calculated using the squared returns. A brief examination of the descriptive statistics reveals interesting findings. Specifically, MOEXBC exhibits the highest mean value (102.589), closely followed by IMOEX (16.692). Additionally, MOEXBC shows the greatest volatility in systemic risk, as indicated by its standard deviation of 145930.721. On the other hand, RTSTN displays the lowest mean (0.218) and the least volatility in market risk, evident from its standard deviation of 0.218. Furthermore, we conducted the Jarque–Bera test to assess the normality of all ten indices. Results indicate that all series demonstrate excess kurtosis, deviating from the normal distribution. The *p*-value provided in the table is significant for both the Jarque–Bera test and the measure of kurtosis.

Fig. 1 depicts the volatility of returns for the selected stock indices. In response to the crisis event in February 2022, the returns of the stock market seem to be unaffected as expected.

Furthermore, Fig. 2 illustrates the correlation matrix of the Russian stock markets, demonstrating the unconditional correlation between the main and sectorial indices.

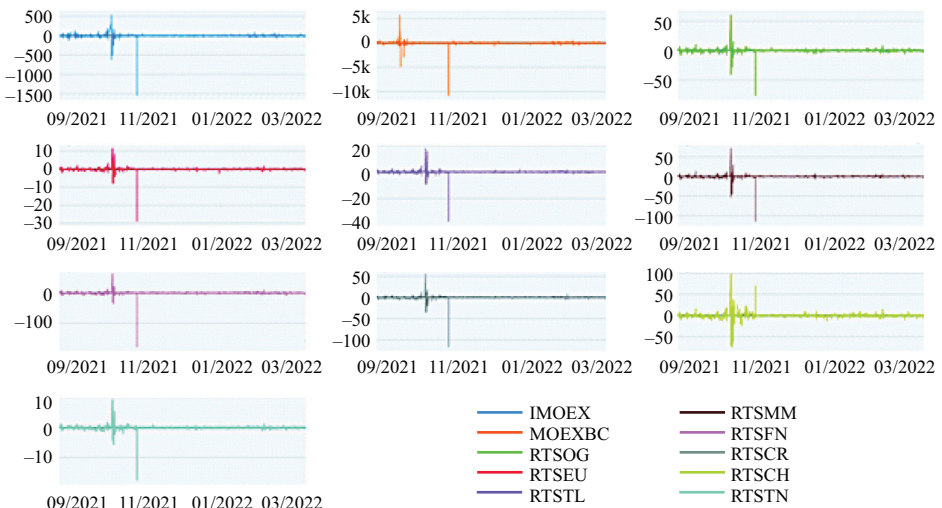


Fig. 1. Return volatility of stock indices.

Source: Authors' calculations.

**Table 1**  
Summary statistics.

	IMOEX	MOEXBC	RTSOG	RTSEU	RTSTL	RTSMM	RTSFN	RTSCR	RTSCH	RTSTN
Variance	2919.315	145930.721	10.625	0.979	1.7	19.837	30.361	15.813	31.845	0.399
Skewness	19.203***	20.143***	15.301***	19.996***	19.887***	16.872***	25.216***	20.592***	9.849***	18.632***
Kurtosis	486.055***	495.347***	297.606***	525.565***	504.634***	361.399***	778.189***	540.844***	126.422***	457.351***
JB	142.454***	1477.961***	5355.580***	1662.746***	153.972***	788.989***	363.643***	1760.435***	979.042***	1259.146***
ERS	-13.149***	-12.359***	-12.594***	-14.604***	-14.580***	-13.477***	-13.557***	-13.142***	-11.324***	-11.697***
Q (10)	195.482***	106.873***	184.704***	67.255***	47.972***	151.243***	24.652***	66.852***	350.550***	80.448***
Q2 (20)	2.730	4.837	32.633***	0.645	0.378	10.463*	0.039	0.862	155.441***	0.751

Note: This table demonstrates the summary statistics of the Russian stock markets. JB is the Jarque–Bera normality test statistics. ERS denotes the Elliot-Rothenberg-Stock unit-root test.  $p < 0.01$ , \*\*  $p < 0.05$ .

Source: Authors' calculations.

The results indicate that most markets positively correlate with RTSCH and each other, suggesting a high degree of interconnectedness and market integration. Notably, the market pair RTSEU-RTSTL exhibits the highest correlation (0.98), followed closely by the pair RTSN-RTSMM (0.96). These findings are particularly intriguing, as they reveal a strong positive correlation between both main and sectorial indices during the sample period of our study. More remarkably, both main and sectorial indices exhibit a weakly negative correlation. Further analysis and interpretation of these correlations will be conducted to gain deeper insights into the dynamics of the Russian stock markets.

Fig. 3 examines the potential shocks on returns. Despite no evident shocks being observed, further investigation confirms the interconnectedness among

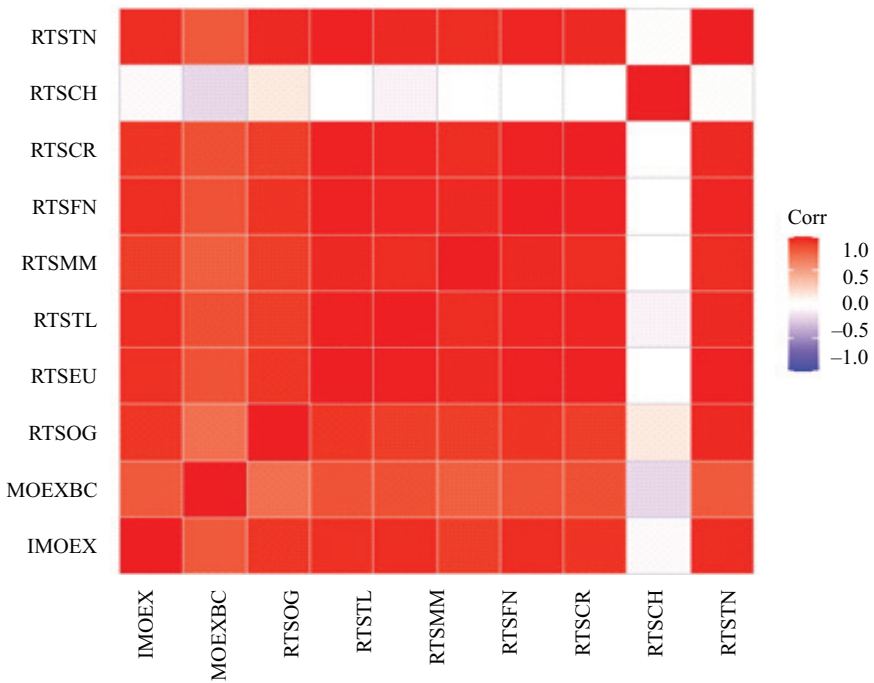


Fig. 2. Pairwise correlation matrix.

Source: Authors' calculations.

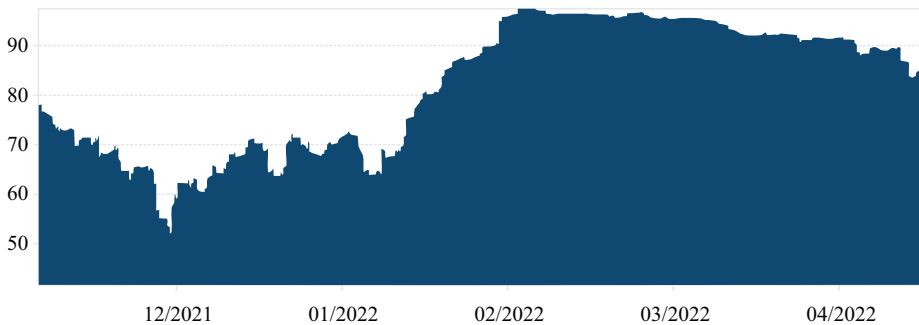


Fig. 3. Dynamic total connectedness.

Source: Authors' calculations.

the main and sectorial indices during the crisis period. Additionally, the spikes observed before the event could possibly be attributed to other factors such as the impact of the COVID-19 pandemic.

#### 4. Results and discussion

The Russia–Ukraine conflict has renewed researchers’ attention towards monitoring financial markets for cross-market spillover effects. The relationship between financial markets has undergone changes in the aftermath of the Russia–Ukraine conflict (Boubaker et al., 2022; Boungou and Yatié, 2022; Umar et al., 2022b; Wang et al., 2022). In this study, we specifically focus on analyzing the connectedness of ten main and major sectorial indices during the designated sample period, encompassing the periods before and after the outbreak of conflict. To achieve this, we employ the Time-Varying Parameter Vector Autoregressive (TVP-VAR) approach to examine the dynamic total connectedness. Additionally, we adopt the quantile connectedness approach to perform static spillover analysis of the Russian stock markets.

Fig. 4 presents the total dynamic connectedness within the Russian stock markets, revealing a notable increase in interconnectedness between main and sectorial indices following the Russia–Ukraine conflict (Wang et al., 2022). Market risk witnessed a significant surge during and after the invasion, specifically around February 24, 2022. The total connectedness reaches a relatively high peak, exceeding 90, between February and March, indicating event dependency. This finding is consistent with previous studies, such as Boungou and Yatié (2022) who reported a change in the relationship of stock markets due to the conflict. Similarly, Boungou and Yatié (2022) documented the negative impact of the Russia–Ukraine conflict on global stock markets.

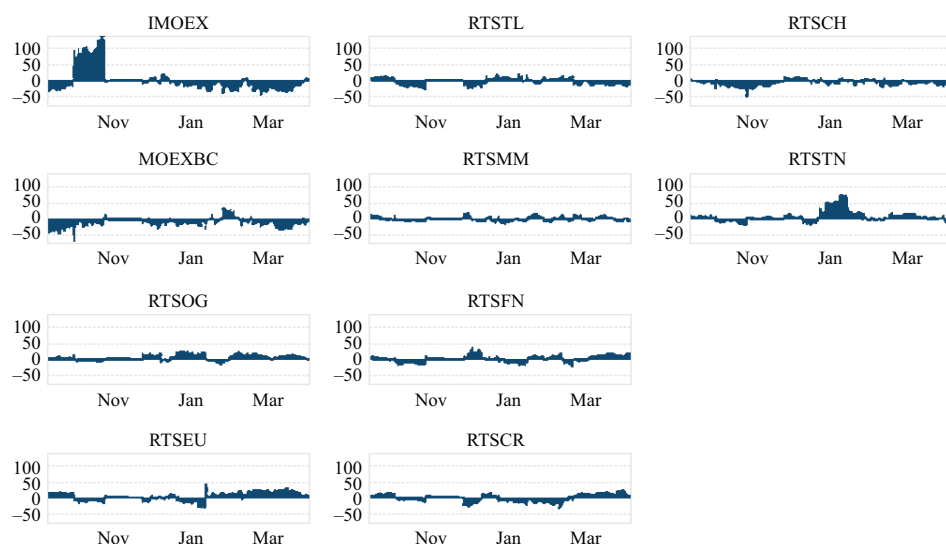


Fig. 4. Dynamic net directional connectedness.

Notes: Results are based on a TVP-VAR model with log length of order one (AIC) and a 10 step-ahead generalized forecast error variance decomposition.

Source: Authors’ calculations.

Fig. 4 illustrates the dynamic total connectedness overlying the onset of the Russia–Ukraine conflict, with the market reaching its highest interconnectedness after the event. This asymmetry is demonstrated through a TVP-VAR framework model with a log length of order one (AIC) and a 10-step-ahead generalized forecast error variance decomposition.

Moreover, Fig. 4 presents the net-connectedness of Russian stock markets, capturing both positive and negative returns during the study period. The colored area depicts the symmetric net connectedness among the main and sectorial indices. The figure identifies the indices that acted as net receivers of shocks and those that transmitted volatility throughout the study period. The X-axis indicates dates from November 2021 to March 2022. Positive values correspond to net transmitters in the market, while negative values indicate net recipients. The selected indices interchange roles over time, highlighting the varying impact of the event on the stock market.

Furthermore, Boubaker et al. (2022) examined the impact of the same event on the global stock market and found an increase in energy stock prices. Additionally, Fig. 6 demonstrates that the main index IMOEX remains persistent as the net recipient of return spillovers from all other indices during the study period. The higher occurrence of negative return spillovers in the market might be attributed to the influence of the crisis in media news. These findings are consistent with previous studies that reported similar results (Umar et al., 2022b).

Moreover, we observe a comparable pattern for the RTSL, MOEXBC, and RTSCR indices, as they persistently act as net receivers of shocks. Conversely, the RTSEU exhibits a consistent role as a net transmitter. Additionally, the RTSTN, RTSMM, RTSFN, and RTSCR indices predominantly serve as net transmitters, although they occasionally assume a net receiving role for short intervals. Furthermore, our analysis indicates asymmetry in volatility spillovers among all indices, with positive and negative return spillovers being equally distributed across the indices.

#### 4.1. *Quantile spillover analysis and Network connectedness*

The findings from the VAR return spillover analysis for the selected markets are presented in Tables 2, 3, and 4, respectively. We explore bear, normal, and bull market conditions using the 5th, 50th, and 95th quantiles. Each spillover system in these tables comprises three paths: the unidirectional spillover of each variable, the total spillover both from and to individual series, and the net directional connectedness from a specific series. These tables (2–4) also demonstrate a significant spillover effect among different indices, with substantial transmitting and receiving behaviors observed during bear, normal, and bull market conditions.

The Russia–Ukraine conflict precipitated a sudden increase in the connectedness of financial markets, as indicated by Wang et al. (2022) and the global impact of this ongoing event, as mentioned by Umar et al. (2022b). Specifically, Table 2 focuses on the 5<sup>th</sup> quantile, representing bear market events, where the total connectedness reaches 83.89%. Notably, (RTSFN) and (RTSCR) emerge as the strongest transmitters of spillover, with values of 92.26% and 91.48%, respectively, followed by (RTSOG) with a value of 90.8%.

**Table 2**  
Average connectedness, Static quantile spillover analysis Q = 25.

Indices	Interbank currency exchange	Blue chip index	Oil & gas	Electric utilities	Telecom	Metals & mining	Financial	Consumer goods & services	Chemicals	Transport	???
	IMOEX	MOEXBC	RTSOG	RTSEU	RTSTL	RTSMM	RTSFN	RTSCR	RTSCH	RTSTN	FROM
IMOEX	45.29	6.75	5.81	5.65	5.69	6.80	5.56	5.25	6.45	6.74	54.71
MOEXBC	6.81	51.84	4.49	5.66	6.31	4.67	4.73	5.57	4.43	5.49	48.16
RTSOG	6.58	3.03	25.98	10.43	8.14	9.26	10.10	8.90	7.50	10.07	74.02
RTSEU	5.86	3.34	10.35	23.37	9.26	9.89	10.65	9.80	8.06	9.41	76.63
RTSTL	5.92	3.81	9.17	10.55	25.21	8.95	9.64	9.65	8.20	8.90	74.79
RTSMM	6.58	4.15	10.24	10.13	7.51	25.09	10.05	8.65	7.80	9.80	74.91
RTSFN	5.74	3.70	10.92	10.60	8.86	9.42	24.11	9.36	7.17	10.12	75.89
RTSCR	5.48	4.02	10.18	10.59	9.64	8.81	9.76	24.33	8.18	9.00	75.67
RTSCH	5.89	4.18	8.41	10.61	8.53	9.23	8.79	9.45	26.54	8.37	73.46
RTSTN	6.23	3.62	10.40	8.58	7.68	8.50	9.36	8.84	7.63	29.17	70.83
TO	55.11	36.59	79.96	82.81	71.61	75.53	78.65	75.48	65.42	77.90	699.06
Inc.Own	100.40	88.43	105.94	106.19	96.83	100.62	102.76	99.81	91.96	107.07	TCI
NET	0.40	-11.57	5.94	6.19	-3.17	0.62	2.76	-0.19	-8.04	7.07	69.91
NPT	6.00	0.00	7.00	6.00	2.00	5.00	6.00	3.00	2.00	8.00	

Note: Table 2 show the Static quantile spillover connectedness between 10 main and sectorial indices based on 10-step-ahead forecasting horizons, quantile VAR with 200 days rolling window and Q = 25.

Source: Authors' calculations.

**Table 3**  
Average connectedness, Static quantile spillover analysis Q = 50.

	IMOEX	MOEXBC	RTSOG	RTSEU	RTSTL	RTSMM	RTSFN	RTSCR	RTSCH	RTSTN	FROM
IMOEX	41.55	6.63	6.74	6.77	6.54	6.19	6.97	6.53	5.92	6.16	58.45
MOEXBC	5.70	48.59	6.57	6.53	5.92	5.18	5.94	5.42	4.42	5.74	51.41
RTSOG	7.81	4.50	23.34	10.68	8.72	8.37	10.06	9.69	6.75	10.09	76.66
RTSEU	6.37	4.28	10.78	23.28	9.86	9.12	9.96	10.01	7.12	9.22	76.72
RTSTL	6.99	5.28	10.20	10.61	25.64	9.06	8.59	8.90	6.20	8.53	74.36
RTSMM	7.92	5.02	10.20	10.48	8.29	22.38	9.37	9.44	8.33	8.58	77.62
RTSFN	7.33	4.45	10.48	10.57	8.19	9.15	24.29	9.89	6.73	8.93	75.71
RTSCR	7.46	4.72	10.89	10.41	8.90	8.91	9.76	22.85	7.28	8.81	77.15
RTSCH	8.85	4.41	7.89	9.34	8.23	9.74	8.16	8.48	27.20	7.71	72.80
RTSTN	6.97	4.36	10.65	9.92	8.58	8.24	9.09	9.36	6.70	26.13	73.87
TO	65.41	43.66	84.40	85.30	73.23	73.95	77.89	77.71	59.45	73.77	714.77
Inc.Own	106.96	92.25	107.74	108.58	98.87	96.33	102.17	100.55	86.64	99.90	TCI
NET	6.96	-7.75	7.74	8.58	-1.13	-3.67	2.17	0.55	-13.36	-0.10	71.48
NPT	7.00	1.00	8.00	8.00	3.00	3.00	5.00	6.00	1.00	3.00	

Note: Table 3 shows the Static quantile spillover connectedness between 10 main and sectorial indices based on 10-step-ahead forecasting horizons, quantile VAR with 200 days rolling window and Q = 0.50.

Source: Authors' calculations.

**Table 4**  
Average connectedness, Static quantile spillover analysis Q = 75.

	IMOEX	MOEXBC	RTSOG	RTSEU	RTSTL	RTSMM	RTSFN	RTSCR	RTSCH	RTSTN	FROM
IMOEX	31.31	7.46	8.16	7.30	7.16	7.52	8.04	8.64	6.91	7.49	68.69
MOEXBC	7.84	32.22	8.38	7.63	7.69	7.43	7.62	7.62	6.20	7.35	67.78
RTSOG	7.43	5.11	19.43	10.54	9.56	9.58	10.55	9.97	7.17	10.65	80.57
RTSEU	6.30	5.43	11.08	18.32	10.31	9.64	10.51	10.18	7.51	10.72	81.68
RTSTL	6.92	5.62	11.01	10.32	20.39	9.37	9.72	9.73	7.12	9.78	79.61
RTSMM	7.12	5.60	10.70	10.02	9.35	18.40	10.26	10.13	8.69	9.74	81.60
RTSFN	6.90	5.43	10.78	10.40	9.17	9.72	19.48	10.46	7.47	10.19	80.52
RTSCR	7.31	5.53	11.13	9.86	9.60	9.89	10.26	18.67	7.86	9.91	81.33
RTSCH	8.18	5.64	8.86	9.46	8.76	9.80	9.71	9.42	21.06	9.10	78.94
RTSTN	7.02	5.51	10.43	9.89	9.78	9.43	10.09	10.18	7.24	20.42	79.58
TO	65.01	51.33	90.52	85.43	81.38	82.39	86.77	86.35	66.18	84.93	780.29
Inc.Own	96.33	83.56	109.95	103.76	101.78	100.79	106.24	105.02	87.24	105.34	TCl
NET	-3.67	-16.44	9.95	3.76	1.78	0.79	6.24	5.02	-12.76	5.34	78.03
NPT	2.00	0.00	8.00	5.00	3.00	4.00	6.00	8.00	1.00	8.00	

Note: Table 4 table shows the Static quantile spillover connectedness between 10 main and sectorial indices based on 10-step-ahead forecasting horizons, quantile VAR with 200 days rolling window and Q = 0.75.

Source: Authors' calculations.



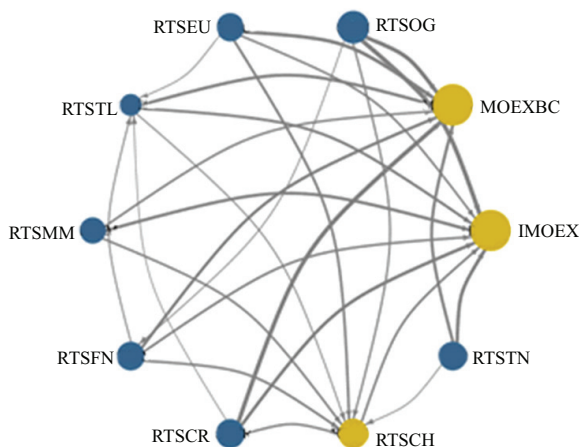
Moreover, MOEXBC and IMOEX are the primary recipients of spillover from other indices, closely followed by RTSCH. Concurrently, all the selected sectoral indices exhibit significant effects from the event, as indicated by Boubaker et al., 2022 in the context of global indices.

Table 3 corresponds to the 50<sup>th</sup> quantile, representing normal market events, where the total connectedness measures 72.75%. The Oil & Gas index (RTSOG) and Electric Utilities index (RTSEU) are identified as the most substantial transmitters of spillover, with values of 83.74% and 82.84%, respectively, followed by the financial index (RTSFN) with a value of 82.73%. Additionally, we observe that MOEXBC, IMOEX, Chemical's index (RTSCH) and RTSTL are the primary recipients of spillover from other indices.

Table 4 illustrates the Bull market events (95<sup>th</sup> quantile) with a total connectedness of 83.89%. The results reveal that the Electric Utilities index (RTSEU) and Oil & Gas index (RTSOG) are the most significant transmitters of spillover, with values of 92.57% and 90.29%, respectively, followed by RTSTN with a value of 87.73%. Furthermore, the remaining indices in this network system are observed as net recipients.

Fig. 5 presents a network diagram depicting the connectedness among the stock indices. The diagram offers insights into the spillover relationships among the stock indices, where seven indices are identified as transmitters of volatility, while three indices act as receivers of volatility shocks during the crisis period. The figure effectively portrays the intensity and direction of information flow at a lower quantile. The size of the nodes and the thickness of the edges represent the strength of linkages between pairs of indices.

Notably, sectors such as oil & gas (RTSOG), electric utilities (RTSEU), metals & mining (RTSMM), financial (RTSFN), transport (RTSTN), telecom (RTSTL), and consumer goods & services (RTSCR) emerge as significant sources of volatility transmission to other indices, signifying their critical role in the economy. Conversely, the MOEXBC, IMOEX, and chemicals (RTSCH) sectors are identi-



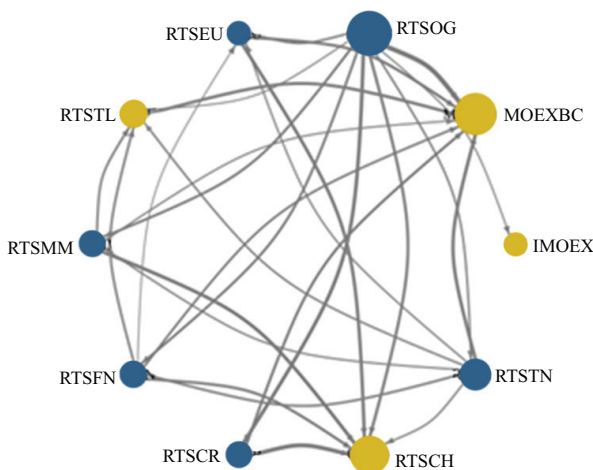
**Fig. 5.** The information's intensity and direction at lower quantile.

*Note:* The figure shows network connectedness between 10 main & sectorial indices based on 10-step-ahead forecasting horizons, quantile VAR with 200 days rolling window, and  $Q = 0.05$ .

*Source:* Authors' calculations.

fied as net recipients of spillover, indicating that they receive higher levels of volatility. Based on these findings, Boungou and Yatié (2022) recommend that investors and portfolio managers should consider favoring indices with potential volatility transmission.

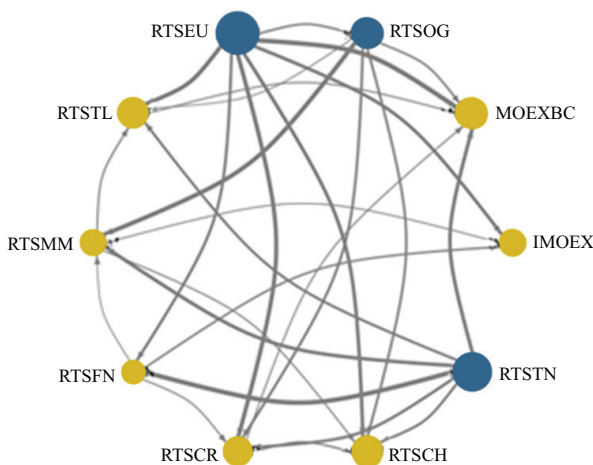
Fig. 6 presents the network connectivity diagram for the median quantile, revealing the Metals & Mining index (RTSMM) and financial index (RTSFN) as bidirectional transmitters and receivers. The thin edges between indices indicate low volatility spillovers among the Russian sectoral indices. Similar results were obtained by Wang et al. (2022) using geopolitical risk and systemic risk for the Russian commodity markets during the crisis. In Fig. 7, the network con-



**Fig. 6.** Network connection for median quantile and number of transmitters and receivers.

*Note:* The figure shows network connectedness between 10 main & sectorial indices based on 10-step-ahead forecasting horizons, quantile VAR with 200 days rolling window, and  $Q = 0.05$ .

*Source:* Authors' calculations.



**Fig. 7.** Network connection for high quantile and number of transmitters and receivers.

*Note:* The figure shows network connectedness between 10 main & sectorial indices based on 10-step-ahead forecasting horizons, quantile VAR with 200 days rolling window, and  $Q = 0.05$ .

*Source:* Authors' calculations.

nection for the high quantile is displayed, indicating a decrease in the number of transmitters and an increase in the number of receivers during the crisis period.

## 5. Conclusion

Stock markets are inherently susceptible to systemic events and exhibit rapid responses to such occurrences. Just as the COVID-19 pandemic severely impacted global stock markets (Umar et al., 2022a), the Russia–Ukraine conflict has significant implications, particularly for the Russian stock market. Hence, this study investigates the impact of the Russia–Ukraine conflict on the Russian stock market using high-frequency daily data from September 12, 2021 to April 29, 2022, covering both the period before the conflict and after its eruption. The investigation employs the Time-Varying Parameter Vector Autoregressive (TVP-VAR) and Quantile-VAR connectedness approaches. The findings reveal that the Russia–Ukraine conflict significantly affects the Russian stock market, leading to spillover effects among different sectoral indices. Compared to the pre-conflict period, the connectedness has undergone changes and become stronger since the onset of hostilities, indicating heightened market connectivity and sensitivity. Furthermore, the study observes that the main Russian stock indices, namely oil and gas, electric utilities, metals and mining, financials, consumer goods, and services, act as net transmitters, while chemicals, transport, and telecoms serve as net receivers.

Based on the study's results, several policy implications are recommended. Firstly, policymakers should prioritize the establishment of robust risk arrangements for stockholders and financial organizations. This measure can help mitigate the negative influence on the market and promote stability. Secondly, relevant institutions should implement sector-specific rules and oversight mechanisms to prevent market manipulation, especially within the Russian stock indices, oil and gas, electric utilities, metals and mining, financials, consumer goods, and services. Thirdly, investments should be directed towards sectors that foster growth and resilience, thus reducing the economy's dependence on sectors vulnerable to geopolitical events. Lastly, engaging in peaceful dialogues has the potential to reduce uncertainties and geopolitical risks, contributing to a more stable and resilient stock market.

This study aims to empirically analyze the potential impact of the Russia–Ukraine conflict in 2022 and the role of various sanctions on the stock market performance of Russian financial markets. We utilize main and sectorial indices to assess the individual impact of the crisis. However, it is important to acknowledge that we may have overlooked the emotional impact of this conflict on the Russian financial market, which could be considered a limitation of this study. As a future direction, we suggest investigating the influence of the diverse sanctions imposed by the West on the Russian economy. Additionally, to better measure the impact of the crisis on the Russian economy, future research could consider using the newly developed Russia–Ukraine conflict economic sanctions, News Sentiment Index (RUWES). This index incorporates data from Twitter Sentiments (TS), Google Trend (GT), Wikipedia Trend (WT), and News Sentiments (NS), which may prove beneficial in examining the impact of the Russia–Ukraine conflict on the Russian financial market.

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