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CO-MOVEMENT OF FINANCIAL MARKETS IN EMERGING AND DEVELOPED ECONOMIES

This paper investigates the nature and interactions between Serbian equity market and selected regional and developed equity markets. Using the most recent data for the appropriate stock market indices spanning the period 2005-2009, market interdependencies are gauged by running cross-correlation and Granger causality tests. The results show statistically significant correlations between Serbian and German equity markets as well as Slovenian and Croatian equity markets. The highest correlation is documented between equity returns in Serbia and Germany. In addition, evidence on bidirectional causality is found for Serbian, Croatian and Slovenian markets. Also the paper finds unidirectional causality from Hungarian and German markets to Serbian market.

Keywords: *time series analysis; correlation; equity index; interdependence; causality.*

JEL classification: C32, G15.

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РУХ МІЖ ФІНАНСОВИМИ РИНКАМИ КРАЇН, ЩО РОЗВИВАЮТЬСЯ, ТА РОЗВИНЕНИХ КРАЇН

У статті досліджено природу взаємодії фондового ринку Сербії з фондовими ринками інших країн регіону та розвинених країн. Використано дані щодо біржевих індексів за 2005-2009 роки. Взаємозалежність між ринками розраховано шляхом перехресної кореляції та тесту Грейнджера на причинність. За результатами виявлено статистично значущі кореляції між сербським та німецьким фондовими ринками, а також між ринками Словенії та Хорватії. Найбільша кореляція спостерігається між прибутками від акцій на сербському та німецькому ринках. Крім того, доведено існування двостороннього причинного зв'язку між ринками Сербії, Хорватії та Словенії. Односторонняя причинність спостерігається в напрямку від ринків Угорщини та Німеччини до фондового ринку Сербії.

Ключові слова: *аналіз часових рядів; кореляція; фондовий індекс акцій; взаємозалежність; причинність.*

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ДВИЖЕНИЕ МЕЖДУ ФИНАНСОВЫМИ РЫНКАМИ РАЗВИВАЮЩИХСЯ И РАЗВИТЫХ СТРАН

В статье исследована природа взаимодействия фондового рынка Сербии с фондовыми рынками других стран региона и развитых стран. Использованы данные по биржевым индексам за 2005-2009 годы. Взаимозависимости между рынками просчитаны путем перекрестной корреляции и теста Грейнджера на причинность. Результаты выявили статистически значимые корреляции между сербским и немецким фондовыми рынками, а также между рынками Словении и Хорватии. Наибольшая корреляция

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отмечена между прибылями от акций на сербском и немецком рынках. Кроме того, доказано наличие двусторонней причинной связи между рынками Сербии, Хорватии и Словении. Односторонняя причинность отмечена исходящей от рынков Венгрии и Германии к фондовому рынку Сербии.

Ключевые слова: *анализ временных рядов; корреляция; фондовый индекс акций; взаимозависимость; причинность.*

1. Introduction. The emerging capital markets of the countries of former Yugoslavia are becoming increasingly important for both institutional and individual investors. However, they still remain small, fragmented and underdeveloped, as Muller-Jentsch (2007) has described them. For example, market capitalisation of all Western Balkan countries together amounts to just over 50 bln. (equity only) in 2006, which is equivalent to about a third of the already small Vienna Stock Exchange. What is even worse is that this small amount of market capitalisation is fragmented between too many exchanges[4].

Serbia, which also has an emerging capital market, is slowly becoming a part of the global financial system after a period of economic isolation. One of the main steps on this road was the establishment of Belgrade stock exchange as representation of Serbian institutional equity market. After changes in the model of privatisation from 2001, the Belgrade stock exchange began trading with papers. That was the beginning of new era in business at Belgrade stock exchange. Serbia now has interactions with all the regional equity markets (Samitas, Kenourgios, and Paltalidis, 2006). The stock market has traditionally been viewed as an indicator or "predictor" of the economy (Comincioli and Wesleyan, 1996). Investigating causality is a topic of key interest in scientific research. Assessing the causality between two processes in a common and well-defined (non-experimental) framework, one usually refers to the well-known concept of Granger causality. Most researchers believe that large decreases in stock prices are reflective of a future recession, whereas large increases in stock prices suggest future economic growth. The stock market as an indicator of economic activity, however, does not go without controversy. Sceptics point to the strong economic growth that followed the 1987 equity market crash as the reason to doubt the equity market's predictive ability. Given the controversy that surrounds the equity market as an indicator of future economic activity, it seems relevant to research this topic further.

A number of papers analyse interdependencies among variables using Granger causality. For instance, Chris Brooks (1998) reports bidirectional Granger causality between volume and volatility on the New York Stock Exchange. Yue and Kanas (2000) report evidence for nonlinear Granger causality from French money to the FFr/DM exchange rate. In financial literature, Granger causality test has been applied, for instance, to identify price-leadership patterns among national stock prices (Peiers, 1997), to study the stock price-volume relationship (Hemstra and Jones, 1994), or to gain insight into dynamic behaviour of bonds and stocks

[4] Some countries, such as Montenegro and Bosnia and Herzegovina, even have two stock exchanges.

(Park and Shenoy, 2002) or into international links between interest rates (Bruneau and Jondeau, 1999). Granger causality has become a useful tool for characterising dependence relations between time series in economics and econometrics. Traditional parametric tests for Granger causality have reached a mature status and have become part of the standard toolbox for economists. As pointed out by Bekaert and Harvey (2000), the correlation between emerging markets' opening up their capital markets to foreign investors and developed markets tends to increase over time. In their recent empirical work, Gupta and Donleavy (2009) argue that the increasing integration among financial markets gradually reduces benefits derived from international diversification. Recent studies have identified the relationships among developed and CEE emerging equity markets. Gilmore and McManus (2002) find that Czech, Hungary and Poland are not cointegrated with the US equity market during the period from 1995 to 2001. Also, the correlations among returns of these markets seem to be very low. Voronkova (2004) shows evidence of the long-run relationship between German and Polish stock indices as well as German and Hungarian indices over the period between 1993 and 2002. Gilmore et al. (2005) find evidence of no cointegration relationship among German and CE equity markets for the period from 1995 to 2005. The analysis of a different period shows stronger evidence of cointegration of CEE equity markets with UK markets rather than with the German market. Egert and Kocenda (2007) test the existence of a long-run relationship among Western and Eastern European equity markets. The study of Egert and Kocenda (2007) does not find a relationship among German and Polish equity markets. However, they find cointegration between German and other two Eastern Europe equity markets. Syriopoulos and Roumpis (2008) investigate time-varying linkages among Balkan and developed equity markets using the Constant Conditional Correlation (CCC) and Asymmetric Dynamic Conditional Correlation (ADCC) models, their results show that correlations among equity markets are not constant over time, whereas correlations with developed markets seem to be quite modest. Fedorova and Saleem (2010) examine the interdependence between the emerging Eastern European market and the Russian equity market and find direct linkage between the equity markets with regard to returns and volatility. Morales (2007) examines the dynamic relationship between exchange rates and stock prices in 4 Eastern European markets, Czech Republic, Hungary, Poland and Slovakia, using stock prices and exchange rate data from these countries. She finds no evidence of stock prices and exchange rates moving together either in the long run or in the short run, with the exception of Slovakia, where cointegrating relationships were found. In terms of their causality analysis, the results show a unidirectional causal relationship from the exchange rates to the stock prices in the case of Hungary, Poland and the Czech Republic.

For the last few years, the development of the financial market in Serbia has opened a new era of the financial resources mobility, whereby the flow of private capital has assumed an increasing role as a source of finance for this market. In this study, emphasis is given to test the inter-market relationship among the equity market in Serbia with equity markets of regional countries and equity markets in the developed world through the following:

(i) Descriptive statistics, (ii) Correlations and (iii) Granger causality.

This paper indicates how strong this impact is using correlations between regional and equity market indices of Germany and the US and that of Serbian equity market. Also, this paper demonstrates causality between them, using Granger causality to prove a potential causality. To the author's best knowledge, this is the first paper that studies interactions between Serbian equity market and such a broad panel of other markets for the period after 2005.

The rest of the paper is organised as follows: in the next section, the data for causality is briefly presented. The methodology is reviewed in Section 3. Section 4 discusses the findings, and the final Section 5 concludes the paper.

2. Data analysis. To provide updated results, this study uses daily closing data of 6 selected equity markets, namely, Serbia, Croatia, Slovenia, Hungary, Germany and the US, covering the period from October 4, 2005 to August 18, 2009 (Figure 1-6). In this study, the conventional stock returns for these markets are calculated from the following indices:

- BELEX 15 blue chip index for Serbia,
- CROBEX for Croatia,
- SBITOP for Slovenia,
- CETOP for Hungary,
- DAX for Germany, and
- S&P 500 for the USA.

These 4 years are very interesting because regional indices reached their highest historical values in 2008. And in 2009, because of the impact of the world economic crisis, dropped substantially. Before proving the potential causality and their effects, we will show correlations between BELEX 15 and other indices. Because of the differences in working days between Belgrade equity market and other equity markets in the region, the numbers of observations are also different. The numbers of observations are in the range of 900 to 957. The estimations with these observations include percentile changes in ROI [5] values. These ROI values represent two variables used in estimations. Before we use the test for direct Granger causality, we will test correlations between ROI values of BELEX 15 as a represent of Serbian equity market and other indices from US, German, Hungarian, Croatian and Slovenian equity markets. Table 1 shows summary data for the estimated markets. There are several methods for testing the flow of information and comovement of prices at stock markets across the countries.

Table 1. **Data summary**

Country	Index name	Domestic market capitalization (in USD mln)*
1. Serbia	BELEX 15	11 490.5
2. Croatia	CROBEX	26 619.0
3. Slovenia	SBITOP	12 140.9
4. Hungary	CETOP	30 036.6
5. Germany	DAX	1 292 355.3
6. United States of America	S&P 500	11 837 793.3

* 2009 data

Source: World Federation of Exchanges

[5] Return on investments-calculated like log different between 2 values of stock market index.

Descriptive statistics for the stock indices' returns are given in Table 2. These include the distribution of the mean, the standard deviation, the skewness and the kurtosis. A careful examination reveals that Slovenian equity market offers the highest return at a reasonable risk level. Approximately at the same level of risk, Serbian market is offering negative returns. The stock markets of the US, Croatia and Hungary are exhibiting average negative returns for the period under study. Slovenian market appears to be less risky, whereas the standard deviations of the other markets, except for the US, are not significantly different. Only Serbian and German equity markets are positively skewed. The negativity of skewness is seen as a sign of nonlinearity in the dynamics of stock markets. All of the displayed skewness statistics have asymmetric distributions. Serbian and German are skewed to the right, as shown by the positive skewness statistics, all the others are skewed to the left (negative skewness).

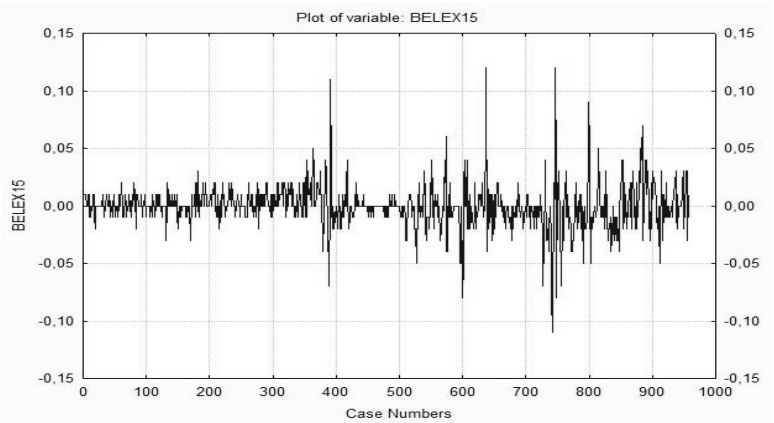
Kurtosis provides a measure of "thickness" of the tails of a distribution relative to normal distribution. For normal distribution, kurtosis is usually equal to 3. All daily stock returns have excess kurtosis, which means that they have a thicker tail and a higher peak than a normal distribution. The coefficient of variation (C.V.) measures the degree of volatility of relative daily market returns. For developed markets (the US and Germany), the coefficients of variation are higher on average than those for all the other countries, except Croatia. Overall, based on the coefficient of variation, the figures seem to indicate that Serbian stock market has the least level of volatility relative to all the other countries:

Table 2. **Descriptive statistics of daily returns**

Index	N. obs	Mean	Std. Dev.	Skewness	Kurtosis	C.V
BELEX 15	957	-0.0004725	0.018441	0.19990	9.0158	39.025
CETOP	941	-0.0002688	0.022135	-0.75381	7.8903	82.321
CROBEX	910	-0.0001067	0.018449	-0.21067	8.8507	172.83
SBITOP	896	0.00019236	0.015468	-0.52237	7.2370	80.411
DAX	957	0.00002268	0.016467	0.21088	7.6612	726.17
S&P 500	942	-0.0002280	0.078846	-0.46473	425.75	345.80

Source: Authors' calculations

Figure 1. **Stock index returns for BELEX 15, October 2005 to August 2009**



Source: Authors' calculations

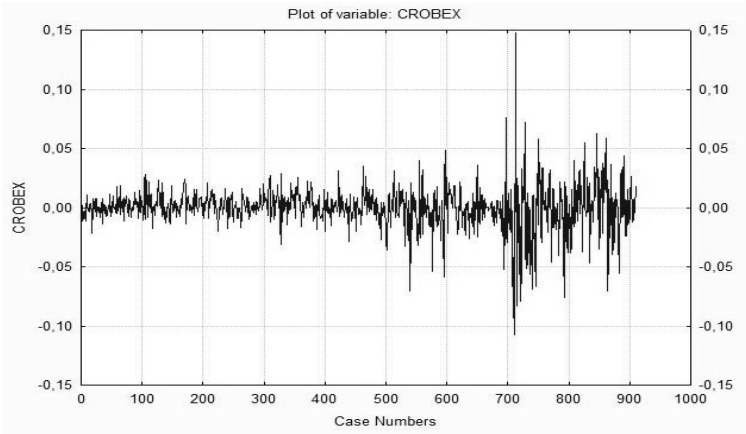


Figure 2. **Stock index returns for CROBEX, October 2005 to August 2009**
Source: Authors' calculations

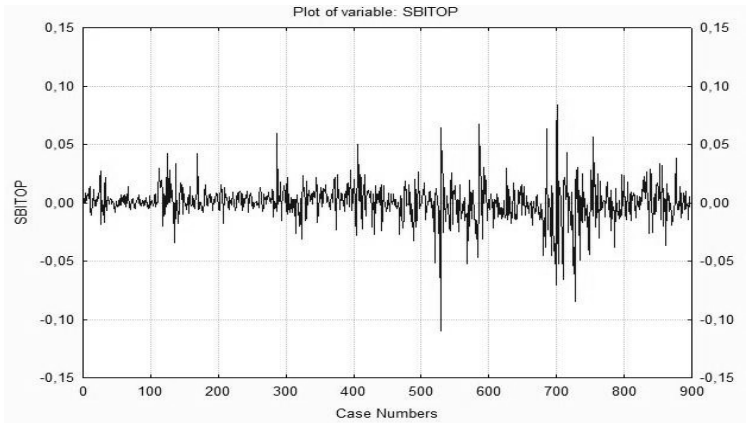


Figure 3. **Stock index returns for SBI TOP, October 2005 to August 2009**
Source: Authors' calculations

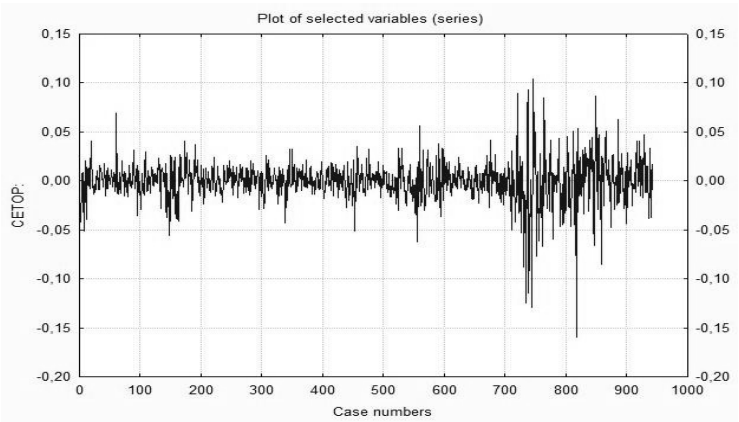


Figure 4. **Stock index returns for CETOP, October 2005 to August 2009**
Source: Authors' calculations

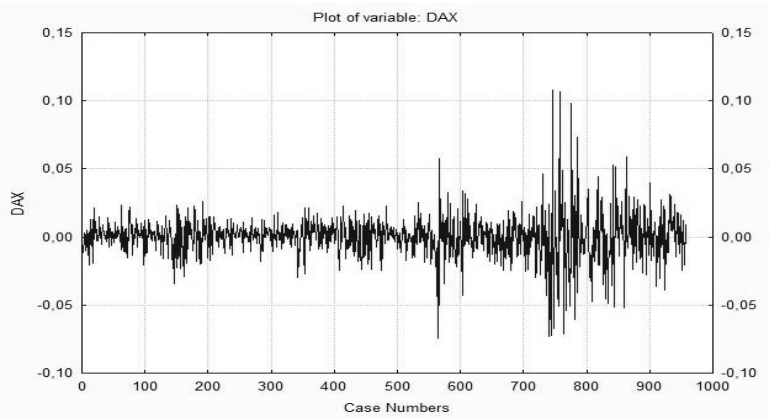


Figure 5. **Stock index returns for DAX, October 2005 to August 2009**
Source: Authors' calculations

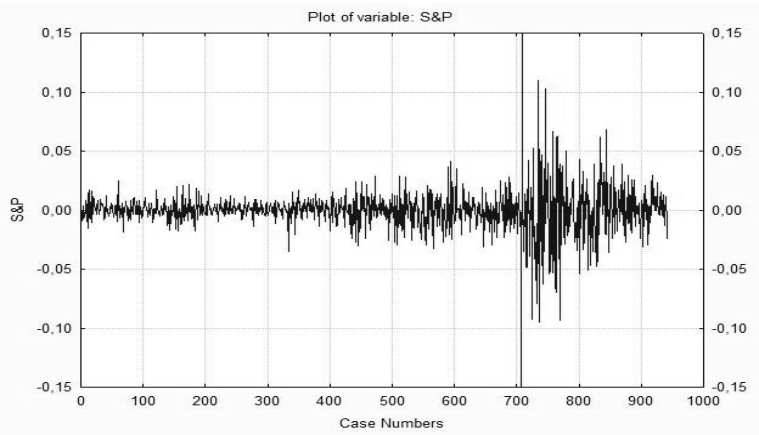


Figure 6. **Stock index returns for S&P 500, October 2005 to August 2009**
Source: Authors' calculations

3. Methodology. In this process, first, we must find the coefficient of correlation of daily returns for every pair of indices. The correlation values suggest the extent of linkage between the indices. The correlation of coefficient is used to measure the extent of association between the stock markets. It shows how changes in one index affect the other, where a higher correlation leads to a higher comovement between the indices.

Granger causality is thus a powerful tool that allows us test for things that we might otherwise assume away or take for granted. There are 4 different types of situations in which a Granger causality test can be applied:

- In a simple Granger causality test, there are two variables and their lags;
- In a multivariate Granger causality test, more than two variables are included because it is presupposed that more than one variable can influence the results;
- Granger causality can also be tested in a VAR framework; in this case, the multivariate model is extended to test for the simultaneity of all included variables;
- ARIMA models.

As the name suggests, we can also access Granger causality in a more direct way, by regressing each variable on lagged values of itself and the other, such as in the following:

$$Y_t = \beta_0 + \sum_{j=1}^{J} \beta_j Y_{t-j} + \sum_{k=1}^{K} \gamma_k X_{t-k} + \mu_t. \quad (1)$$

We can simply use an F-test or the like to examine the null hypothesis. The choice of J and K lags is critical; insufficient lags yield auto-correlated errors (and incorrect test statistics), whereas too many lags reduce the power of a test. This approach also allows determination of causal direction of relationships, as we can also estimate the "reverse" model:

$$X_t = \beta_0 + \sum_{j=1}^{J} \beta_j X_{t-j} + \sum_{k=1}^{K} \gamma_k Y_{t-k} + \mu_t. \quad (2)$$

Also, it is important to remember that Granger causality testing should take place in the context of a fully specified model. If a model is not well specified, "spurious" relationships may be found, despite the fact of no actual (conditional) relationship between variables.

This study uses a direct Granger causality method.

4. Results and discussion

Table 3. **Unconditional market returns correlation matrix**

	BELEX 15	DAX	S&P	CETOP	CROBEX	SBITOP
BELEX 15	1					
DAX	0.143498	1				
S&P	0.007024	-0.03796	1			
CETOP	0.018035	0.000798	0.020038	1		
CROBEX	-0.03235	0.008762	0.034737	0.06925	1	
SBITOP	0.094716	-0.00872	-0.02233	0.008962	0.022422	1

Notes: bold correlations are significant at $p<0.05$
Source: Authors' calculations.

Unconditional correlation coefficients in equity market index returns (Table 3) indicate significant pairwise correlations among the BELEX 15 index and several index markets.

Whereas almost all the equity markets are positively correlated with the return of Serbian market, correlations are quantitatively and statistically negligible, ranging between 0.009 to 0.09[6].

Onay's (2006) study is congruent in correlations with this paper that regional equity markets do not have strong relationship with each other[7]. The BELEX 15 market index shows the highest correlation with German DAX equity index returns. This result is expected for many reasons. Germany is the largest European economy and has been the largest exporter in the world for the last 9 years. In this study, the most important reason is that Germany has been the second largest export-import partner for Serbia in

[6] Jacob Cohen (1988) has suggested $0.1<\rho<0.29$ to be a small correlation, $0.30<\rho<0.49$ to be a medium correlation and $0.5<\rho<1$ to be a large correlation. The same benchmark is taken for negative values of ρ (Pallant, 2005, p. 126).

[7] The study investigates cointegration between Croatian, Bulgarian, Romanian and Turkish equity markets and reveals very low correlations among these markets.

the last few years. Serbian equity market also shows significant correlation with Slovenian market. The explanation for this lies in the fact that investors from are Slovenia the second largest group in total investment[8] in the Serbian economy for the last 10 years. Serbia currently hosts more than 500 companies from Slovenia. All these facts have impact on Serbian equity market and on the country's relationship with Slovenia.

The low correlations between most of the markets found in this paper lead to two major conclusions. From one point of view, this can prove that the characteristics of transition markets are the same as for all other emerging markets. From another point of view, low correlation between transition and global markets creates opportunities for portfolio diversification. These results could be viewed as the starting point for quantifying the portfolio diversification possibilities for investors. As pointed out by Bekaert and Harvey (2000), the correlation between emerging markets' opening up their capital markets to foreign investors and developed markets tends to increase over time. Financial liberalisation does not necessarily lead to full integration of an emerging market into the global market, although the lack of financial integration among world markets seems to be one of the main characteristics that investors take into account in their investment decisions given the benefits from diversifying internationally (Schmukler, 2004). Low correlation among transitions countries equity markets may be due to factors such as the lack of free trade and inadequate information on foreign securities. We must know that Serbian equity market index BELEX 15 was established later than other regional and transition indices, especially indices of developed countries. Low correlations in some way could be the result of this fact. Additionally, low correlations between all the countries from in study with the US and Germany as representatives of developed markets are also confirmed by the working paper of Egert and Kocenda (2007). The existing correlation between the markets under study implies their interdependence, but it does not reveal the direction of influence, that is, the causality between the markets. Correlation analysis is a weak technique and does not discuss the cause and effect relationship, so Granger causality is tested. The results of the causality tests are presented in Table 5.

Granger causality may have more to do with precedence or prediction than with causation in the usual sense. It suggests that although the past can predict the future, the future cannot predict the past. Granger causality tests are conducted for variables to establish whether the movement in equity prices from BELEX 15 has an impact on movements in equity prices on other indices and vice versa and apply Akaike's information criteria to ensure that the lag length specified in the causality tests is optimal. Table 4 shows the number of time lags used in the causality estimations.

Table 4. **Optimal endogenous number of lags from information criteria**

	OPTIMAL NUMBER OF LAGS Akaike Info Criterion (AIC)
1. BELEX 15 and CROBEX	2
2. BELEX 15 and CETOP	9
3. BELEX 15 and SBI TOP	4
5. BELEX 15 and DAX	9
6. BELEX 15 and S&P 500	1

Notes: searched up to 10 lags of 1. difference
Source: Authors' calculations.

[8] The total value of Slovenian investment amounts to 1.6 bln.

After these requirements have been satisfied, Granger causality tests are computed. Taking equation (1) as an example, the two-step procedure in testing whether BELEX 15 causes other indices is as follows:

1. Other regional indices are regressed on its past values excluding BELEX 15 in the regressors. This is called the restricted regression, from which we obtain the restricted sum of squared residuals.

2. Therefore, a second regression is computed including the lagged BELEX 15. This is called the unrestricted regression from which the unrestricted sum of squared residuals is obtained.

The statistics are defined as follows:

$$F = \frac{[(RSS_r - RSS_{ur})/k]}{RSS_{ur}/[n-2k-1]}, \quad (3)$$

where SSR_r and SSR_{ur} are the two sums of squared residuals related to the restricted and unrestricted forms of the equation; the elements that form the degrees of freedom are n, that is, the number of observations, whereas k represents the number of lags. The same procedure is used to test for the inverse Granger-causality relation in 2. With the F statistic, the hypothesis of the statistical significance of specific groups of explanatory variables was tested for each separate function. The result reflects the I(0) state of the variables. In the cases where the F-stat[9] is higher than the result of F-test, causality exists. In the cases where the F-stat is smaller than or equal to values from the F-test, the causality does not exist. Table 6 gives the evidence regarding the existence of bidirectional causality. The model used in these estimations is the OLS (Ordinary Least Squares) model. All these estimations employ the 0.05% significance level.

Table 5. **Results of Granger-Causality Tests**

Null Hypothesis	Obs.	F-statistics	Probability	Decision
BELEX_15 does not Granger Cause CROBEX	908	3.50828	0.0304	Reject
CROBEX does not Granger Cause BELEX_15	908	16.1431	1.E-07	Reject
BELEX_15 does not Granger Cause CETOP	932	1.32664	0.2185	Accept
CETOP does not Granger Cause BELEX_15	932	4.14890	2.9326e-05	Reject
BELEX_15 does not Granger Cause SBI_TOP	892	2.69138	0.0300	Reject
SBI_TOP does not Granger Cause BELEX_15	892	5.47124	0.0002	Reject
BELEX_15 does not Granger Cause DAX	948	1.62045	0.1048	Accept
DAX does not Granger Cause BELEX_15	948	5.60573	1.E-07	Reject
BELEX_15 does not Granger Cause S&P 500	941	0.08309	0.7732	Accept
S&P 500 does not Granger Cause BELEX_15	941	1.58658	0.2081	Accept

Notes: The results in this table are received from two software programs specialised in work with time series estimations: E-view 7 and J-Multi software. ADF test used to find the optimal number of time lags determined with the Akkaike criterion.
Source: Authors' calculations.

[9] In all estimations, ROI is used (percent daily changes in the values of stock market indices).

We find the unidirectional result from Hungary to Serbia and from Germany to Serbia. This indicates that CETOP Granger causes BELEX 15. We can also say that the past values of CETOP predict present or future values of BELEX 15. The results of this causality show strong interdependence between the two equity markets. Also, the past values of DAX predict present or future values of BELEX 15. Results with this causality pair are also expected if we know that Germany is the biggest European economy and the second foreign trade partner. Also Germany is the fourth largest country with foreign direct investment in Serbia (Serbian Chamber of Commerce, 2008).

These evidence of two unidirectional causality also mean that CETOP and DAX are the first move and BELEX 15 follows it, but with a certain delay.

We find two bidirectional or full causality between Serbian and Croatian and Slovenian markets. The results of the BELEX 15 and SBITOP index pair show another bidirectional causality. This means that changes in the prices at Serbian equity market predict changes in the prices at Slovenian and Croatian equity markets and vice versa. The causality in these two cases are expected if we know that majority of foreign investors in Serbian economy are from Croatia and Slovenia (Serbian Chamber of Commerce, 2008) and the causality results only confirm that.

We don't find evidence for causality only for Serbian and US equity markets. Explanations could lie in the fact that Serbian equity market is still not integrated with the developed world financial markets. A possible explanation of this difference in the results could be the specifics of the analysed data, as the Granger causality test is sensitive to time-series properties (e.g., lag length).

Over all this Granger causality result supports the idea that knowing current prices improves the forecast ability of stock prices.

5. Conclusion. The empirical evidence presented in this paper suggests there are significant relationship between some of the equity markets. This paper has tried to assess the possibility that one of the two variables could cause (in the Granger's sense) the other. First, the paper tested a possible correlation coefficient between BELEX 15 and all other equity markets index pairs. The results show that Serbian market has significant positive correlation coefficients with German, Slovenian and Hungarian equity markets. All of them are positive, so if one of them increases, this means that values of Serbian equity market index increase as well. The results of the correlations tests show that Serbian equity market and, indirectly, the whole economy have the strongest interaction with German equity market, as expected.

Next, the paper explores causality between them using the direct Granger causality method. In some index pairs, we had one kind of causality between them. We conclude that BELEX 15 predicts CROBEX and SBI TOP. Also we conclude that CROBEX and SBI TOP predict changes in BELEX 15. Therefore, this study finds evidence of bidirectional Granger causality between equity returns in Serbia and equity returns in Croatia and Slovenia.

The results of correlations and causality estimations suggest that regional and developed equity markets and Serbian equity market had different size of relationships. The results support the view that globalisation of the world economy has enhanced their interrelations. However, there are also two bidirectional Granger causalities running from Serbia to Croatia and Slovenia and vice versa. Therefore, any abnormal movement in Serbian's equity returns could lead to similar changes in

Slovenia and Hungary and vice versa. Also, any abnormal movement in Hungarian's and German's equity returns could lead to similar changes in Serbia.

The reported causality test results are useful for any assessment of the East European and developed world equity markets. For example, the interplay between these pairs of countries (Serbia-Slovenia and Serbia-Hungary) can be useful for central bankers and international investors evaluating a stock market performance. The above findings lead us to infer that Serbian equity market is partially integrated into the global market.

The findings of the paper have important implications for investors and policymakers. The presented empirical results support the view that international investors have long-run opportunities for portfolio diversification by acquiring stocks from these 6 countries. However, higher integration also implies there are fewer opportunities to diversify portfolios within the Euro area, thus providing incentives to focus more on diversifying across sectors or across regions. For policymakers, the process of European financial integration causes some challenges. Financial integration has increased competition and market efficiency, and at the same time, continuing financial integration has made individual European markets increasingly interdependent and subject to spill-overs resulting from endogenous and exogenous shocks.

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