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The Ukraine-Russia war and systemic financial stress

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Abstract

In this paper, we investigate the impact of the ongoing conflict between Ukraine and Russia on systemic risk in financial markets. Using daily systemic risk data from 28 countries between December 2021 and April 2022, we highlight strong financial stress since the invasion of Ukraine by Russia. In doing so, we provide the first evidence of the impact of the Ukraine-Russia war on systemic risk.

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1. Introduction

"*The daily Composite Indicator of Systemic Stress (CISS) […] indicates severe financial stress in the euro area caused by the war in the Ukraine*."
Manfred Kremer, Head of Financial Research ECB, 14 March 2022.

Ten days after the celebration of Love (i.e. Valentine's Day), Russia invaded Ukraine on 24 February 2022. Although it is still early to assess the socio-economic consequences of the war with sufficient precision, the human and material losses have been mounting since the beginning of the war began. Moreover, previous studies argue that the war had a significant negative impact on global financial markets (Boubaker et al. 2022; Boungou and Yatié, 2022; Deng et al. 2022). The negative shock of the war on the performance of global stock indices has been stronger from the day of the invasion and in the days after the event (Boungou and Yatié, 2022; Yousaf et al. 2022). Furthermore, this negative impact does not seem to have been the same across countries (Boubaker et al. 2022; Deng et al. 2022).

Besides, the negative responses of global financial markets to the Ukraine-Russia war accentuate the pre-invasion environment of stress and uncertainty (e.g. related to the COVID-19 pandemic). This negative shock of the war on financial markets then raises questions about the stability of global financial systems. Indeed, the existence of dense interconnections in global markets serves as a mechanism for spreading shocks, leading to a more fragile financial system (Acemoglu et al. 2015). Due to the interconnections between countries, the Russian invasion of Ukraine has led to a deterioration of financial stability

conditions in several regions of the world, including the euro area (ECB, 2022). As a result, the intensity and uncertainty of the Russian-Ukrainian war could increase the vulnerabilities of global financial markets and thus increase the risks to financial stability. On this basis, a natural extension of previous studies is therefore to investigate the impact of the Ukraine-Russia war on the systemic stress in financial markets, given the obvious importance of the architecture of financial linkages in the world (Eisenberg and Noe, 2001).

Using daily data between December 2021 and April 2022 and an international panel of countries, our analysis is articulated as follows: (i) we use a DCC-GARCH for the determination of dynamic correlations; (ii) we investigate the impact of the war on systemic stress in the financial system. While we use Wikipedia search trends to measure the intensity of the war, we measure systemic stress using the Composite Indicator of Systemic Stress - CISS (Hollo et al. 2012).[1] The results of our analysis are summarized as follows: (a) we observe a positive correlation between systemic stress and the ongoing conflict; (b) we highlight that the war induced an increase in systemic stress in financial markets. These effects were most pronounced in the days following the Russian invasion of Ukraine.

Whereas previous studies have mainly focused on the performance of stock market indices in response to the conflict, our study provides a comprehensive overview of how the Ukraine-Russia's war has triggered systemic risk in

[1] "*The CISS aims to measure the current state of instability in the financial system as a whole or, equivalently, the level of systemic stress […] the CISS puts relatively more weight on situations in which stress prevails in several market segments at the same time, capturing the idea that financial stress is more systemic and thus more dangerous for the economy as a whole if financial instability spreads more widely across the whole financial system.*" (Holló et al. 2012).

financial systems. We show that the invasion of Ukraine by Russia has induced significant stress in financial systems. By providing additional insights into the impact of the Ukraine-Russia war, the results of this analysis are important as they could be used to help design relevant policies to mitigate the negative consequences of the war around the world.

The remainder of the paper is organized as follows. Section 2 presents our empirical strategy. Section 3 concludes.

2. Empirical strategy

To advance our understanding of the financial impact of the current conflict, we investigate the relationship between the Ukraine-Russia war and the systemic stress. Although international analysts believed that the conflict between Ukraine and Russia would eventually erupt, no one really anticipated the impact that such a conflict would have both within the warring territories and across borders (because of the interconnections between the countries). In other words, it could generate stress in international financial markets. On this basis, it is more difficult to say with certainty whether this conflict is correlated with systemic stress in financial system and/or would cause more stress in financial system. This article is therefore an attempt to shed some light on the relationship between the war between Ukraine and Russia and systemic financial stress. To do so, we first identify the existence of a correlation relationship (through the DCC-GARCH) and then a causality relationship (through a panel data analysis with fixed effects).

For our analysis, we use data from the 19 euro area countries as well as China, the Czech Republic, Denmark, Hungary, Poland, Sweden, the United Kingdom, and the United States over the period from December 2021 to April 2022 (at daily frequency). To measure systemic stress in the financial system, we use the composite indicator of systemic stress – CISS (Holló et al., 2012). CISS, which is a country-specific measure, is extracted from the European Central Bank (ECB) database.[2] We measure the ongoing war using the intensity of Wikipedia searches related to it, considering several keywords such as "War", "Putin", and "Russia".[3] In doing so, the intensity of the searches reflects concerns about the war or investors'sentiment related to tensions between Ukraine and Russia.[4] Indeed, searches on Wikipedia (or Google trends)[5] are often used as proxies for public sentiment (Zang et al. 2018b), thus they can amplify stress on financial markets and by extension have an impact on assets 'price (Qadan and Nama, 2018; Yao and Sun, 2018; Zhang et al. 2018; Yang et al. 2019) or predict the future prices (Chen et al. 2021).[6]

[2] Unfortunately, the data of the CISS is only for some countries.
[3] Using geopolitical risk fluctuations as another proxy for war, we find similar results, Bedowska-Sojka et al. (2022) show that war also impacted the hedging of several asset classes.
[4] The searches volumes on Wikipedia Trends indicate people's interest on a subject (Kristoufek, 2013, Dastgir et al. 2019) and are used by Zhang et al. (2018b) as an "online sentiment proxy" which could have an impact on financial market for instance (Zhang et al. 2018a).
[5] For robustness, we use Google searches and continue to see similar results (available on request).
[6] We recognize that internet research on a specific topic is not necessarily the best proxy for capturing market behavior and that it may vary from country to country. However, we assume that the intensity of these should at least send a signal about concerns and therefore influence behavior.

2.1. DCC-GARCH analysis

2.1.1. Methodology

Using DCC-GARCH, we first start our analysis by investigating the dynamic correlation between war and systemic financial stress. DCC-GARCH[7] allows the analysis of dynamic time-varying relationships. It also allows the number of parameters estimated in the correlation process to be independent of the number of series to be estimated, which is a great computational advantage when estimating large covariance matrices (Engle 2002). To do so, the model is defined as follows:

$$r_d = \mu_d + \varepsilon_d \quad ,\varepsilon_d | \; E(\varepsilon_d) = 0, Cov\,(\varepsilon_d) = H_d \tag{1}$$

$$\varepsilon_d = \sqrt{H_d} u_d \,, \;\; u_d \sim N(0, I) \tag{2}$$

$$H_d = D_d R_d D_d \tag{3}$$

where r_d, μ_d, ε_d and u_d are $N \times 1$ dimensional vectors representing log returns of n assets at day d, expected value of the conditional r_d, mean-corrected returns of n assets at day d and ε_d errors, respectively.

H_d, R_d and D_d are $N \times N$ dimensional matrices illustrating time-varying matrix of conditional variances of ε_d, time-varying conditional correlation matrix of ε_d and time-varying diagonal matrix of conditional standard deviations of ε_d, respectively.

[7] We use a Dickey-Fuller test to verify the stationarity of the variables. All the variables are stationary.

The DCC-GARCH[8] (1, 1) equation is then given by Q_d:

$$Q_d = (1 - \alpha - \beta)\bar{Q} + a\varphi_{d-1}\varphi'_{d-1} + \beta Q_{d-1} \qquad \text{with } \varphi_d = D_d^{-1}\varepsilon_d \qquad (4)$$

where φ_d is a vector of standardized residuals from the first-step estimation of the GARCH (1, 1) process, Q_d is the time-varying unconditional correlation matrix of φ_d and $\bar{Q}$ is a $N \times N$ dimensional positive-definite matrix which represents the unconditional covariance matrix of φ_d.

α and β satisfy $\alpha + \beta < 1$. As long as $\alpha + \beta < 1$ is fulfilled.

To investigate whether the correlations are dynamic, we perform the constant correlation test of Engle and Sheppard (2001). The constant correlation test suggests that the correlations are dynamic. Also, the sum of α and β in all the regressions is less than unity.[9]

For our analysis, we use daily data covering the period from 2 December 2021 to 21 April 2022. Our sample of countries covers China, Germany, Portugal, Spain, the United Kingdom (UK), the United States (USA) and the euro area (EA). The choice of countries was constrained by the availability of data. Otherwise, the ECB database only offers the CISS for this set of countries.

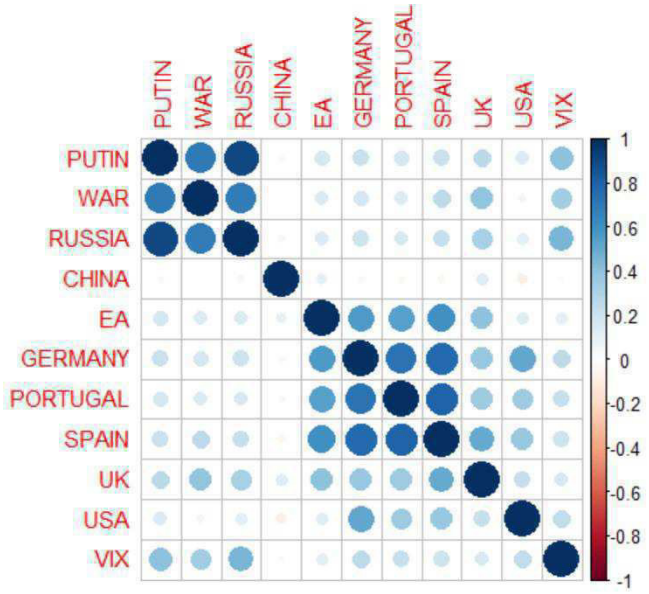
[8] The numerical results of the DCC-GARCHs are available upon request. We also confirm the presence of auto-correlation and volatility clustering in all the return series. Finally, there is the presence of ARCH effect and GARCH effect.

[9] The results of these analyses are available on request.

2.1.2. DCC-GARCH results

Figure 1 presents the heatmap of the static correlation between the series. A dark red color indicates that the respective two variables are highly negatively correlated, while dark blue indicates a highly positive correlation.

Figure 1. Heatmap of the correlation between the series



The main results of our analysis are shown in Figure 2. They highlight a positive correlation (with the exception of China)[10] between the ongoing conflict (measured using the keyword "War") and the CISS of the different countries and areas considered. Similarly, when we consider the VIX instead of the CISS, we obtain similar results.[11] Overall, our results shed light on the existence of a positive dynamic correlation between war and systemic financial stress. While

[10] The absence of war-related financial stress in the Chinese market probably stems from the fact that China positioned itself as neutral to the Russian invasion of Ukraine. In the same vein, Boungou and Yatié (2022) show that the stock market indices of countries neutral to the ongoing conflict were less affected. Similarly, Boubaker et al. (2022) and Deng et al. (2022) also highlight a heterogeneous impact of the war across countries.

[11] Using other search keywords, such as "Putin", "Russia" we obtain similar results reported in Figure 3 and Figure 4, respectively.

the relationship was weaker before the invasion, it increases again after the Russian invasion of Ukraine.

[Insert Figure 2 here]

2.2. Panel data analysis

2.2.1. Data and model

To deepen our understanding of the financial impact of the war, we now consider a panel data analysis to investigate the effects of Ukraine-Russia on systemic stress in financial markets. In doing so, we also use the country-specific CISS of the 19 euro area countries[12] as well as that of nine other countries, namely, China, the Czech Republic, Denmark, Hungary, Poland, Sweden, the United Kingdom, and the United States. For our estimations, we estimate the following model:

$$CISS_{c,d} = c + \alpha_1 War_{c,d} + \theta_d + \lambda_c + \varepsilon_{c,d} \qquad (5)$$

where $CISS_{c,d}$ denotes the log of the CISS of country c, on day d.[13] $War_{c,d}$ represents the log of Wikipedia search trends data using the word "war" in country c on day d. It therefore measures the intensity (or anxiety) of internet searches related to the Ukraine-Russia war (reported in Tables with "War").[14] Being in daily frequency, it is more difficult to obtain macroeconomic controls at this frequency that could be related to systemic stress. Therefore, we include fixed effects in our estimates to control for unobservable factors. In doing so, we

[12] We use the aggregate CISS for the euro area, when it is not available at country level for some euro area countries.
[13] Using the CISS values directly, our results remain unchanged (not reported but available on request).
[14] Furthermore, we consider other words such as Putin and Russia (results presented in Table 2).

control for changes in level for each day by including time fixed effects, θ_d, to capture the overall trend. Country fixed effects, λ_c, are also included to absorb the different fixed and time-invariant levels of search intensities across countries.

Table 1. Ukraine-Russia war and systemic financial stress

	CISS		
	(I)	(II)	(III)
War	1.206***	1.206***	5.049***
	[0.09]	[0.09]	[0.58]
Number of observations	919	919	919
Number of countries	27	27	27
Country fixed-effect	No	Yes	Yes
Day fixed-effect	No	No	Yes
R2 (within)	0.166	0.166	0.644

Notes: Robust stantard errors clustered at the country level are presented in brackets. ***, **, and * stand for significance at the 1%, 5%, and 10% levels, respectively.

2.2.2. Panel analysis results

Our baseline results are reported in Table 1 and show a positive and significant relationship at the 1% level between war intensity and financial stress. In other words, we observe an increase in systemic financial stress induced by the intensity of the war between Ukraine and Russia, considering several specifications. Using alternative measures highlighting the anxiety around the war, we continue to observe a positive and significant relationship (see Table 2).

Table 2. Alternative measures of the Ukraine-Russia war

	CISS	
	(I)	(II)
Putin	0.493***	
	[0.06]	
Russia		2.030***
		[0.23]
Number of observations	919	919
Number of countries	27	27
Country fixed-effect	Yes	Yes
Day fixed-effect	Yes	Yes
R2 (within)	0.886	0.886

Notes: Robust stantard errors clustered at the country level are presented in brackets. ***, **, and * stand for significance at the 1%, 5%, and 10% levels, respectively.

Given that tensions between Ukraine and Russia do not date from the day of Russia's invasion of Ukraine, i.e. 24 February 2022, we complete our analysis by investigating how tensions between Russia and Ukraine affected systemic financial stress before and after the invasion. Our results show that the impact of the war was greater from the invasion of Ukraine onwards (see Table 3). In the same vein, Yousaf et al. (2022) also find a larger effect from the invasion onwards when analyzing the performance of world stock markets.

Table 3. The impact before and during the invasion

	CISS	
	Pre-invasion	Post-invasion
War	-4.758	5.049***
	[3.27]	[0.58]
Number of observations	567	352
Number of countries	27	27
Country fixed-effect	Yes	Yes
Day fixed-effect	Yes	Yes
R2 (within)	0.762	0.893

Notes: Robust stantard errors clustered at the country level are presented in brackets. ***, **, and * stand for significance at the 1%, 5%, and 10% levels, respectively.

3. Conclusion

This paper analyses whether the war between Ukraine and Russia induces contemporaneous stress in the financial system, using the composite indicator of systemic stress (CISS) at the country level. Our results provide the first empirical evidence of the war on systemic stress in financial system and highlight that the war has led to severe stress in financial markets. Finally, we observe that these tensions were more important after the invasion of Ukraine by the Russian army. Overall, our results highlight that the conflict between Ukraine and Russia negatively impacts financial stability through an increase in systemic risk.

As the literature on the economic and financial impact of the war is still in its infancy, for potential future research, it might be interesting to examine the macroeconomic consequences of the Ukraine-Russia war.

References

Acemoglu D., Ozdaglar A., Tahbaz-Salehin A., 2015. Systemic risk and stability in financial networks. *American Economic Review*, 105 (2): 564-608.

Bedowska-Sojka B., Demir E., Zaremba A., 2022. Hedging geopolitical risks with different asset classes: A Focus on the Russian invasion of Ukraine. *Mimeo*.

Boubaker S., Goodell J., Pandey D., Kumari V., 2022. Heterogeneous impacts of wars on global equity markets: Evidence from the invasion of Ukraine. *Mimeo*.

Boungou W., Yatié A., 2022. The Impact of the Ukraine-Russia war on world stock market returns. *Economics Letters*, Vol. 215, 110516.

Chen Z., Liang C., Umar M., 2021. Is investor sentiment stronger than VIX and uncertainty indices in predicting energy volatility? *Resources Policy*, *74*, 102391.

Dastgir S., Demir E., Downing G., Gozgor G., Lau C., 2019. The causal relationship between Bitcoin attention and Bitcoin returns: Evidence from the Copula-based Granger causality test. *Finance Research Letters*, *28*, 160–164.

Deng M., Leippold M., Wagner A., Wang Q., 2022. Stock prices and the Russia-Ukraine war: Sanctions, Energy and ESG. *Mimeo*.

ECB, 2022. Euro area economic outlook weakens on the back of global cost pressures and the war in Ukraine. Financial Stability Review, May 2022, pp. 17-24.

Eisenberg L., Noe T., 2001. Systemic risk in financial systems. *Management Science*, Vol. 17, No. 2, pp. 236-249.

Engle R., 2002. Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional heteroskedasticity models. *Journal of Business and Economic Statistic*, Vol. 20, Issue 3, pp. 339-350.

Engle R., Sheppard K., 2001. Theoretical and empirical properties of dynamic conditional correlation multivariate GARCH. NBER, Working paper No. 8554.

Holló D., Kremer M., Lo Duca M., 2012. CISS - a composite indicator of systemic stress in the financial system (Working Paper). ECB Working Paper, No. 1426.

Kristoufek L., 2013. Bitcoin meets Google Trends and Wikipedia: Quantifying the relationship between phenomena of the Internet era. *Scientific Reports*, *3* (1), 3415.

Qadan M., Nama H., 2018. Investor sentiment and the price of oil. *Energy Economics*, 69, 42–58

Yang C., Gong X., Zhang H., 2019. Volatility forecasting of crude oil futures: The role of investor sentiment and leverage effect. *Resources Policy*, *61*, 548–563.

Yao C., Sun B., 2018. The study on the tail dependence structure between the economic policy uncertainty and several financial markets. *The North American Journal of Economics and Finance*, 45, 245–265.

Yousaf I., Patel R., Yaravaya L., 2022. The reaction of G20+ stock markets to the Russia-Ukraine conflict 'Black-Swan' event: Evidence from event study approach. Mimeo.

Zhang W., Li Y., Zhang Z., Shen D., 2018. The dynamic cross-correlations between foreign news, local news and stock returns. *Physica A: Statistical Mechanics and Its Applications*, 509, 861–872.

Zhang Z., Zhang Y., Shen D., Zhang W., 2018a. The dynamic cross-correlations between mass media news, new media news, and stock returns. *Complexity*, 2018. Scopus.

Zhang Z., Zhang Y., Shen D., Zhang, W. 2018b. The cross-correlations between online sentiment proxies: Evidence from Google Trends and Twitter. *Physica A: Statistical Mechanics and Its Applications*, 508, 67–75.

Online Appendix

Figure 2. The Ukraine-Russia war ("War") and systemic financial stress

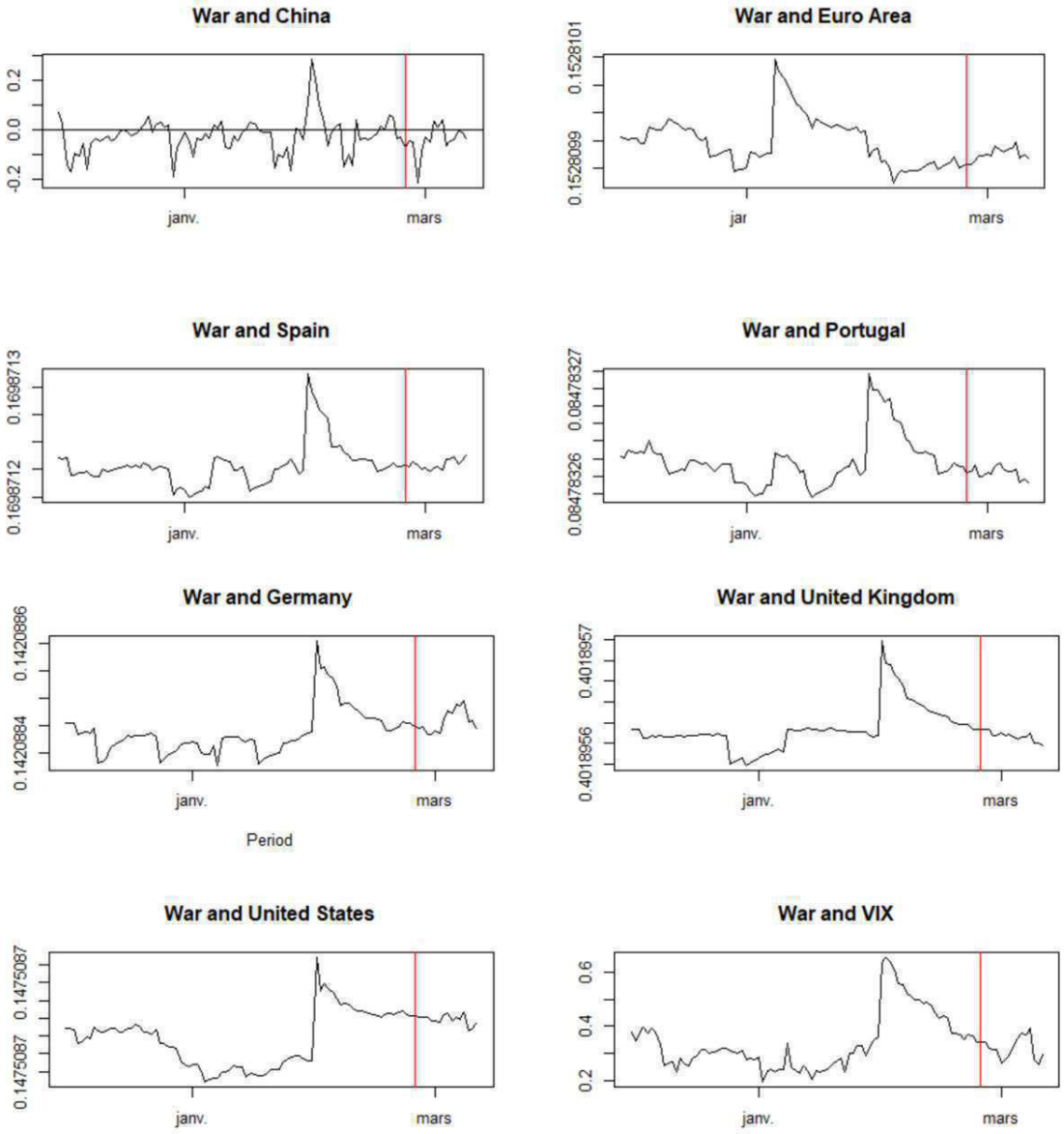


Figure 3. The Ukraine-Russia war ("Putin") and systemic financial stress

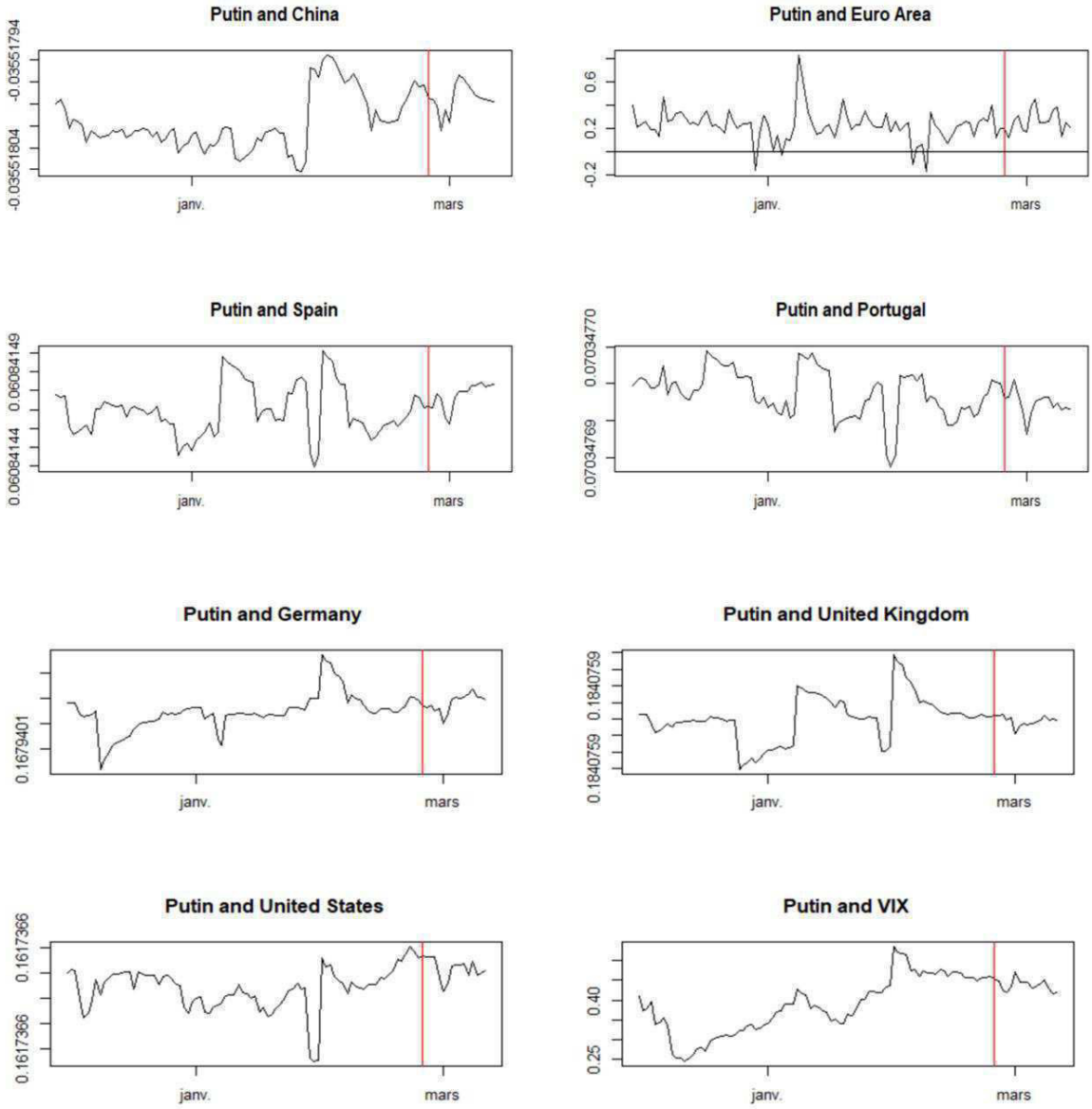


Figure 4. The Ukraine-Russia war ("Russia") and systemic financial stress