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Impact of Volatility Spillovers upon Electric Utilities during the Russia-Ukraine Conflict

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ABSTRACT

Considering the period of crises, the fluctuations in the stock market returns increase sharply. Consequently, volatility spillovers are observed across the equities. Thus, this paper investigates the volatility spillovers across the sector indices of the Russian economy during the ongoing Russia-Ukraine conflict (2022). For this purpose, the Diebold and Yilmaz (2012) spillover index methodology was used to model the risk spillover effects among the ten stock market sectors namely; chemicals, consumer, electric utilities, financials, metal and mining, oil and gas, telecommunications, and transport throughout February 24th, 2022-May 31st, 2023. The empirical findings showed significant volatility transmissions across the stock market sectors. Moreover, the market sectors including chemicals, electric utilities, transport, and telecommunications were the net recipients of the volatility spillovers. Meanwhile, the sectors consumer, financials, metal and mining, and oil and gas were recognized as the net transmitters. Furthermore, these findings provide useful implications for policymakers to investigate the volatility spillovers across stock market sectors, especially during times of crisis. Additionally, the empirical findings assist investors in gaining insight regarding the diversification of the investor's portfolio assets to optimize returns, forecast possible future volatilities, and construct optimal portfolios.

Keywords: Volatility Spillovers, Russia-Ukraine Conflict, Energy Crisis, Russian Stock Market Sectors, and Oil and Gas
JEL Classifications: G11, G12, G17

1. INTRODUCTION

Understanding the mechanisms behind stock market volatility and spillovers across various equity markets poses challenges to the participants of the financial markets, which include individual investors, institutional investors, policymakers, and portfolio managers (Kayani et al., 2024; Ullah et al., 2024). In the past, the occurrence of several financial crises has caused researchers to study the transmission of volatility between developed and developing economies. Furthermore, geopolitical risk, which includes wars, invasions, and political conflicts, has always had an impact on economies worldwide. However, limited literature has emphasized its financial impacts. For example, Frey and Kucher (2001) examined the effects of World War II on Austrian and German government bonds. Likewise, Hudson and Urquhart (2015) reported the effects of World War II on equity markets. Moreover, empirical studies revealed that invasions and political wars hurt financial markets. Furthermore, it has been found that Iraq's invasion of Kuwait hurt equity markets (Schneider and Troeger, 2006). Similarly, Fernandez (2008) examined the effects of the USA-Iraq war on world markets. Likewise, Alshwawra (2020) investigated the effects of regional turbulence on the

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stock market in Jordan. Whereas, Gu et al. (2021) addressed the spillover of the Sino-USA conflict on China's equity market. Also, these geopolitical risks negatively affect the stock returns of emerging economies (Zaremba et al., 2022).

The gradual economic recovery following the systemic shocks of the ongoing COVID-19 health crisis, which reached its peak in March 2020 (Gubareva, 2021), has been disrupted by Russia's invasion of Ukraine on February 24th, 2022. The invasion has resulted in a heated geopolitical conflict, thus, affecting the various financial markets, globally (Alam et al., 2022; Kusi et al., 2022; Sonnenfeld et al., 2022; Umar et al., 2023; Umar et al., 2022). In principle, wars, military conflicts, and geopolitical conflicts raise investors' anxiety about corporate profitability, which results in higher stock price volatility (Choudhry, 2010; Rigobon and Sack, 2005; Yousaf et al., 2022).

Prior studies showed how financial markets reacted to the invasions. For instance, Boubaker et al. (2022) in their study unveiled that war negatively affects the returns of global equity markets. Likewise, Boungou and Yatié (2022) showed that the stock markets of 94 countries negatively responded to the conflict. Furthermore, Abbassi et al. (2022) investigated the influence of invasion on G7 stock markets. Moreover, geopolitical threats have strengthened the financial market connectedness (Umar et al., 2022). Moreover, Almansour et al. (2023) examined the volatility spillovers across equity indices of the US, Russia, and Ukraine during the Russia-Ukraine war. The findings indicate that the Nasdaq, Small Cap 100, DJIA, and MOEX were the net receivers of the volatility shocks whereas, the S&P 500 and PFTS were identified as net transmitters of the spillovers.

This study expands the current body of knowledge in various ways. Firstly, till now no study has investigated the volatility spillovers across Russian Stock Market Sectors during the Russia-Ukraine war (2022), this paper fulfills this gap. Additionally, examining the volatility spillovers on the sectoral level within Russian stock market is of prime significance to the economic policymakers and investment and managers. Moreover, analyzing the volatility spillovers across different sectors indices assists policymakers in identifying the main sectors that transmits and receives spillovers. Secondly, in addition to the growing literature regarding the foot-prints of war on financial markets, the empirical evidence from the Russian stock market is lacking. Therefore, this study addresses this gap by investigating the volatility spillovers across the Russian sector markets.

The remaining section of this empirical paper is structured accordingly. Section 2 provides a literature review. Section 3 covers data and methods. Section 4 analyzes the empirical results, while Section 5 provides discusses the conclusion.

2. REVIEW OF RELATED STUDIES

Recently, academicians and practitioners have emphasized analyzing the adverse financial effects of market crises such as turbulence in the financial markets due to the deadly viral disease known as COVID-19 (Aslam et al., 2020; Gubareva, 2021; Khan and Jan, 2021; Khan et al., 2023; Khan and Khan, 2021; Naeem et al., 2022; Umar et al., 2021; Umar et al., 2022; Yousaf et al., 2022; Yousaf et al., 2022; Yousaf et al., 2022). However, studies on the financial impacts of geopolitical risk and military warfare are limited, notably during the ongoing Russia-Ukraine conflict (2022). Moreover, Choudhry (2010) revealed that war activities between 1939 and 1945 generated major disruptions in the returns and volatility structure of US equities. Similarly, Hudson and Urquhart (2015) found a minute effect of war-like events on UK equities. Also, Frey and Kucher (2000) documented negative effect of wars on the prices of government bonds.

Prior research has emphasized on the implications of the Russia-Ukraine war (2022) on many financial markets. For example, Alam et al. (2022) investigated the impact of Russia invasion of Ukraine (2022) on different financial markets including commodities, and equity markets of BRIC and G7 countries. Moreover, Boungou and Yatié (2022) reported negative returns for global stocks during the Russia-Ukraine conflict. Furthermore, the conflict had a weak effect on emerging economies (Boubaker et al., 2022). Besides, Sun et al. (2022) concluded that this ongoing Russia-Ukraine conflict has adversely influenced the manufacturing sector of EU countries. Similarly, Ahmed et al. (2022) demonstrated a negative association between geopolitical risk and European stocks. Likewise, Lin and Wang (2024) in their study analyzed the effects of the Russia-Ukraine war on the volatility transmission across the financial markets. Their results reveal that there exist significant volatility spillovers across the equity market, commodity market, and energy market. Similarly, Hoque et al. (2024) investigated the volatility connectedness across financial and geopolitical markets during the COVID-19 pandemic and Russia-Ukraine crises. Their empirical results showed substantial spillovers between geopolitical risk and financial markets.

Following the 2008 global financial crisis (GFC), multiple empirical research used various approaches to analyze the spillover effects across several financial markets. For this purpose, Diebold and Yilmaz (2009) introduced the spillover index called DY's index, to analyze the interconnectedness of returns and volatility series. Moreover, Yilmaz (2010) examined the volatility spread across the Asian equity markets and found that there exists dynamic returns and volatility spillovers across these markets over the period of time. Using generalized vector autoregression (VAR), Diebold and Yilmaz (2012) examined the volatility spillovers across equity markets of America, bonds, currencies, and commodities. Their empirical results revealed significant changes in market volatilities, along with the spillovers to other markets during the GFC of 2008.

Furthermore, Belcaid and El Ghini (2019) studied the returns and volatility shocks across the equities of Germany, France, the United Kingdom, the United States, and Morocco. Using DY methodology, their results showed significant interconnectedness among them. Additionally, during the immediate aftermath of GFC, sharp rise in the spillover index was also observed. Similarly, Beraich et al. (2021) investigated the influence of the COVID-19 on Moroccan stock market using GARCH models. The results indicated that the volatility of the MASI stock index increased during the pandemic. Thus, after reviewing most of the spillover-related studies, the contribution of this study is as follows. First, this study examines the volatility spillovers across eight different Russian stock market sectors. Second, this paper is novel in terms of investigating these spillovers in Russian economy during the Russia-Ukraine conflict (2022).

3. DATA AND METHODS

3.1. Dataset

Financial integration has developed on both a sectoral and global scale, providing considerable challenges for financial markets and sectors. Thus, it is crucial to analyze the volatility spillovers during the present Russia-Ukraine war (2022) on a sectoral level, especially because it may provide significant inputs to investment managers regarding which sectors are notable in terms of impacting other sectors. Hence, this study attempts to investigate the volatility spillovers across the Russian stock market sectors during the Russia-Ukraine conflict (2022). For this purpose, this study used the daily prices data of Russian sector markets ranging from February 24th, 2022 to May 31st, 2023 obtained from www.investing.com. Moreover, list of selected Russian stock indices along with their respective ticker codes are given in Table 1.

3.2. Diebold and Yilmaz (2012) Spillover Framework

To investigate the volatility spillovers across the Russian stock sector markets, this study applied Diebold and Yilmaz (2012) spillover framework. The advantage of using DY spillover index is that the estimation of directional spillovers is possible. We chose this model because it is generated from the variance decomposition of n-variables.

Suppose a N-variable based on covariance, VAR(p), $z_t = \sum_{i=1}^{p} {}_i z_{t-1} + \varepsilon_t$ where ε~(0, ∑) is i.i.d term. Its MA depiction is $z = \sum_{i=0}^{\infty} A_i \varepsilon_{t-i}$. The $n \times n$ coefficient matrices A_i obey the recursion $A_i = \Phi_1 A_{i-1} + \Phi_2 A_{i-2} + . + \Phi_p A_{i-p}$, along with A_0 being an $n \times n$ identity matrix and with $A_i = 0$ for $i<0$. The MA coefficients, impulse response functions, and variance decompositions all contribute to understanding the system's variability. We employ variance decompositions, which are necessary to divide the variance of inaccurate forecasts for each variable into portions linked to system shocks. Variance decompositions determine H-step-ahead error variance in forecasting z owing to shocks to z_j, $\forall_j \neq$ i for each i can be assessed.

Table 1: List of Russian stock market sectors with their ticker codes, respectively

Sector indices	Ticker codes
MOEX chemicals	MOEXCH
MOEX consumer	MOEXCN
MOEX electric utilities	MOEXEU
MOEX Financials	MOEXFN
MOEX metal and mining	MOEXMM
MOEX oil and gas	MOEXOG
MOEX telecommunications	MOEXTL
MOEX transport	MOEXTN

MOEX refers to the Moscow Exchange

To quantify variance decompositions, orthogonal arrangements based on Cholesky factorization type identification procedures are required. However, we also need to avoid problems created by dependency on the ordering of the variables. To solve this issue Diebold and Yilmaz (2012) have imitated the generalized VAR setup of (Koop et al., 1996). The reason for the appropriateness of this approach for our analysis is that it permits correlated shocks.

The primary step is to clarify variance segments as the fragments of T-step-ahead error variances in speculating z_i based on shocks to z_i for i = 1,2,3,…, n and to z, for $i,j = 1,2,3,…,n$ so that $i \neq j$. Error variance for shocks z_j are spillovers.

Showing the KPPS T-step-ahead FEVD as $\theta_{ij}^{g}(T)$, for T=1,2,…, we have

$$\theta_{ij}^{g}(T) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{T-1} (e_i' A_t \sum e_j)^2}{\sum_{t=0}^{T-1} (e_i' A_t \sum A_t' e_i)} \tag{2}$$

In Equation (2), e_i indicates the selection vector, which is equal to 1 for the ith component and zero otherwise, while σ_{ij} illustrates the standard deviation of the error of the jth equatio.

It is also applicable to write the equation as $\sum_{j=1}^{N} \theta_{ij}^{g}(T) \neq 1$, this is because the summation of elements over rows of variance decomposition is not similar to the unity. Thus,

$$\tilde{\theta}_{ij}^{g}(T) = \frac{\theta_{ij}^{g}(T)}{\sum_{j=1}^{n} \theta_{ij}^{g}(T)} \tag{3}$$

It is applicable for calculating the spillover index.

By definition, $\sum_{j=1}^{N} \tilde{\theta}_{ij}^{g}(T) = 1$ and $\sum_{i,j=1}^{n} \tilde{\theta}_{ij}^{g}(T) = n$

KPPS variance decomposition is utilized to acquire volatility contributions so as to build total spillover-index as:

$$S^{g}(T) = \frac{\sum_{\substack{i,j=1 \\ i \neq j}}^{n} \tilde{\theta}_{ij}^{g}(T)}{\sum_{i,j=1}^{n} \tilde{\theta}_{ij}^{g}(T)} \times 100 = \frac{\sum_{\substack{i,j=1 \\ i \neq j}}^{n} \tilde{\theta}_{ij}^{g}(T)}{n} \times 100 \tag{4}$$

We may investigate the directional aspects of spillover by acquiring data on the overall spillover index. We assess the directional volatility spillovers to market i of all the new markets j as:

$$S_{i.}^{g}\left(T\right)=\frac{\sum_{\substack{j=1\\ j\neq i}}^{n}\tilde{\theta}_{ij}^{g}(T)}{\sum_{i,j=1}^{n}\tilde{\theta}_{ij}^{g}(T)}\times 100=\frac{\sum_{\substack{j=1\\ j\neq i}}^{n}\tilde{\theta}_{ij}^{g}(T)}{n}\times 100 \qquad (5)$$

The generalized VAR decomposition also permits the capturing of the spillovers from market i to all j markets:

$$S_{.i}^{g}\left(H\right)=\frac{\sum_{\substack{j=1\\ j\neq i}}^{n}\tilde{\theta}_{ji}^{g}(T)}{\sum_{i,j=1}^{n}\tilde{\theta}_{ji}^{g}(T)}\times 100=\frac{\sum_{\substack{j=1\\ j\neq i}}^{n}\tilde{\theta}_{ji}^{g}(T)}{n}\times 100 \qquad (6)$$

By using equations 5 and 6 and taking the difference, we measure net volatility spillover between the market i and all the other markets:

$$S_{i}^{g}\left(T\right)=S_{.i}^{g}\left(T\right)-S_{i.}^{g}\left(T\right) \qquad (7)$$

Equation 7 allows us to gather information just from the perspective of a single market while taking into account the receipt and transmission of spillover to all new markets. It can also become a matter of curiosity to consider net association for a pair. We calculate for market i and j,

$$S_{ij}^{g}\left(T\right)=\left(\frac{\tilde{\theta}_{ji}^{g}\left(T\right)}{\sum_{i,k=1}^{n}\tilde{\theta}_{ik}^{g}\left(T\right)}-\frac{\tilde{\theta}_{ij}^{g}\left(T\right)}{\sum_{j,k=1}^{n}\tilde{\theta}_{jk}^{g}\left(T\right)}\right)\times 100$$

$$=\left(\frac{\tilde{\theta}_{ji}^{g}\left(T\right)-\tilde{\theta}_{ij}^{g}\left(T\right)}{n}\right)\times 100. \qquad (8)$$

4. EMPIRICAL ANALYSIS

4.1. Descriptive Statistics

Table 2 refers to the descriptive statistics (mean, median, skewness, and kurtosis) of Russian stock sector markets returns. It can be noted that the average mean returns for all the sector markets are positive except MOEXMM. The highest mean returns are shown by MOEXCH (0.0018) followed by MOEXTN (0.0017), and MOEXEU (0.0015). Moreover, the value of Kurtosis for each of Russian stock market sector returns is greater than 3 thus, indicating the presence of fat tail phenomena. The skewness values for all the markets are positive except MOEXTN, which means that the returns distribution of these markets is positively skewed. To confirm this non-normal distribution of returns, this study also employed the Jarque Bera test, and the values of JB for all the sectors' returns are significant at 1%, thus ensuring that the returns series for all the markets are non-normally distributed. Furthermore, ADF test values show that the Russian stock sector markets returns series exhibit stationary behavior at a 1% significance level.

4.2. Total Volatility Spillovers

To study the dynamics of Russia-Ukraine conflict (2022) and Russian stock sector markets, the volatility spillovers across them is investigated by using 100 observations rolling windows analysis. This rolling window analysis determines the magnitude and nature of the spillover dynamics over the period of February 24th, 2022-May 31st, 2023. For this purpose, Figure 1 shows the total volatility spillovers across the Russian sectors which provides

Figure 1: Total volatility spillovers for all the Russian Stock Sector Markets during the Russia-Ukraine crisis (2022)

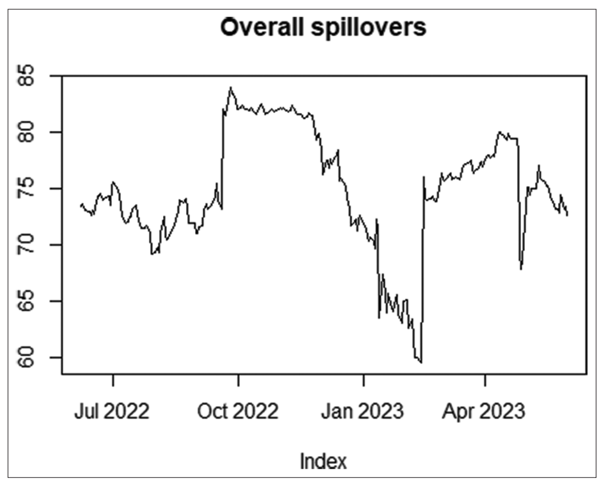


Table 2: Descriptive Statistics of Russian stock sector markets

Particulars	MOEXCH	MOEXCN	MOEXEU	MOEXFN	MOEXMM	MOEXOG	MOEXTL	MOEXTN
Mean	0.001807	0.000741	0.001516	0.001389	−0.00019	0.001088	0.001127	0.00172
Median	0.00078	0.000998	0.00107	0.002434	−0.00026	0.000749	0.000616	0.000914
SD	0.029786	0.019841	0.020796	0.022139	0.0198	0.021898	0.025542	0.022645
Kurtosis	67.83996	12.1561	29.37757	5.944136	16.95921	42.37857	30.88056	9.44235
Skewness	5.853065	0.708348	1.506728	0.25622	1.132491	3.449365	0.836199	−0.10442
Minimum	−0.10389	−0.09615	−0.13962	−0.09167	−0.09888	−0.08719	−0.19661	−0.11985
Maximum	0.352884	0.140016	0.183989	0.122803	0.160749	0.231279	0.20491	0.126912
JB test	56903***	1792.8***	10458***	424.5***	3507.7***	22125***	11468***	1066.3***
ADF test	−19.622***	−11.705***	−13.408***	−12.875***	−12.197***	−12.573***	−16.917***	−12.408***

*10% significant level, **5% significant level, ***1% significant level. JB: Jarque Bera, ADF: Augmented Dickey-Fuller. MOEX: Moscow Exchange, MOEXCH: MOEX Chemicals, MOEXCN: MOEX Consumer, MOEXEU: MOEX Electric Utilities, MOEXFN: MOEX Financials, MOEXMM: MOEX Metal & Mining, MOEXOG: MOEX oil and gas, MOEXTL: MOEX telecommunications, MOEXTN: MOEX Transport useful insights. In the first window, starting just below 75% in February, it variates from 70% to 75%.

Moreover, it can be noted that immediately after the month of July at some point the total volatility spillover index fell below 70% and aftermath the spillovers started to increase gradually and crossing the 80% in the month of October, and sustained around 80% for significant amount time, due to fact that during this period the tension increased between Russia and Ukraine. Furthermore, the total volatility spillovers across the Russian sector markets started to decline from the month of December and reaching to the lowest point of 60% in the mid of February, followed by the sharp rise in the total volatility spillovers achieving the 75% and 80% afterwards. In addition to this, these spillovers fluctuated between the range of 70% and 75%.

4.3. Directional Volatility Spillovers (FROM, TO, and NET)

Figure 2 reflects the directional volatility spillovers from each of the eight sector markets to the other sector markets, which is shown as "Directional FROM Others" in Table 2. It can be noted that during the Russian and Ukraine crisis (2022), overall directional volatility spillovers from other market sectors varies over the period of February 24th, 2022-May 31st, 2023 ranging from 2% to 10%. Overall, it can be observed from Figure 2 that the directional volatility spillovers from other market sectors increased up to 10% approximately. Thus, it can be comprehended that there have been significant volatility spillovers from other market sectors to each of the sector market.

Table 3 below illustrates the volatility spillovers (both directional and net volatility spillovers) across the Russian stock sector markets during the Russia-Ukraine crisis (2022). The column "FROM" reflect the directional volatility spillovers from other markets to a particular sector market. Among the set of Russian stock sector markets, the financials sector receives the highest directional volatility spillovers from the other sectors with a value of 86.26%. Likewise, the sector oil and gas along with the sector transport after financials are subject to highest directional volatility spillovers from other sector markets with

Figure 2: Directional volatility spillovers, from all eight Russian stock sector markets during the Russia-Ukraine crisis (2022)

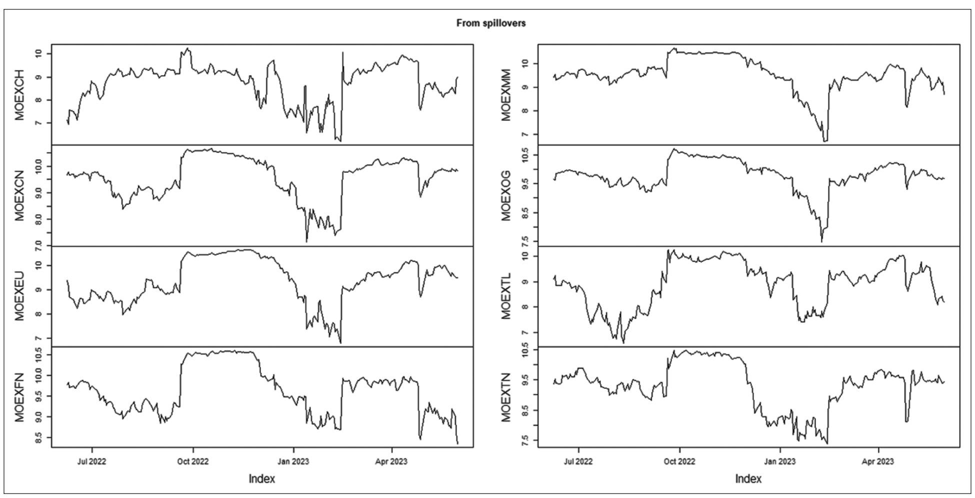


Figure 3: Directional volatility spillovers, to all the Russian stock sector markets during the Russia-Ukraine crisis (2022)

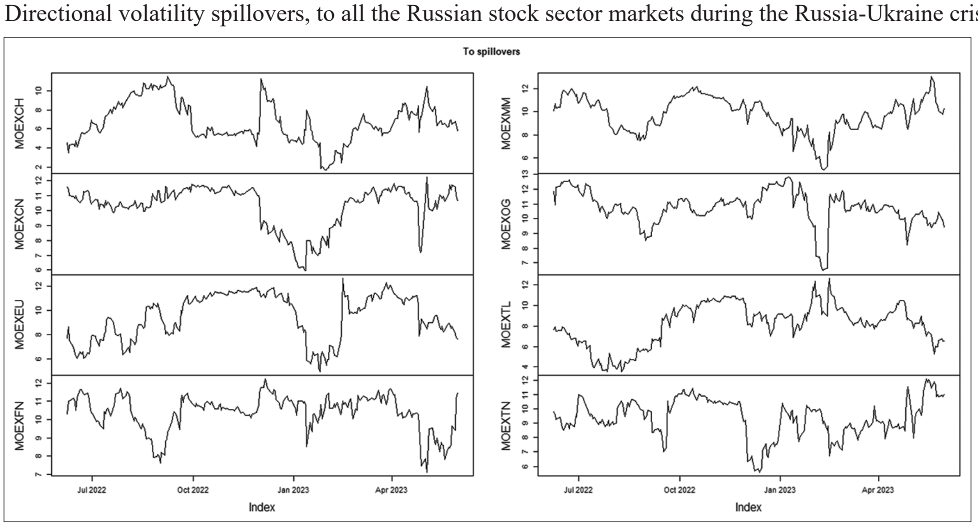


Table 3: Volatility Spillovers across eight Russian Stock Sector Markets during the Russia-Ukraine Crisis (2022)

Sectorindices	MOEXCH	MOEXCN	MOEXEU	MOEXFN	MOEXMM	MOEXOG	MOEXTL	MOEXTN	FROM
MOEXCH	40.02	6.82	4.04	10.46	10.85	10.82	8	10.86	81.54
MOEXCN	5.65	18.4	3.92	10.24	11.82	8.43	14.67	12.18	81.59
MOEXEU	6.25	4.64	22.03	12.39	6.82	13.99	7.04	7.79	77.97
MOEXFN	4.50	8.16	7.69	13.76	9.55	12.58	9.85	10.63	86.26
MOEXMM	5.18	10.92	4.47	10.65	17.13	9.52	10.15	11.06	82.86
MOEXOG	6.98	6.76	8.96	12.9	8.87	14.81	9.05	9.87	85.19
MOEXTL	3.70	13.05	5.08	11.13	9.83	10.02	15.95	11.78	84.04
MOEXTN	5.08	10.49	4.98	11.32	10.35	10.1	11.17	15.22	84.79
Directional TO others	68.75	74.09	53.88	102.53	86.61	98.92	87.21	94.29	829.72
Directional including own	87.22	92.49	75.91	116.29	103.74	113.73	103.16	109.51	82.97%
Net directional connectedness	−12.79	−7.5	−24.09	16.27	3.75	13.73	3.17	9.5	82.97%
Summary	Net-recipient	Net-recipient	Net-recipient	Net-transmitter	Net-transmitter	Net-transmitter	Net-transmitter	Net-transmitter	

MOEX: Moscow Exchange, MOEXCH: MOEX Chemicals, MOEXCN: MOEX Consumer, MOEXEU: MOEX Electric Utilities, MOEXFN: MOEX Financials, MOEXMM: MOEX Metal & Mining, MOEXOG: MOEX Oil & Gas, MOEXTL: MOEX Telecommunications, MOEXTN: MOEX Transport

a magnitude of 85.19% and 84.79%, respectively. In contrast, electric utilities followed by chemicals, and consumer sectors receives the lowest directional volatility spillovers from other sector markets with the values of 77.97%, 81.54%, and 81.59%, respectively.

Moreover, Figure 3 illustrates the directional volatility spillovers to all the Russian stock sector markets from each of the sector. It can be seen that for all the Russian market sectors the directional volatility spillovers to other markets from each of the sector market varies over the period of time ranging from 7% to 12%. Moreover, the financials, and oil and gas sectors transmitted the highest volatility spillovers to other markets for most of the time. Overall, the presence of significant directional volatility spillovers (TO other markets) from each of the sector market can be observed in the Russian economy.

Additionally, in Table 3 the sum of the off-diagonal column (excluding the diagonal term) refers to the directional volatility spillovers to the other Russian stock sector markets. Also, the "Directional TO Others" row shows the directional volatility spillovers. It can be noted that among the set of sector markets, highest directional volatility spillovers to other equity sectors is shown by the financials (102.53%), followed by the oil & gas (98.92%), and transport (94.92%). Apart from this, electric utilities followed by chemicals gives the lowest volatility spillovers to other markets with the value of 53.88%, and 68.75%, respectively.

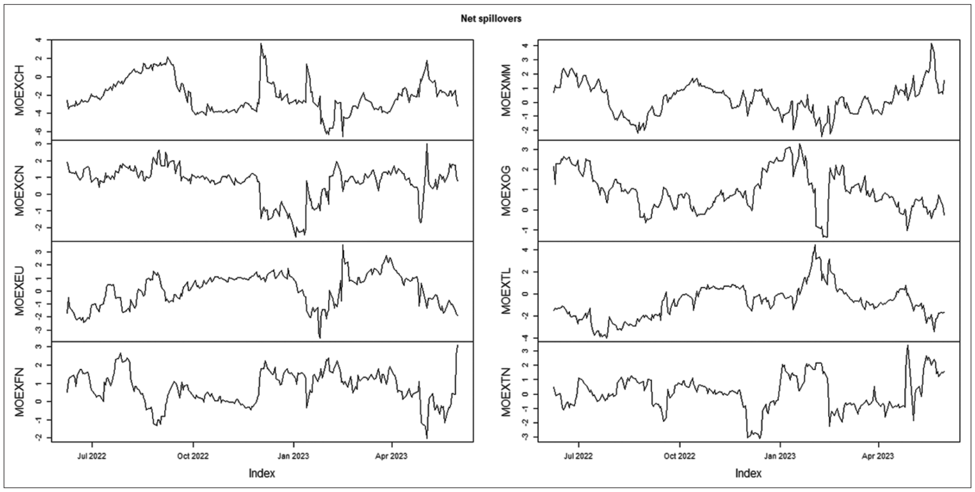
Figure 4 illustrates the net volatility spillovers in the Russian stock sector markets during the Russia-Ukraine crisis (2022). Each point in the Figure 4 reflects the (equation 8) which is equal to the difference between the sums of "contribution from" column and "contribution to" row. It can be seen that at the start of the crisis the stock sector markets including chemicals, electric utilities, transport, and telecommunications were net-recipients of the volatility spillovers whereas, remaining sector markets including consumer, financials, metal and mining, and oil and gas were the net-transmitters. Moreover, among the sector markets of Russian economy, the nature of their volatility transmission and receiving varies during the period of Russia-Ukraine crisis (2022).

Overall, the nature of these volatility spillovers during the Russia-Ukraine conflict can be analyzed through Table 2. As shown, during the Russia and Ukraine crisis (2022) out of the eight Russian stock sector markets, three of them (chemicals, consumer, electric utilities) are net-recipients of the volatility spillovers in the Russian equities. Whereas, the sector markets which includes financials, metal and mining, oil and gas, telecommunications, transport are the main contributors to the volatility spillovers, particularly they are regarded as the net-transmitters of these volatility spillovers.

5. DISCUSSION AND CONCLUSION

Considering the significance of the Russia-Ukraine conflict (2022) disrupting the Russian economy, it is important to understand the risk transmission across the Russian sector markets. For this purpose, we utilized the Diebold and Yilmaz (2012) spillover framework to investigate the volatility spillovers among the 10

Figure 4: Net volatility spillovers in Russian stock sector markets during the Russia-Ukraine crisis (2022)



stock sector markets of Russia over the period of February 24th, 2022-May 31st, 2023. The empirical findings of this study reveal that during the Russia and Ukraine conflict (2022) there has been significant volatility spillovers across the sector markets of Russian economy. Thus, verifying the presence of "spillover effect" among the equity sector markets. Furthermore, the volatility spillovers were highest at the first half of the Russia and Ukraine conflict (2022) however, the spillovers declined during the second half.

Furthermore, the statistical results give the following concluding statements. First, the sector markets including financials and oil and gas gave highest directional volatility spillovers to other sector markets whereas, electric utilities sector and the chemicals sector gave the lowest directional volatility spillovers to other sectors. Second, in the Russian economy, the sector markets namely; financials, oil and gas, and transport received the highest amount of directional volatility spillovers from other markets, in contrast, electric utilities, chemicals, and consumers received the lowest directional volatility spillovers from other markets. Third, among the set of Russian stock sector markets, the sectors (consumer, financials, metal and mining, oil and gas) were recognized as the major net transmitters of the overall volatility spillovers, on the other hand, sectors (chemicals, electric utilities, transport, telecommunications) were identified as the major net-recipients of the volatility spillovers across the Russian economy.

Considering the statistical findings, this study gives useful insights for portfolio managers, and policymakers regarding the risk transmission across the Russian stock sector markets during the period of crises. The results reported that the sector markets of the Russian economy remained interconnected with high volatility spillovers i.e., variability in the returns series of one sector market are transmitted and affect the returns of another sector market. The presence of a volatility spillover effect across the eight market sectors of the Russian economy recommends chances of low diversification during period crises such as the Russia-Ukraine conflict (2022). As a result, investment and portfolio managers should be rational, and cautious when investing in the Russian sector markets. Therefore, investors may purchase those stocks that gives low returns spillovers with regards to investors' risk appetite.

Apart from the significant contribution of this empirical study, it also has a few limitations that can be used as inputs for future studies. Firstly, except for Russian stock market sectors, future studies can include the effect of the Russia-Ukraine conflict on the economic sectors of Ukraine. Secondly, future researchers can employ the same methods to investigate the sectoral volatility spillovers across the European stock markets during the Russia-Ukraine conflict (2022). Thirdly, this study is restricted to DY (2012) spillover framework, studies may apply several other useful methods including Multivariate GARCH models and the cross quantilogram approach. Fourthly, this paper is restricted to the "During Phase" of the Russia-Ukraine conflict, studies can incorporate both the "Pre" and "Post" periods of the conflict. Fifthly, this study limits itself to the use of daily price data; hence, exploring intraday data of these sector markets can be a potential investigation topic for future researchers. Lastly, this study can also be extended to FOREX markets to document a comprehensive survey of volatility spillovers.

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