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Risk Diversification in Central and Eastern European Capital Markets: Evidence from Russia's Invasion of Ukraine

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Abstract: *Following the Revolution of Dignity in Ukraine in 2014, Russia annexed Crimea, while separatist forces supported by the Russian government seized part of the Donbas region in south-eastern Ukraine. Since the beginning of 2021, a build-up of Russian military presence has occurred along the Russia-Ukraine border. The United States and other countries have accused Russia of planning an invasion of Ukraine. On February 24th, Putin announced a "special military operation," supposedly to "demilitarize" and "denazify" Ukraine. In light of these events, the global economy and consequently the financial markets had significant structural breaks; based on these facts, this paper aims to analyze the synchronizations between the capital markets of Austria (Austrian Traded), Budapest (BUX), Bulgaria (SE SOFIX), Croatia (CROBEX), Russia (MOEX), Czech Republic (Prague SE PX), Romania (BET), Slovakia (SAX 16), and Slovenia (SBI TOP), in the period from January 2nd, 2017 to May 6th, 2022. To perform this analysis and to get more robust results we divided the sample into two sub-periods: The first from January 2nd, 2017, to December 31st, 2019, with the second sub-period called capital markets stress comprising the time lapse from January 1st, 2020, to May 6th, 2022. In order to answer the research question, we aim to find out, whether the Russian invasion of Ukraine accentuated interdependencies in Central/Eastern European financial markets. The time series do not show normal distributions, with the Russian market showing the highest risk; we find that the markets broke down significantly, mostly in March 2022 arising from instability in the global economy. The results obtained suggest very significant levels of integration during the stress period in the capital markets analyzed, and we see that during the quiet period the Slovakian market tends to be highly integrated (8 out of 8 possible), while the Slovenian market shows no integration with its regional peers, which shows that we are dealing with a segmented market. These findings suggest that markets tend toward integration in periods of extreme volatility, calling into question the implementation of efficient portfolio diversification strategies.*

1. INTRODUCTION

Financial instability is a very important factor for society since a financial crisis or a stock market crash can directly or indirectly affect the level of the economic well-being of a country's inhabitants. If a certain stock market is strongly linked to the stock market of another country, the financial stability of the former depends in part on the financial stability of the latter. For this reason, a close or strong connection between markets increases the levels of vulnerability

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to external shocks and, as a result, influences the economic conditions and welfare levels of the respective countries. Thus, the occurrence of integration between markets can have significant implications for international risk diversification (Bagão et al., 2020; R. Dias et al., 2020; Dias et al., 2021b, 2021a; Dias et al., 2020, 2021, 2022; Pardal, P., Dias, R., Šuleř, P., Teixeira, N., and Krulický, 2020; Pardal et al., 2021; Silva et al., 2020).

When integrating equity markets, investors generally seek to include assets in their portfolios that hold lower levels of correlation to promote effective diversification strategies. In the same context, Grubel (1968) and Levy and Sarnat (1970) argue that investing in international stock markets is substantiated by the fact that the correlation between assets is lower than that examined in domestic assets. Therefore, the low correlation between international stock markets is a key factor for portfolio diversification.

This paper aims to analyze financial integration in the capital markets of Austria (Austrian Traded), Budapest (BUX), Bulgaria (SE SOFIX), Croatia (CROBEX), Russia (MOEX), Czech Republic (Prague SE PX), Romania (BET), Slovakia (SAX 16), and Slovenia (SBI TOP) during the period from January 2nd, 2017, to May 6th, 2022. The results obtained suggest very significant levels of integration, and this evidence decreases the chances of portfolio diversification in the long run, except for the Slovenian market.

This research adds relevant contributions to the literature, namely to the study of risk diversification in Central and Eastern European markets in the context of the Russian invasion of Ukraine; to the best of our knowledge, this is the first study that analyzes in isolation these financial markets during this time-lapse. In terms of structure, this paper is organized into 5 sections. Section 1 is represented by the current introduction. Section 2 presents a Literature Review of articles on financial market integration. Section 3 describes the data and methodology. Section 4 contains the results. Finally, Section 5 presents the general conclusions of the paper.

2. LITERATURE REVIEW

Understanding international linkages between financial markets in periods of the financial crisis is relevant for investors, fund managers, and academics in different aspects, including portfolio diversification (Lee, 2017).

Voronkova (2004) analyzed the level of financial integration between Central European markets and developed markets; after accounting for structural changes, the author shows that Central European capital markets exhibit significant levels of integration, suggesting that the hypothesis of portfolio diversification may be called into question. Authors Lucey and Voronkova (2008), on the other hand, analyzed the integration of financial markets before and after the 1998 crisis, with cointegration tests with regime shifting, suggesting that markets are partially integrated.

Syllignakis and Kouretas (2011) highlight that the Central European capital markets (Czech Republic, Hungary, Poland, Slovenia, and Slovakia), and the German and US stock markets are integrated, while the Estonian and Romanian markets are segmented.

Özer, Kamışlı and Kamışlı (2016) show hybrid results by failing to highlight comovement between the market of Germany, Austria, Czech Republic, Croatia, Lithuania, and Greece. These findings have important implications for international investors, portfolio managers and

policymakers. Authors Moagar-Poladian, Clichici and Stanciu (2019), meanwhile, highlight that Central and Eastern European capital markets show a significant level of integration during the 2010 financial crisis.

Liu, Manzoor, Wang, Zhang and Manzoor (2020) studied the impact of the 2020 global pandemic on 21 capital markets, suggesting the presence of significant structural breaks. Zeren and Hizarci (2020), analyzed the effects of the Covid-19 epidemic on equity markets over the period January 23, 2020, and March 13, 2020. The authors' evidence levels of causality between the number of deaths from the global outbreak and financial markets. It was understood that the global outbreak cases have cointegrating relationships with the SSE, KOSPI and IBEX35 markets, but not with the FTSE MIB, CAC 40, DAX 30 markets.

In more recent studies, author Hung (2022) analyzed the integration in the capital markets of Croatia, Czech Republic, Hungary, Poland, and Romania using the multivariate dynamics equicorrelation - generalized autoregressive conditional heteroskedasticity (DECOGARCH) model and the spillover index. The results show that the average return equicorrelation between CEE and world stock indices is positive; this evidence undermines the benefits of portfolio diversification in these regional markets.

In summary, this work aims to contribute by providing information to investors and regulators in Central and Eastern European capital markets, where individual and institutional investors seek diversification benefits, as well as to help promote the implementation of policies that contribute to the efficiency of these markets.

3. METHODOLOGY AND DATA

3.1. Data

Data for the closing prices of the capital markets in Austria (Austrian Traded), Budapest (BUX), Bulgaria (SE SOFIX), Croatia (CROBEX), Russia (MOEX), Czech Republic (Prague SE PX), Romania (BET), Slovakia (SAX 16), and Slovenia (SBI TOP) for the period from January 2nd, 2017, to May 6th, 2022, were analyzed.

In order to perform this analysis and obtain more robust results, we have divided the sample into two sub-periods: the quiet one from January 2nd, 2017, to December 31st, 2019, and the second one called capital markets stress, which includes the super-period from January 1, 2020, to May 6, 2022. To mitigate distortions in exchange rates, we have maintained the stock indices in local currency.

3.2. Methodology

The research was developed in several stages. The sample was characterized using descriptive statistics, the adherence test of Jarque and Bera (1980), and quantile plots. To assess the stationarity of time series we will use the ADF (Dickey and Fuller, 1981), PP (Perron and Phillips, 1988) tests in the panel with Fisher and Choi transformations. To answer the research question, we will use the methodology of Gregory and Hansen (1996), considering we have examined a very turbulent period in the financial markets. Additionally, the reason why standard cointegration tests such as Engle and Granger (1987) and Johansen (1988) are not appropriate for testing cointegration with regime change is that such tests assume that the cointegration vector is time-invariant.

4. RESULTS

Figure 1 shows the evolution, in levels, of the 9 capital markets under analysis, namely, the stock market indices of Austria (Austrian Traded), Budapest (BUX), Bulgaria (SE SOFIX), Croatia (CROBEX), Russia (MOEX), Czech Republic (Prague SE PX), Romania (BET), Slovakia (SAX 16) and Slovenia (SBI TOP). Through graphical observation of the period from January 2nd, 2017, to May 6th, 2022, we see the existence of significant structure breaks, arising from the 2020 pandemic crisis as well as during the Russian invasion of Ukraine. These findings are in line with the evidence suggested by authors Vasco et al. (2021), Dias et al. (2022), Zebende et al. (2022) that show significant structure breakdowns in international capital markets.

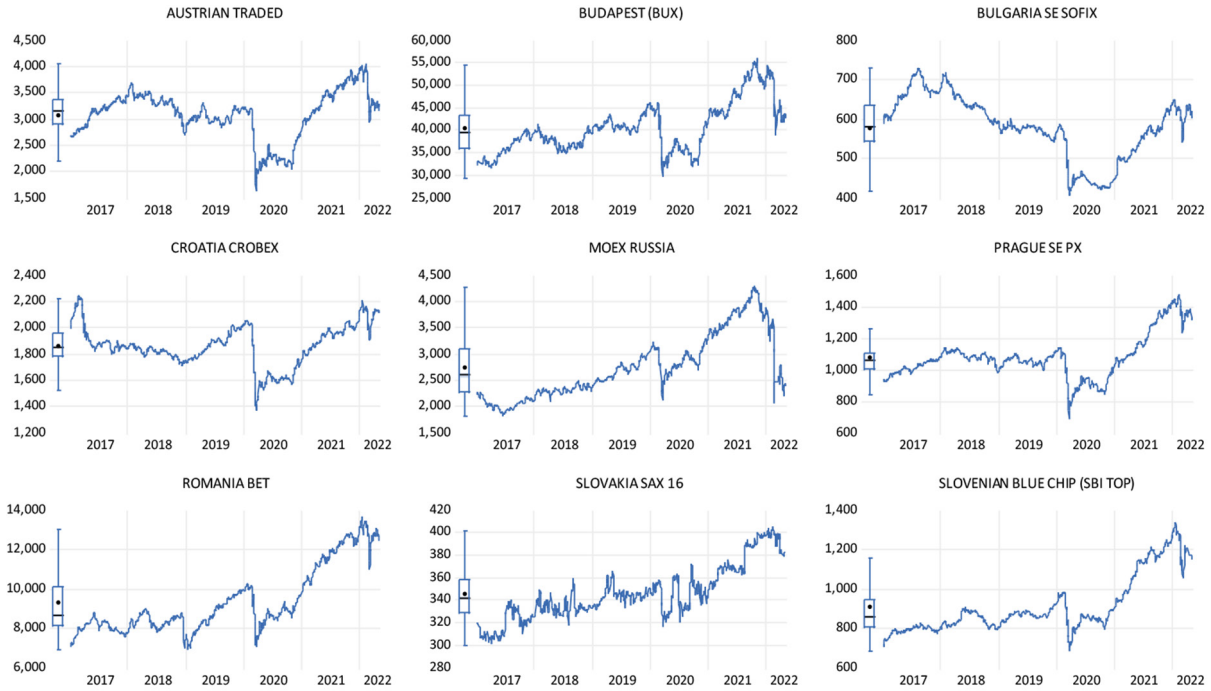

Figure 1. Evolution, in levels, of the 9 financial markets, in the period from January 1st, 2017, to May 6th, 2022

Source: Own elaboration

Figure 2 shows the evolution of the return of the 9 stock markets under analysis and shows extreme volatility during the first and second quarters of 2020, as well as in 2022, derived from a sharp drop in the index prices due to the evolution of the global pandemic (Covid-19) and in 2022 due to the military operation carried out by Russia on Ukrainian territory.

In table 1 we can observe the descriptive statistics and verify that the average returns are positive, while the Russian market presents the sharpest standard deviation (0.17251). When we check the distribution of the data, we see that the time series present negative skewness, namely the IMOEX index (-8.837122), while considering the kurtosis, the values are different from 3, i.e., the skewness and kurtosis coefficients are statistically different from those with a normal distribution. These findings are validated by the adherence test of Jarque and Beta (1980), where the null hypothesis that the data follow a normal distribution is rejected at a significance level of 1%.

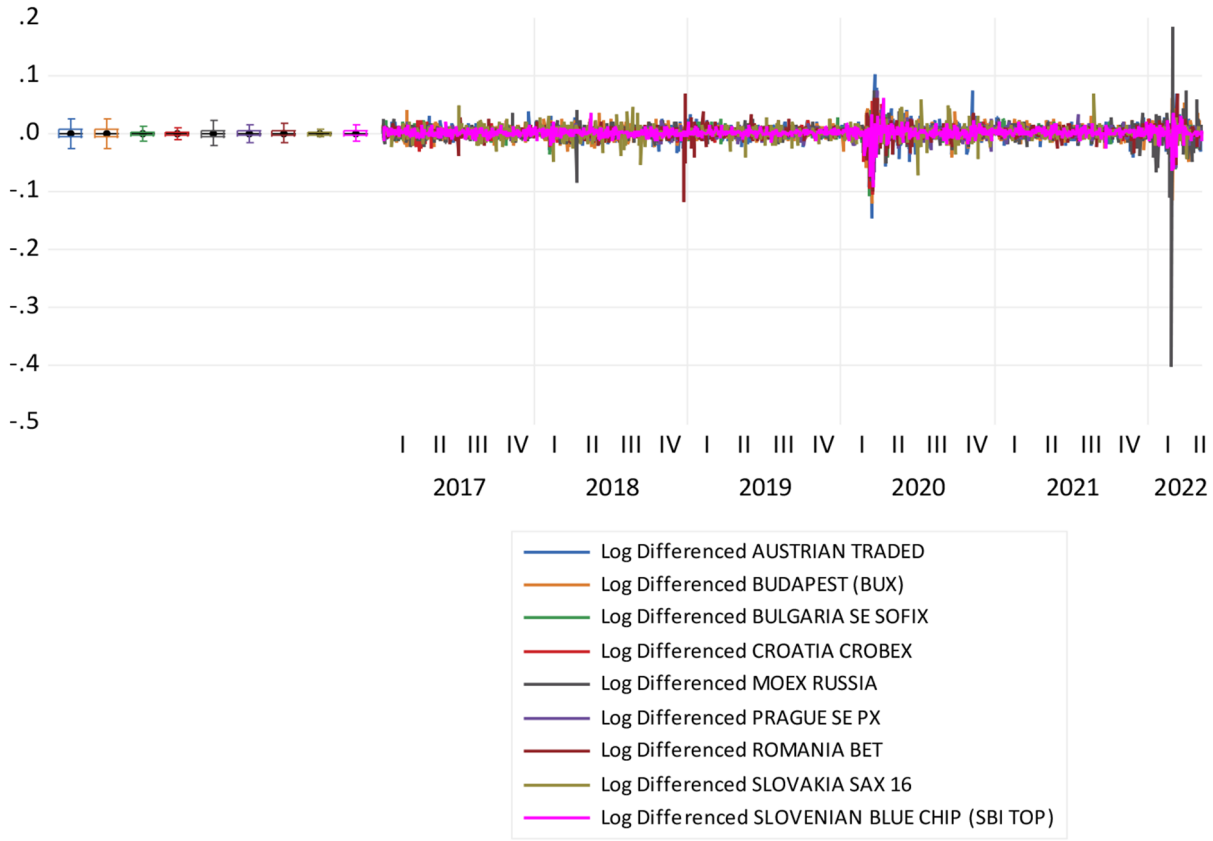

Figure 2. Evolution of the return of the 9 capital markets, in the period from January 1st, 2017, to May 6th, 2022

Source: Own elaboration

In summary, the Russian market shows much higher than average levels of volatility which was expected due to the Russian invasion of Ukraine in February 2022 and the instability caused in the global economy.

Table 1. Descriptive statistics, in returns, of the 9 capital markets over the period January 1st, 2017, to May 6th, 2022

	Mean	Median	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability	Observations
BUX	0.000201	0.000223	0.013073	-1.655406	18.63376	14843.73	0.000000	1395
SOFIX	2.28E-05	0.000000	0.008050	-2.722058	39.15623	77707.97	0.000000	1395
CROBEX	4.81E-05	0.000100	0.008220	-3.632165	49.42244	128329.1	0.000000	1395
MOEX	5.32E-05	0.000298	0.017251	-8.837122	230.9672	3038857.	0.000000	1395
PRAGUE	0.000255	0.000259	0.009319	-1.365256	19.44129	16145.49	0.000000	1395
BET	0.000404	0.000411	0.010737	-1.878556	26.88813	33989.09	0.000000	1395
SAX16	0.000131	0.000000	0.009444	-0.043912	13.64513	6587.103	0.000000	1395
SBITOP	0.000338	0.000116	0.008565	-2.049224	26.18284	32215.27	0.000000	1395
AUSTRIAN	0.000123	0.000230	0.013821	-1.347490	22.11028	21649.56	0.000000	1395

Source: Own elaboration

Through the graphic observation of quantiles illustrated in Figure 3, one can also infer the normality of the time series data under analysis. Comparing the data dispersion relative to the normal distribution line, it appears that none of the series is completely overlapping, and there is some skewness. Nevertheless, we find that the time series tend towards an approximately normal distribution, given that the number of observations is sufficiently large.

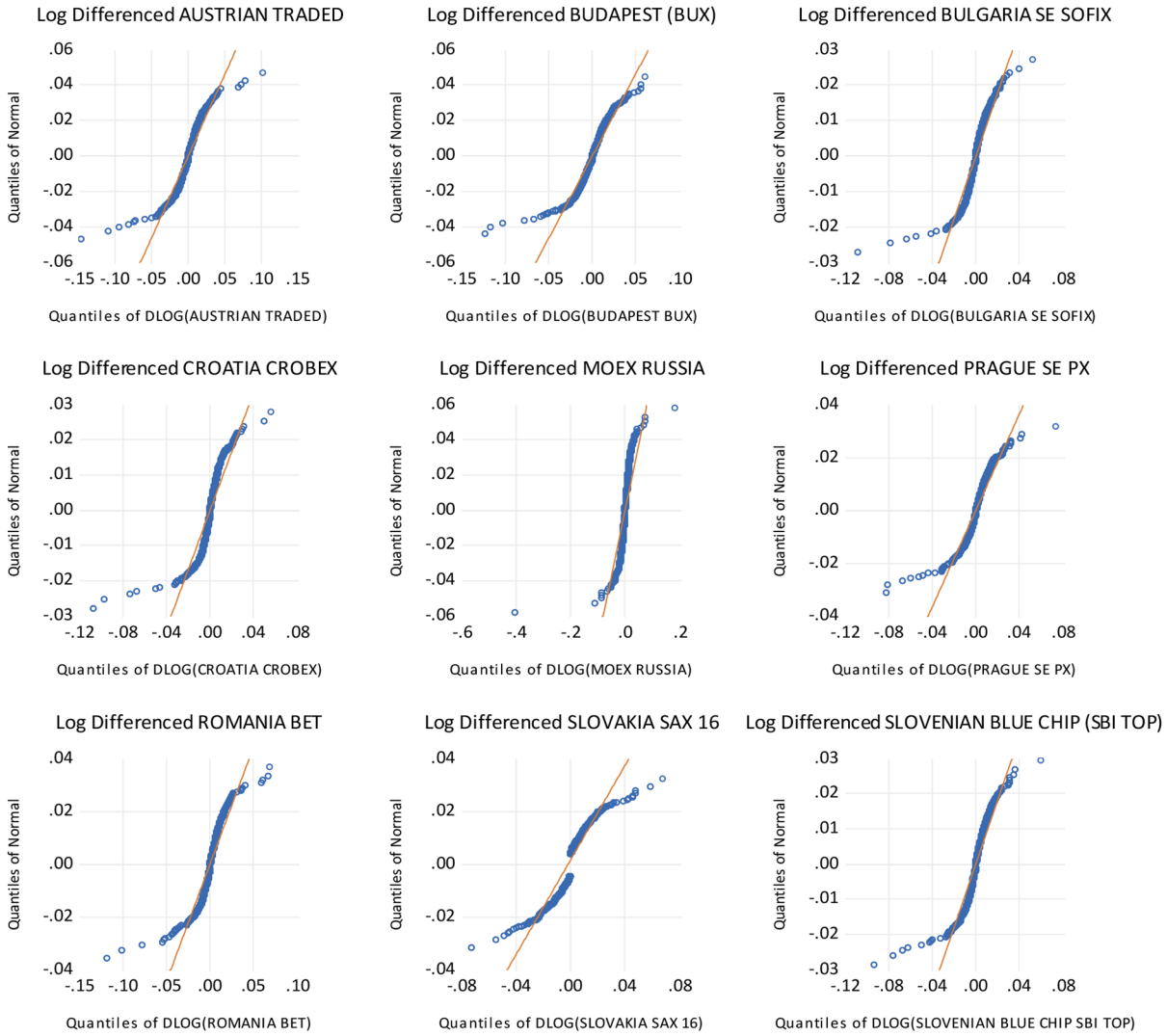

Figure 3. Evolution of the return of the 9 capital markets, in the period from January 2nd, 2017, to May 6th, 2022

Source: Own elaboration

Table 2 shows the ADF and PP stationarity tests with Fisher and Choi transformations for the 9 capital markets under analysis, namely, the stock indices of Austria (Austrian Traded), Budapest (BUX), Bulgaria (SE SOFIX), Croatia (CROBEX), Russia (MOEX), Czech Republic (PragueSE PX), Romania (BET), Slovakia (SAX 16) and Slovenia (SBI TOP), for the complete sample period. The tests suggest that the time series are stochastic only in the first differences, that is, we are facing a white noise that allows us to validate the robustness of the results.

Table 2. Stationarity tests, in return, of ADF, with Fisher and Choi transformation, concerning the 9 capital markets for the period from January 2nd, 2017, to May 6th, 2022

Null Hypothesis: Unit root (individual unit root process)		
Method	Statistic	Prob.**
ADF - Fisher Chi-square	1295.75	0.0000
ADF - Choi Z-stat	-33.2900	0.0000

**Note: Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Source: Own elaboration

Table 3. Stationarity tests, in return, of PP, with Fisher and Choi transformation, concerning the 9 capital markets, in the period from January 2nd, 2017, to May 6th, 2022

Null Hypothesis: Unit root (individual unit root process)		
Method	Statistic	Prob.**
PP - Fisher Chi-square	605.291	0.0000
PP - Choi Z-stat	-22.5453	0.0000

**Note: Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Source: Own elaboration

In Table 4 it is possible to analyze the integrations between the pairs of financial markets under analysis during the two sub-periods: Quiet and during the period marked by the 2020 pandemic and more recently by Russia's invasion of Ukraine in 2022. During the quiet period we verified the presence of 15 integrated market pairs (out of 72 possible), with the Slovakian market registering the highest level of integration (8 out of 8 possible). Slovenia, on the other hand, has no integrations with its regional peers, which shows that this is a market that is segmented. When we analyze the sub period of stress in capital markets, we see that the level of integration rose sharply (from 15 to 33); the Slovak market continues to maintain, among the analyzed markets, the highest number of integrations, registering 7 out of 8 possible, followed by the Russian and Romanian markets with 5 integrations (out of 8 possible). The stock indices of Budapest and Prague showed 4 integrations, while the markets of Austria and Slovenia with 3 integrations. Bulgaria and Croatia maintained their level of integration (1 out of 8 possible). These findings are in line with the evidence suggested by Dias et al. (2020), Dias et al. (2021), Dias and Carvalho (2021), and Dias et al. (2022) that in periods of extreme volatility markets tend towards integration thus calling into question the hypothesis of efficient portfolio diversification.

Table 4. Summary of the results obtained in the Gregory-Hansen tests, in the financial markets under analysis, in the Quiet and Crisis periods

Markets	Quiet	Crisis	Evolution
BUDAPEST BUX	1/8 possible	3/8 possible	↑
BULGARIA SE SOFIX	1/8 possible	4/8 possible	↑
CROATIA CROBEX	1/8 possible	1/8 possible	=
MOEX RUSSIA	1/8 possible	1/8 possible	=
PRAGUE SE PX	0/8 possible	5/8 possible	↑
ROMANIA BET	1/8 possible	4/8 possible	↑
SLOVAKIA SAX 16	2/8 possible	5/8 possible	↑
SLOVENIAN BLUE CHIP SBI TOP	0/8 possible	3/8 possible	↑
AUSTRIAN TRADED	8/8 possible	7/8 possible	↓

Source: Own elaboration

5. CONCLUSION

This paper analyzed financial integration in the capital markets of Austria (Austrian Traded), Budapest (BUX), Bulgaria (SE SOFIX), Croatia (CROBEX), Russia (MOEX), Czech Republic (Prague SE PX), Romania (BET), Slovakia (SAX 16), and Slovenia (SBI TOP) during the period from January 2nd, 2017, to May 6th, 2022. In order to perform this analysis and gauge more robust results we partitioned the sample into two sub-periods: quiet from January 2nd, 2017, to December 31st, 2019, and the second called capital markets stress that comprises the super-period from January 1st, 2020 to May 6th, 2022. In order to answer the research question, we intend

to find out, whether the Russian invasion of Ukraine accentuate interdependencies in Central/ Eastern European financial markets. The results show that during the Quiet period there were 15 integrated market pairs (out of 72 possible), with the Slovak market registering the highest level of integration (8 out of 8 possible). Slovenia, on the other hand, has no integrations with its regional peers, which shows that we are facing a market that is segmented. When we analyze the sub period of stress in capital markets, we see that the level of integration rose sharply (from 15 to 33); the Slovak market continues to maintain, among the analyzed markets, the highest number of integrations, registering 7 in 8 possible, followed by Russia and Romania with 5 integrations (in 8 possible). The stock indices of Budapest and Prague showed 4 integrations, while the markets of Austria and Slovenia with 3 integrations. Bulgaria and Croatia maintained their level of integration (1 in 8 possible).

The general conclusion to be retained and supported by the results obtained through the econometric model tests, is that the global pandemic of 2020 and the Russian invasion of Ukraine in 2022 have a significant impact on the memory properties of the Central and Eastern European financial markets. We find that the level of financial integration is very significant in these markets during this uncertainty in the global economy; so, these findings call into question the implementation of efficient portfolio diversification strategies. In conclusion, we believe that this evidence is relevant for policymakers and investors concerning regional development policies and portfolio diversification strategies in Central and Eastern European financial markets.

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