

The Interdependence of the Stock Markets Developed in Central and Eastern- European Stock Markets - Represented by the Stock Indices

Mitica Pepi

"Ovidius" University of Constanta

pepi.mitica@gmail.com

Abstract

In our research, we looked at how the interdependence of stock markets has changed over time. For this, we looked at three stock markets in Europe: one in Western Europe that is well-developed, one in Central Europe that is medium-sized, and one in Eastern Europe that is less well-developed. In the analysis, stock indices from these markets were used. For the western market, we examined the indices KAK40 for the French stock market, DAX for the German stock market, and FTSE100 for the British stock market. The PX index in the Czech Republic and the BUX index on the Hungarian stock exchange were examined for the average market in Central Europe, and the BET index in Romania and the LJSEX index in Slovenia were examined for the less developed market. The linear and nonlinear Granger tests conducted on the closing rates of the corresponding stock exchanges were correlated without the use of the conditionality clause. The first three stock markets (Germany, France, and Great Britain) were found to be more interdependent than the Romanian and Slovenian markets, which displayed a weaker connection. The Granger tests were used to come to the conclusion that there are various statistically calculated levels of stock market returns that result from the interdependencies between the three types of financial markets examined.

Key words: stock markets, global crisis, stock market return, correlation, Granger causality

J.E.L. classification: F21, F36, G11, G15

1. Introduction

The capital markets in Slovenia, the Czech Republic, and Hungary have some things in common: a recent post-communist history; a small market capitalization; and a small percentage of listed companies are owned by joint holding companies (together with the Vienna Stock Exchange, these three CEE stock exchanges form the CEE Stock Exchange Group).

These stock markets have been similarly impacted by the global pandemic crisis in terms of declining stock market liquidity, rising price volatility, and declining stock market investors. Additionally, there are a few significant variations between them: The Slovenian market has attracted fewer foreign investors than the Czech and Hungarian stock markets, which also have lower turnover and liquidity than their post-communist counterparts (Caporale and Spagnolo, 2010).

The integration of the stock market, the co-movement, and the spread of profitability between developed and developing stock markets (CEE markets) are very important to international investors. Greater stock market co-movement may not be advantageous for globally diversified investment portfolios (Ling in Dhesi, 2010). Additionally, if profitability series spillovers are discovered, then it may be possible to exploit the strategy's profits, which is unfavorable to market efficiency criteria (Harris in Pisedtasalasai, 2005).

According to Ling and Dhesi (2010), a symmetrical, linear dependency metric called linear correlation, also known as Pearson's correlation coefficient, is the most popular way to assess stock market movements. It can be used to assess dependence in multivariate normal distributions (Embrechts et al., 1999). Although they can change over time, correlations are not always nonlinear (Ling and Dhesi, 2010; Egert and Koenda, 2010). Additionally, the dependence between

two stock markets may differ from the dependence when the market declines (Necula , 2010). The interdependencies of the stock market may be better understood by using econometric techniques. For this purpose, the VAR (Vector AutoRegression) method is frequently used (eg, Malliaris and Urrutia, 1992; Gilmore and McManus, 2002; Tudor, 2010).

Our goal is to examine the degree of co-movements and the return distribution between the developed European stock markets and the CEE stock markets, which are less developed. LJSEX, PX, and BUX stock indices from Eastern and Central Europe, as well as ATX, CAC40, DAX, and FTSE stock indices from Western Europe, were examined. The daily profitability series was examined using Granger unconditional correlation analysis and causality tests (based on VAR models) from 1 April 1997 to 12 May 2010. Three sub-periods were established, namely the pre-accession period to the European Union, the accession period , and the pandemic crisis period, in order to track changes in co-movements and spillovers throughout the investigation period.

2. Literature review

Greater interdependence between CEE stock exchanges and more developed European stock markets should result from the ongoing integration of CEE nations into the economic ideals of the European Union and from the globalization of global financial markets. Correlation analysis, Granger's causality testing mechanism, and cointegration analysis are frequently used in the more recent empirical literature that discusses the interdependence between CEE stock markets and more developed stock markets.

In their 2005 study, Serwa and Bohl examined the interdependence of 17 European financial markets, specifically those in Central and Eastern Europe (Czech Republic, Poland, and Hungary), while also examining the market's seven periods of financial stress between 1997 and 2002. To assess interdependence and breakdowns in stock market relationships, use correlation coefficients. After the crisis, there has been a significant amount of market link instability. The authors came to the conclusion that stock markets in Western and Eastern Europe are equally susceptible to contagion.

Syllingnakis and Kouretas conducted studies on medium- and long-term interdependence in countries in Central and Eastern Europe and on the German and American advanced financial markets, respectively (2006). There were frequent analyzes of patterns in the weekly yields of representative stock indices between January 1995 and December 2005. The findings show that stock markets are only partially integrated because they share more long-term trends than short-term ones. We can also demonstrate that the German and American stock exchanges, along with the five stock markets in CEE (the Czech Republic, Hungary, Poland, Slovenia, and Slovakia), have a significant common permanent component that drives this stock market system on a long - term.

Before, during, and after significant emerging market crises, Patev et al. (2006) looked into the CEE equity market co-movements (the 1997 Asian crisis, the 1998 Russian crisis and the 1999 Brazilian crisis). The idea of co-integration serves as the study's foundation. Three CEE stock markets—the Czech Republic, Hungary, and Poland—as well as the Russian and American stock markets are included in the study. The monthly returns span the months of August 1996 through August 2001. According to the findings of cointegration analysis (Johansen test), there is no long-term correlation between the US stock market and the four stock markets in Central Europe. The authors discovered a feedback effect and causality in one direction both during and after the crisis period by employing the Granger causality test. In times of crisis, portfolio benefits are reduced; however, in times of recovery, they have increased.

Three measures were developed as a result of Harrison and Moore's (2009) analysis of the level of interdependence between stock exchanges in CEE countries and those in Western European markets (UK and Germany). The measurements, which used unit root tests with temporal variation and recursive cointegration statistics, covered the years 1990 to 2006 and were based on daily yield series. With the exception of the Czech Republic, Hungary, and Poland, where the correlation was average, there was little correlation between the daily yields in CEE nations and those in Western Europe.

The connection between the stock exchanges in these financial markets can be regarded as consolidated even in these circumstances. According to research, stock markets experience comparable shocks and, implicitly, experience comparable daily return fluctuations. However, it has also been discovered that stock prices do not always tend to maximize Western European stock prices.

Horobet and Lupu (2009) conducted research on the integration of five Eastern European markets (Czech Republic, Poland, Romania, and Hungary) in comparison to the Russian market and the developed financial markets in the EU in the period from 2013 to 2017. According to research, there is good market integration in terms of reaction times. Given that information flows in both directions, from developed markets to emerging markets and vice versa, this research, which used Granger cointegration and causality tests, came to the conclusion that markets respond quite well to the information contained in the yields of other markets.

Allen et al. (2010) examined the effects on these investors of the expansion of European financial markets to young financial markets in Eastern Europe. Data from two sub-periods, pre- and post-crisis, covering the period from January 2020 to September 2021, were examined for 12 countries in Central and Eastern Europe. According to the correlation study, the financial markets in Hungary, Poland, and the Czech Republic were much better correlated with each other than other markets in Eastern Europe during the pre- and post-crisis periods.

Between January 2020 and March 2021, an estimate was made using the "VAR-GARCH-on average" model (Corporal and Spanish, 2020) using weekly yield data to determine the correlations of volatility between the financial markets of three CEE nations. Poland, Hungary, and the Czech Republic), as well as the Moscow and London stock exchanges. According to the empirical research, regional ties have gotten stronger, and using the Markowich model to diversify a portfolio has turned into an investment strategy with lower returns. Given these facts, we can say that the financial markets in CEE and Western European nations have become more integrated.

Analysis of intraday correlations between the DAX, CAC40, and FTSE100 indices in Western Europe and the BET and SOFIX indices in Eastern Europe by Égert and Koenda (2007) and the three Central European stock markets (BUX, PX, and WIG20 indices, respectively) . For the time frame of June 2013 to February 2016, five-minute intervals were used. No significant cointegration relationship was discovered for any of the stock index pairs as a result of this research.

Eastern European stock market indices have a lower correlation coefficient (around 0.2), while Central and Western European stock markets have a slightly higher correlation coefficient (around 0.3), and Western European stock markets have much stronger correlation coefficients between the indices DAX, CAC, and FTSE (approx. 0.8-0.9). Through the Grange model, our research has also discovered important causal relationships: stock returns in Frankfurt, London, and Paris have a predictive power for the profitability of stocks in the three CEE countries. While the profitability of the stock markets in Central and Eastern Europe is influenced by one another, it is similar to the return on shares in the design of the DAX, FTSE, and CAC stock market indices.

Using yield data from January 2016 to March 2019, Tudor (2010) examined the causal link between Central and Eastern European stock markets (Czech Republic, Hungary, Bulgaria, Poland, Russia, and Romania) and US stock markets. Specifically between those markets with a lower degree of interconnection prior to the crisis (Bulgaria, Romania), it was noted that the effects of the financial crisis increased interconnections between the analyzed markets. However, the opposite was also discovered. The Granger causation test was also used to confirm the findings regarding the rise in interconnection following the financial crisis.

3. Research methodology

Our study is based on the analysis of correlations and causal relationships between the US financial market and six CEE financial markets (the Czech Republic, Hungary, Bulgaria, Poland, Russia, and Romania), using daily yield data from January 2016 to March 2019. We discovered that the financial crisis resulted in a confirmation of the connections between the observed markets, particularly between the less connected markets (Bulgaria and Romania), while the opposite was discovered for the stock exchanges in the Czech Republic and Hungary. The findings of increased interconnection following the financial crisis were confirmed using a Granger causality test.

In developed markets like the DAX, FTSE, and ATX, as well as MSCI indices and European EAFE and EMEE indices, closing weekly prices were applied. The use of weekly closing prices in Hungary, the Czech Republic, Poland, and Romania was necessary for the analysis of the dynamics of CEE nations. The data were pulled from DataStream between July 2020 and June 2021 since Romania joined later.

The developed capital markets were also represented by the EAFE index. The data for the weekly macroeconomic indicators, including the price of oil (WTI), the price of gold on the London Metal Exchange, the interest rate for 3-month TBILL bonds (TB3M) and 10-year maturity bonds (DG10Y), and the euro/USD exchange rate, were provided by the FRED bases.

4. Findings

Granger's unconditional correlation and causality tests for logarithmic daily closing price differences for stock indices, including the LJSEX (Slovenia), PX (Czech Republic), BUX (Hungary), ATX (Austria), CAC40 (France), DAX (Germany), and FTSE100, served as the foundation for our study (UK). indicators recorded from April 1997 to May 2020. The analysis period's days without trading were excluded. 3060 days in total were examined. The ATX, CAC40, DAX, and FTSE100 indices' data were retrieved from Yahoo Finance, whereas the LJSEX, PX, and BUX indices' data were obtained from the relevant stock exchanges.

From the analysis of the descriptive statistics, a higher spread was observed between the maximum and minimum daily yields at the PX and BUX indices, as well as at the other indices. The lowest standard deviation in daily yields was recorded in the LJSEX index.

It is useless to alter the normal distribution or any other perfectly symmetrical distribution. The distribution of the data is more to the left than to the right of the average if the statistical result is negative. The data dissipates further to the right in the case of positive asymmetry.

Kurtosis: The normal distribution's kurtosis is 3. When a distribution's kurtosis is greater than 3, it has a fat tail; when it's lower than 3, it's less likely to have values that deviate from the norm.

Jarque-Bera test: the alternative is that the sample data do not come from a normal distribution, while the null hypothesis is that they do come from a normal distribution with an unknown mean and variance.

Statistics from Jarque-Bera: The null hypothesis (of a normal distribution) is rejected at a significance level of 1% (the null hypothesis is also rejected at a significance level of 5 % and 10%, respectively).

Stock index yields' unconditional correlation coefficients - the entire observation period (1.4.2020 - 12.5.2021)

We should note that all correlation coefficients have a significant difference from zero to a variation of 1%.

The CAC40, FTSE100, and DAX stock indices have the highest correlation rates. According to the empirical literature that has already been published (such as Serwa and Bohl (2005) and Harrison and Moore (2009)), the financial markets for these indices are most effectively integrated. The most interconnected indices were the CAC40 and FTSE100, with a correlation coefficient of 0.871. LJSEX, PX, and BUX exhibit less co-movement with the other developed European financial markets and EEC financial markets. According to our research, the Jarque-Bera test disproves the idea that a time series observed with a normal distribution because all indices are distributed asymmetrically (to the left) around the sample mean and the kurtosis is higher than it would be for a time series with a normal distribution.

With ATX, BUX, and FTSE100, the PX index is highly mobile. Compared to PX, BUX is marginally less linked to the measured stock indices. The strongest ties are with PX, DAX, and ATX. The Austrian stock exchange has a lower connecting power than the major European markets but is more connected to global markets than the EEC markets (CAC40, DAX and FTSE100).

The interdependencies between all stock market pairs were lower in the first sub-period than in the second. In all three subperiods, the Slovenian stock market underperformed other markets. In the second subperiod, the dynamics of Czech stock market returns with the development of the European markets were higher than in the Hungarian one, suggesting that the Czech stock exchange may be more closely connected to the European stock markets than the Hungarian stock

exchange. The interdependence of CEE has increased as a result of European integration, and financial markets have grown. For developed markets, this analysis supports the findings of Bessler and Yang (2003), as well as Syllignakis and Kouretas (2006), Harrison and Moore (2009), and Allen et al. (2010) for EEC observed markets. Unconditional correlation coefficients of stock market index yields from the time CEE countries joined the EU until the start of the global pandemic crisis (1 May 2020 - 15 September 2021).

According to the analysis, stock market interdependence grew during a crisis. This finding applies to the most recent global financial crisis, which we can confirm. The interdependence of stock markets has grown since the start of the global pandemic crisis. Higher correlation coefficients than in the previous two periods can be found for all index yield pairs. The advantages of portfolio diversification in these markets have been lessened by a strengthening of interdependence.

5. Conclusions

The size of the financial markets in Western Europe and Central and Eastern Europe was examined in our research. Using stock indices, yield distribution and profitability spreads were examined. Four stock indices from developed stock markets (ATX, CAC40, DAX, and FTSE) and three EEC stock indices (LJSEX, PX, and BUX) were also used. The daily return series between April 2020 and May 2021, which was split into three subperiods: the pre-accession period, the accession period, and the period of the global pandemic crisis, was subjected to the Granger unconditional correlation study and causality tests (based on Vector AutoRegression models).

The following conclusions were reached:

- i) The stock exchanges that are best interconnected are CAC40, FTSE100 and DAX. The stock exchanges in France, Great Britain and Germany seem to be the most connected, a fact often observed in the existing literature;
- ii) CEE financial markets have shown a low degree of connection with other CEE and developed European financial markets;
- iii) Of the stock market indices analyzed, the Slovenian stock exchange was the least correlated with other stock markets;
- iv) It is not only the stock market returns in the developed stock markets of Austria, France, Germany and the United Kingdom that Granger causes stock returns in the three CEE markets - the stock market return in the CEE also influences the performance of the shares in developed markets;
- v) European integration and the global pandemic crisis seem to have strengthened the interdependence between CEE and developed stock markets (measured by correlation coefficients and the strength and number of causal links Granger).

6. References

- Baek, E. and Brock, W., 1992. *A General Test for Nonlinear Granger Causality: Bivariate Model*. Iowa State University of Wisconsin-Madison Working Paper.
- Bekiros, S.D. and Diks, G.G.H., 2008. The nonlinear Dynamic Relationship of Exchange Rates: Parametric and Nonparametric Causality Testing. *Energy Economics*, 30, pp.2673-2685. <https://doi.org/10.1016/j.eneco.2008.03.006>
- Bessler, D.A. and Yang, J., 2003. The Structure of Interdependence in International Stock Markets. *Journal of International Money and Finance*, 22, pp.261-287. [https://doi.org/10.1016/S0261-5606\(02\)00076-1](https://doi.org/10.1016/S0261-5606(02)00076-1)
- Caporale, M.G. and Spagnolo, N., 2010. Stock market integration between three CEEs. *Brunel University Working Paper*, No. 10-9. [online] Available at: <http://www.brunel.ac.uk/9379/efwps/1009.pdf>. <https://doi.org/10.2139/ssrn.1571053>
- CEEG - CEE Stock Exchange Group, 2011. *Fact sheet January 2011*. [online] Available at: <http://www.ceeseg.com/static/cms/sites/ceeseg/en/media/pdf/factsheet/cee-stock-xchange-group-fs2011.pdf>.
- Diks, C. and Panchenko, V., 2006. A new statistical and practical guidelines for nonparametric Granger causality testing. *Journal of Economic Dynamics and Control*, 30, pp. 1647-1669. <https://doi.org/10.1016/j.jedc.2005.08.008>

- Égert, B. and Kočenda, E., 2007. Time-Varying Co-movements in Developed and Emerging European Stock Markets: Evidence from Intraday Data. *William Davidson Institute Working Paper Series*. [online] Available at: <http://www.wdi.umich.edu/files/Publications/WorkingPapers/wp861.pdf>. <https://doi.org/10.2139/ssrn.988166>
- Égert, B. and Kočenda, E., 2010. *Time-varying synchronization of European stock markets*. *Empirical Economics*. [online] Available at: <http://www.springerlink.com/content/9553r2714vplt745/fulltext.pdf>
- Embrechts, P., McNeil, A.J. and Straumann, D., 1999. *Correlation and Dependence in Risk Management: Properties and Pitfalls*. In: MAH Dempster (ed.), *Risk Management: Value at Risk and Beyond*. Cambridge: Cambridge University Press, pp. 176-223. <https://doi.org/10.1017/CBO9780511615337.008>
- FESE - Federation of European Securities Exchanges, 2010. *European securities exchange statistics*. [online] Available at: <http://www.fese.be/en/?inc=art&id=3>
- Forbes, J.K. and Rigobon, R., 2002. No contagion, only interdependence: measuring stock market co-movements. *The Journal of Finance*, 57(5), pp. 2223-2261. <https://doi.org/10.1111/0022-1082.00494>
- Gilmore, G.C. and McManus, G.M., 2002. International portfolio diversification: US and Central European equity markets. *Emerging Markets Review*, 3(1), pp. 69-83. [https://doi.org/10.1016/S1566-0141\(01\)00031-0](https://doi.org/10.1016/S1566-0141(01)00031-0)
- Granger, W.C., 1969. Investigating causal relationships by economic models and cross-spectral methods. *Econometrica*, 37(3), pp. 424-438. <https://doi.org/10.2307/1912791>
- Granger, W.C. and Morgenstern, O., 1970. *Predictability of Stock Market Prices*. MA: Lexington.
- Harris, F.R. and Pisedtasalasai, A., 2006. Return and volatility spillovers between large and small stocks in the UK. *Journal of Business Finance and Accounting*, 33(9-10), pp. 1556-1571. <https://doi.org/10.1111/j.1468-5957.2006.00635.x>
- Harrison, B. and Moore, W., 2009. Stock market comovement in the European Union and transition countries. *Financial Studies*, 13(3), pp.124-151.
- Horobet, A. and Lupu, R., 2009. Does it have Capital Markets Integrated? A Test of Information Transmission within the European Union. *Romanian Journal of Economic Forecasting*, 10(2), pp. 64-8
- Harrison, B. and Moore, W., 2009. Stock market comovement in the European Union and transition countries. *Financial Studies*, 13(3), pp.124-151.
- Kwiatkowski, D. Phillips, P. Schmidt, P. and Shin, Y., 1992. Testing the null hypothesis of stationarity against the alternative of a unit root. *Journal of Econometrics*, 54, pp. 159-178. [https://doi.org/10.1016/0304-4076\(92\)90104-Y](https://doi.org/10.1016/0304-4076(92)90104-Y)
- Ling, X. and Dhesi, G., 2010. Volatility spillover and time-varying conditional correlation between the European and US stock markets. *Global Economy and Finance Journal*, 3(2), pp.148 - 164.
- Longin, F. and Solnik, B., 1995. Is the Correlation of International Equity Returns Constant ?. *Journal of International Money and Finance*, 14, pp. 3-26. [https://doi.org/10.1016/0261-5606\(94\)00001-H](https://doi.org/10.1016/0261-5606(94)00001-H)
- Liew, V.K.S., 2004. Which Lag Length Selection Criteria Should We Employ ?. *Economics Bulletin*, 3(33), pp.1-9.
- Malliaris, A.G. and Urrutia, J.L, 1992. The international crash of October 1987: Causality tests . *Journal of Financial and Quantitative Analysis*, 27(3), pp. 353-364. <https://doi.org/10.2307/2331324>
- Necula, C., 2010. Modeling the dependency structure of stock index returns using a copula function . *Romanian Journal of Economic Forecasting*, 13(3), pp. 93-106.
- Patev, P. Kanaryan, N. and Lyroudi, K., 2006. Stock market crises and portfolio diversification in Central and Eastern Europe. *Managerial Finance*, 32(5), pp. 415-432. <https://doi.org/10.1108/03074350610657436>
- Pop Silaghi, M.I., 2009. Exports-economic growth causality: Evidence from CEE countries. *Romanian Journal of Economic Forecasting*, 10(2), pp.105-117.
- Serwa, D. and Bohl, M.T., 2005 . Financial Contagion Vulnerability and Resistance: A Comparison of European Stock Markets. *Economic Systems*, 29, pp. 344-362. <https://doi.org/10.1016/j.ecosys.2005.05.003>
- Syllignakis, M. and Kouretas, G., 2006. Long And Short-Run Linkages In CEE Stock Markets: Implications For Portfolio Diversification And Stock Market Integration . *William Davidson Institute Working Papers Series*. [online] Available at: <http://wdi.umich.edu/files/publications/workingpapers/wp832.pdf>. <https://doi.org/10.2139/ssrn.910507>