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INTERACTIONS BETWEEN STOCK MARKET AND FOREIGN EXCHANGE MARKET: THE CASE OF SERBIA

This paper presents a dynamic interactions between the stock index BELEX 15 and the exchange rate RSD/EUR in the period 2005-2009. Interactions are observed with linear correlation test and Granger causality test. The paper proves the existence of significant interactions between two segments of the financial market in Serbia for the observed period. The results show evidence of a statistically significant negative correlation between stock market and foreign exchange market in Serbia. Also, the results of Granger causality imply the existence of full or bidirectional causality, which proves significant conditionality between markets and foreign exchange market in Serbia.

Keywords: *stock market, foreign exchange market, correlation, causality.*

JEL classification: *C01, F3.*

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ВЗАЄМОДІЇ МІЖ ФОНДОВИМ І ВАЛЮТНИМ РИНКОМ НА ПРИКЛАДІ СЕРБІЇ

У статті освітлено динамічні взаємодії між фондовими індексами BELEX15 і обмінним курсом сербського динара і євро в 2005-2009 роках. Дані проаналізовано методом лінійної кореляції і тестом Грейнджера на причинність. Доведено існування значущої взаємодії між двома сегментами фінансового ринку в Сербії у спостережуваний період. Результати свідчать про статистично значущу негативну кореляцію між фондовим і валютним ринком в Сербії. Крім того, результати тесту Грейнджера на причинність передбачають наявність повної або двонаправленої причинності, що доводить значну умовність між ринками і валютним ринком Сербії.

Ключові слова: *фондовий ринок, валютний ринок, кореляція, причинність.*

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ВЗАИМОДЕЙСТВИЯ МЕЖДУ ФОНДОВЫМ И ВАЛЮТНЫМ РЫНКОМ НА ПРИМЕРЕ СЕРБИИ

В статье освещены динамические взаимодействия между фондовыми индексами BELEX15 и обменным курсом сербского динара и евро в 2005-2009 годах. Данные проанализированы методом линейной корреляции и тестом Грейнджера на причинность. Доказано существование значимого взаимодействия между двумя сегментами финансового рынка в Сербии в наблюдаемый период. Результаты свидетельствуют о статистически значимой отрицательной корреляции между фондовым и валютным рынком в Сербии. Кроме того, результаты теста Грейнджера на причинность предполагают наличие полной или двунаправленной причинности, что доказывает значительную условность между рынками и валютным рынком Сербии.

Ключевые слова: *фондовый рынок, валютный рынок, корреляция, причинность.*

1. Introduction. The relationship between stock prices and exchange rates has received a significant amount of attention: economists, international investors and

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policy makers. Theoretically, it can be summarized that the dynamic relationship between stock prices and exchange rates is observed in two ways: the traditional approach and the portfolio approach. Traditional approach based on exchange rates, commodity markets (Dornbusch and Fischer, 1980) suggests that the real exchange rate affects the competitiveness of national economy, thereby stock market should show a negative response to the appreciation of national currencies. Ma and Kao (1990) argue that currency appreciation has negative (positive) impact on stock prices in the export(import)-oriented economies. However, causality can be directed from the relative domestic productivity shocks to the exchange rates in which case the sign of the association-currency stock market value is less obvious: while the effect of production shocks on stock prices is a clear positive impact on the real value of the currency can be productive if a positive shock covers only interchangeable goods (Chinn, 2000) or negative, if the shock covers nontradables (Pavlov and Rigobon, 2007). The portfolio approach assumes that the exchange rate should reflect the relative demand for domestic vs. foreign assets (Krueger, 1983; Branson, 1983, Frankel 1983, Gavin, 1989). Thus, the increase in demand for domestic shares is associated with both sides over the current capital inflows and a rise in domestic interest rates to continue attracting inflows of foreign fixed income. Both increases will affect the appreciation of domestic currency. In the bilateral environment, portfolio investments will go to the countries with higher returns on stock investments because higher yields mean more profitable investment opportunities in the country, hence the difference in stock returns will be positively correlated with the value of currencies.

Within the export-oriented developing economies, shocks to the demand side in large foreign countries, the swap returns in developed markets, implies a shock to export demand in developing economies, which stimulates the growth stock and the value of national currencies (Philaktis and Ravazzolo, 2005). For economies in transition, the Balassa-Samuelson effect can influence the direction of a positive correlation between the value of the currency and the domestic stock market, when measured at sufficiently low frequencies (Crespo-Cuaresma et al., 2003).

2. Literature review. A set of mixed and unconvincing results starts (ignoring the Bretton Woods era) with the empirical researches of Aggarvala (1981) who found a significant positive impact on the dollar prices of stocks in the US, and then Soenen (1988) who found a significant negative impact on the pattern that included the later period. Both works examined the influence of only one direction (from the dollar to the price of shares), and then the work of Bahman-Oskooee and Sohrabiana (1992) who found evidence of bidirectional causality, but no evidence of stable long term relationships. In the study on several countries, Ajayi (1996) found evidence of negative impacts in the short term, but long-term positive effect of domestic prices on the value of domestic currency, as well as positive currency impact on stock prices on the sample of 8 developed economies. In emerging markets, most of the available research was focused on Asia: Murinde and Abdala (1997) found evidence of a direct causal link directed from exchange rates to stock prices, for India, Korea and Pakistan. Ajayi et al. (1998) tested the Granger causality on the 8 Asian emerging markets using daily and weekly data and found evidence of a direct causal link directed to markets in developed countries, but no consistent results for Asian emerging markets. Using multivariate cointegration and causality tests for Granger, and

Philaktis and Ravazzolo (2005) showed that the value of the stock indexes and currencies in the Pacific Basin economy is positively related to real conditions, and the US stock market index S&P 500 acts as a channel for these connections. Using the real exchange rate for Poland, Czech Republic, Hungary and Slovakia for the period 1993-2003 and the use of exceedingly Stavarek models (2005) found no evidence of any relationship in the short and long term between exchange rates and stock markets in these countries. Using Granger causality and cointegration methodology, using weekly data for Greece, the Czech Republic and Hungary for the period 1994-2000 respectively, Grambovas (2003) found a "strong" ties between the foreign exchange and stock markets of Greece and Hungary, but not the Czech Republic.

Fedorova and Salem (2008) examined the volatility of capital markets and foreign exchange markets in developing countries of Eastern Europe. The results obtained by using the VAR-GARCH-Bekki model showed a high degree of correlation between stock and foreign exchange markets in these countries. They concluded that the significant effect of currency return on stock returns in Hungary, the Czech Republic and Russia, but not in Poland. They also proved that the excess volatility of foreign exchange market aimed towards capital markets. Morales (2007) examined the dynamic relationship between exchange rates and stock prices at 4 Eastern European markets, using data on exchange rates and stock prices. The author came to the conclusion that there is no evidence of a common long-term nor short-term movement of share prices and exchange rates, with the exception of Slovakia where they found evidence of cointegrating relationships with some of these markets. In terms of its causation analysis results in this paper show-way causal relationship between the exchange rate to the price action in the cases of Hungary, Poland and the Czech Republic.

The rest of the paper is organized as follows: Section 3 presents the data description, Section 4 shows the methodology. Section 5 presents the empirical results and Section 6 concludes the paper.

3. Data.

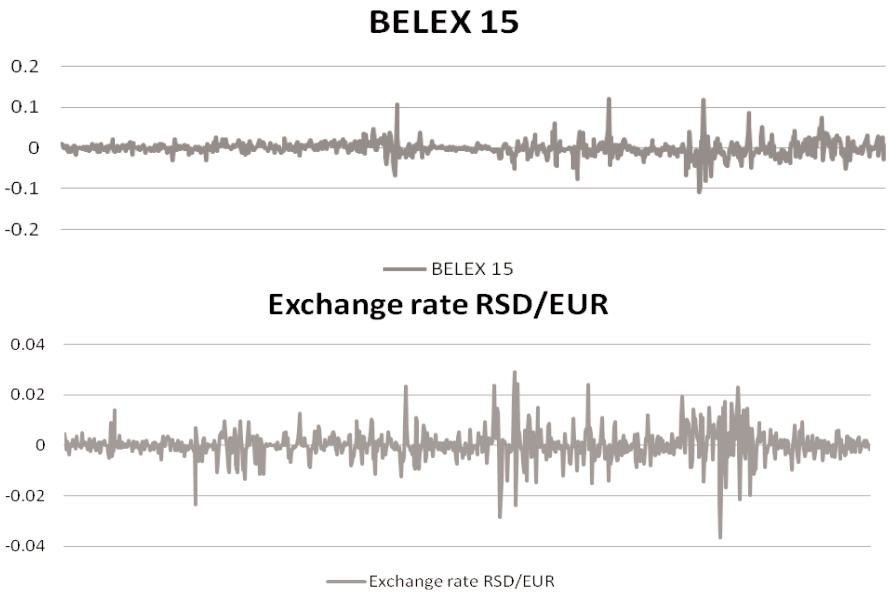
4. The data used includes several daily changes in stock market indices (it is the daily percentage change in value index, eng. ROI-return on investments). Daily logarithmic stock returns are calculated as:

$$r_{t+1} = \log(p_{t+1}) - \log(p_t), \quad (1)$$

where p_t is the value of the stock market index levels.

The data which include stock market index BELEX 15 is taken from the official presentation of their stock exchange market, while the data on the movement of medium of exchange rate RSD/EUR is obtained from the National Bank of Serbia (Figure 1).

Table 1 presents the descriptive statistics of the stock index BELEX 15 and middle exchange rate RSD/EUR. It includes the distribution, standard deviation, a skewness, kurtosis and the coefficient of variation.



Source: Author's calculations

Figure 1. **Upper panel: Percentage changes in Return of Investments of BELEX 15 in the period 2005-2009. Lower panel: Percentage changes of Exchange rate RSD/EUR in the period 2005-2009**

Table 1. **Descriptive statistics of daily returns for BELEX 15 and Exchange rate RSD/EUR in the period 2005-2009**

Variables	Num. of obs.	Mean	Mini-mum	Maxi-mum	St.De-viation	Coef. Of Variation	Skewness	Kurtosis
BELEX 15	957	-0.0003	-0.1100	0.1200	0.0186	-5563.9	0.1699	8.7442
Exchange rate RSD/EUR	957	0.00015	-0.0366	0.04909	0.0058	3803.3	0.2719	9.6568

Source: Authors calculations.

5. Methodology. Granger (1969) proposed a time series data-based approach to determine causality. In the Granger sense, *x* is the cause of *y* if it is useful in forecasting *y*. In this framework, "useful" means that *x* is able to increase the accuracy of the prediction of *y* with respect to a forecast, considering only past values of *y*. One other way Granger causality can be defined (1969) is as a method that determines the degree to which a current endogenous variable can be explained by past values of the variable and that determines whether the explanatory power can be improved by adding lagged values of another exogenous variable. If this is the case, the exogenous variable is said to Granger cause the endogenous variable. Granger causality is thus a powerful tool allowing to test for things that we might otherwise assume away or otherwise take for granted. There are 4 different types of the situations in which a Granger causality test can be applied:

- In a simple Granger causality test, there are 2 variables and their lags.
- In a multivariate Granger causality test, more than 2 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:

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

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 the test. This approach also allows for a determination of the causal direction of the relationships, as we can also estimate the "reverse" model:

$$X_t = \beta_0 + \sum_{j=1}^{J} \beta_j X_{t-j} + \sum_{k=1}^{K} \gamma_k Y_{t-k} + \mu_t. \quad (3)$$

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

Taking equation (2) as an example, the two-step procedure in testing whether BELEX 15 causes exchange rate RSD/EUR is as follows:

1. Exchange rate RSD/EUR is regressed on its past values excluding BELEX 15 in the regression. This is called the restricted regression, from which we obtain the restricted sum of squared residuals.

2. Therefore, the 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:

$$F = \frac{[(RSS_r - RSS_{ur})/k]}{RSS_{ur}/[n-2k-1]}, \quad (4)$$

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, *k* is the number of lags. The same procedure is used to test for the inverse Granger-causality relation in 2. Table 3 shows all types of causality relationships.

6. Results. The procedure for testing statistical causality between Serbian equity market index BELEX 15 and exchange rate RSD/EUR is the direct "Granger-causality" test proposed by Granger (1969). 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 exchange rate RSD/EUR values 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 causality estimations.

Table 2. **The values of the Pearson correlation coefficient r and the values of t test for its significance**

Variables	Coefficient of correlation r	t-test[1] of significance correlation coefficient	the margin value for t-test[2]
1. BELEX 15 and Exchange rate RSD/EUR	-0.068	-2.0494	from-1.960 to +1.960
2. Exchange rate RSD/EUR and BELEX 15	-0.064	-1.92724	from-1.960 to +1.960

[1] With the 0.05 significance level.
[2] This value depends of the number of observations or df in Student's t distribution table, which are in our cases for all indices pairs more then 450, so in Student's t distribution that appropriate to infinity for df values.
Source: Author's calculations.

The results obtained by the correlation shown in Table 2 illustrate the correlation of both pairs of negative connotations. Only t-test between BELEX 15 stock market index and middle exchange rate RSD /EUR gives a significant correlation rejecting the hypothesis on the lack of correlation between populations. Note the negative sign results from this test that only indicates the direction of the impact on the exchange rate RSD / EUR by BELEX 15 index. This means that the growth index values BELEX 15 leads to a reduction in the mean exchange rate RSD/EUR and vice versa. Impact of BELEX 15 index was expected and confirms that a negative sign when the economy strengthens over Serbia to strengthen the value of its shares, then a reduction in the value of European currency in relation to the national currency - the dinar.

Table 3. **Type of causal relationship and interpretation**

Equation	$T=\beta 1+\beta 2$	*Type of causal relationship*	*Interpretation*
Eq. 1	>0	positive	An increase in $x_{i,t}$ implies an increase in $y_{i,t}$ and vice-versa
Eq. 2	>0	positive	An increase in $y_{i,t}$ implies an increase in $x_{i,t}$ and vice-versa
Eq. 1	<0	negative	An increase in $x_{i,t}$ implies a decrease in $y_{i,t}$ and vice-versa
Eq. 2	<0	negative	An increase of $y_{i,t}$ implies a decrease in $x_{i,t}$ and vice-versa

Notes: A positive (negative) T implies that the causal relationship between past $x_{i,t}$ and present $y_{i,t}$ (eq. 1) or between past $y_{i,t}$ and present $x_{i,t}$ (eq. 2) is also positive (negative).

If the F-value exceeds the critical F-value at the chosen level of significance, the lagged BELEX 15 variable belongs in the regression.

The model was used to examine the Granger causal relationships between the variables under examination. As a testing criterion, the F-statistics was used. With the F-statistics, 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[4] is higher than the result from F-test, the causality exists. In the cases where the F-stat is smaller than or equal to the values from the F-test, the

[4] In all estimations, ROI is used (percent daily changes in the values of stock market and foreign exchange market).

causality does not exist. Table 5 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 4. **Optimal endogenous number of lags from information criteria**

Variables	OPTIMAL NUMBER OF LAGS Akaike Info Criterion (AIC)
1. BELEX 15 and Exchange rate RSD/EUR	7

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

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

BELEX 15 (X) and Exchange rate RSD/EUR (Y)				
Null Hypothesis: Lag(s): 7 (k)	Obs.	F-statistics	Probability	Decision
BELEX 15 does not Granger cause Exchange rate RSD/EUR	889	3.9222	0.00032	Reject
Exchange rate RSD/EUR does not Granger cause BELEX 15	889	3.4405	0.0012	Reject

Source: Authors' calculations.

In the case of the first pair of variables, BELEX 15 and the exchange rate RSD/EUR, the Granger causality test results indicate the existence of bidirectional causality (Table 5). This means that the first moves BELEX 15, a move that follows the exchange rate RSD/EUR but with a certain delay that depends on the number of lags and *k*, and vice versa. The results indicate the existence of the impact of stock market upon the foreign exchange market. This is confirmed by the empirical studies dealing with interactions between the two markets in developing countries (Fedorova and Saleem, 2008; Ulku and Demirci, 2011). The results also suggest that exchange rate RSD/EUR has impact on current or future movements of stock exchange indices BELEX 15 as expected, especially because the exchange rate in Serbia in recent years is subject to fluctuations and thus has impact on investment decisions regarding long-term portfolio investment.

7. Conclusion. The results also show that the foreign exchange market and stock market in Serbia are negatively correlated. This means that the increase in value index BELEX 15 is in proportion to the mean exchange rate RSD/EUR, which is expected given that the investment in shares (of) Serbian companies requires the conversion rates thus increasing (decreasing) demand rates.

In the case of testing the impact of capital market in Serbia upon Serbian foreign exchange market, paper found evidence of a two-way causation between capital markets and foreign exchange markets of Serbia (15 BELEX and exchange rate RSD/EUR).

The results of this study are important and interesting, from the temporal aspect. The research results obtained in this paper include the beginning and the culmination of the global financial crisis, which means that the indirect impact of the crisis was present in all the estimations.

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