Considerations on the relantionship between exchange rates and stock markets in Eastern Europe in time of crisis

Lupu, Dan and Asandului, Mircea

Alexandru Ioan Cuza University of Iasi, Alexandru Ioan Cuza University of Iasi

30 September 2014

CONSIDERATIONS ON THE RELATIONSHIP BETWEEN EXCHANGE RATES AND STOCK MARKETS IN EASTERN EUROPE IN TIME OF CRISIS[1]

Dan LUPU
Alexandru Ioan Cuza" University of Iasi
Carol 1 Bld., no 22
700505 Iasi, Romania
danlupu20052000@yahoo.com

Mircea Asandului
Alexandru Ioan Cuza" University of Iasi
Carol 1 Bld., no 22
700505 Iasi, Romania
mircea.asandului@uaic.ro

ABSTRACT

This paper investigates the relationship between exchange rates and stock markets for 4 East-European countries, using a sample of 3,500 daily returns during the period 2000-2014. The research method used is Bayesian VAR for the solution of degrees of freedom specific to the VAR technique and the increased forecast probability of economic variables. For the foreign exchange markets we found interdependence relationships between the exchange rates and the short-term capital markets, these relationships manifesting more strongly and in the long run during the economic crisis periods.

KEYWORDS: crisis, exchange rate, stock markets, interdependence, impulse functions, Eastern European countries

JEL classification: G01, G14, G15, G17.

Introduction

The financial crisis that started in 2008 threw the Eastern-European region into an extended period of exchange rate depreciations and decreases of the capital market with serious consequences for the real economy in the upcoming years. The crisis firstly broke out in the USA with strong drops in the stock markets and dollar in September 2008, and was shortly followed by the contagion of Europe. The decision policy makers in the countries affected by the crisis, such as Poland and the Czech Republic, had some time to react and take the adequate measures to protect their currencies. In turn, governments of Romania and Hungary did not take appropriate measures; they even initiated measures contrary to the economic trend making the crisis consequences even worse.

The relationship between the capital market and exchange rates is a topic of paramount importance for economists, international investors, and political decision makers (Moore, Wang, 2007). From the theoretical viewpoint the dynamic relationship between the capital markets and exchange rates gave birth to two models: on one hand, those oriented towards the exchange rates (they take into account the current account balance or the trade balance: the changes of the

[1] *Please cite as:* Lupu, D., Asandului, M. (2014), "Considerations on the Relationship between Exchange Rates and Stock Markets in Eastern Europe in Time of Crisis", *Transformations in Business & Economics*, Vol. 13, No 3C (33C), pp.430-445.

exchange rates influence international competitiveness and, thus, the incomes and the real production of the companies whose stocks react to the changes of the exchange rate; (Dornbusch, Fischer, 1980; Ma, Kao, 1990; Pavlova, Rigobon, 2007), and, on the other hand, the models oriented towards the capital markets (the decrease in stock price leads to the drop in the domestic investors' wealth which, in their turn, lead to the lower demand for loans followed by lower interest rates. Subsequently, lower interest rates discourage capital inputs determining currency depreciation, and, hence, the dynamics of the exchange rate could be affected by the movements in the capital markets (Dominguez, Frankel, 1993; Bahmani-Oskooee, Sohrabian, 1992; Granger *et al*., 2000).

According to the literature of reference, certain studies have been conducted in order to establish the relationship between the capital market and the foreign exchange rates, using different methodologies and data sets, but the results were not decisive (Hardoulevis *et al*., 2006). Moreover, the majority of this research has been performed on the periods when the stock markets operated under normal circumstances (Granger *et al*., 2000; Kim *et al*., 2005; Syriopoulos, 2007, Butt *et al*.,2010; Busch, 2011). The returns under the crisis conditions will be smaller and the volatility higher, leading to a greater correlation among the markets specified in this study.

The aim of this paper is to investigate the possible relationships between the foreign exchange rates and the stock market indices in Central and Eastern Europe and, namely, the short-term dynamic causality and the long-term balance correlations between exchange rates and stock prices in these four countries for the period January 2000 - April 2014, covering the EU adherence, and then the financial crisis from 2008. Initially it was intended to perform the analysis for all the Eastern European countries, but some of them have either adopted the Euro, or they have their currency in different fixed arrangements in relation to the Euro/dollar, so finally the analysis was undertaken in the Czech Republic, Hungary, Poland, and Romania.

Our study contributes to the literature in the following ways:

First, it examines the major Eastern European markets for a long time: from 2000 to 2014. While previous studies were based on developed countries, the interest of this study focuses on four CEE countries: the Czech Republic, Hungary, Poland, and Romania, which have undergone profound changes during the analysed period.

Secondly, this analysis, based on identifying structural breaks using the Bai-Perron test, tries to estimate the links between the two markets during periods of the economic growth or the economic crisis. This is possible by dividing the initial time series into subseries corresponding to the events with significant impact on the economy.

Thirdly, it has been researched whether a cointegration relationship exists between the two markets, and it has been proved that during the periods of crisis the two markets show a cointegration phenomenon. The long-term equilibrium relationship between the two markets involve expression spillover phenomena: the slowdown in the economy leads to the lower stock markets causing investors to withdraw their capital, and these withdrawals generate pressure on the exchange rate.

Fourth, the methodology used in this study is new when dealing with the Eastern European countries: Bayesian VAR and Impulse function of BVAR. Using BVAR model is motivated at least by the following reasons: traditional VAR methodology involves two statistical phenomena, namely, oversimplification and overfiting, but BVAR eliminates these shortcomings of the classical theory; the more frequent use in the literature of other methodologies than the traditional VAR; imposition of restrictions generated by the economic theory; influence of the national markets on EUROSTOCK 50 is not simultaneous, but is out of phase; greater accuracy in estimation of the results.

The rest of the paper is organized as follows: section 1 provides the analysis of the literature; section 2 explains the econometric methodology; section 3 presents the empirical results and contains the analysis of the results; whereas the last section draws the conclusions.

1. Literature Review

Much vaster literature has appeared at the attempt to analyse the relationship between the exchange rates and stock markets in the last decades (Aggarwal, 1981; Jorion, 1990; Bahmani-Oskooee, Sohrabian, 1992; Amihud, 1993; Ajayi, 1998; Granger *et al*., 2000; Smyth, Nandha, 2003; Moore, Wang, 2007; Lin, 2012; Andries *et al*., 2014). However, most of these studies were performed on the American market and present divergent results: some authors discover a significant positive impact of the dollar on the USA stock market; others find a bidirectional, short-term causality and not a stable, long-run relationship; while others discover that the real value of the dollar is negatively related to the stock index S&P500 by means of a long-term cointegration equation.

The second category of studies is represented by those that analyse the Asian markets, and, namely, those that appeared after the 1997 foreign exchange crisis (Ajayi *et al*., 1998; Granger *et al*., 2000; Phylaktis, Ravazzolo, 2005; Pan *et al*., 2007), where the authors obtained contradictory results in terms of the bivariate Granger causality: unidirectional causality from the stock markets to the exchanges rates in the developed countries still with no conclusive result for the emerging markets.

In their turn, the European stock markets benefited from the increased attention of researchers (Corhay *et al*., 1993; Dickinson, 2000; Kanas, 2000; Syriopoulos, 2007; Lupu, Asandului, 2014), still with non-decisive results, even in most cases, the cointegration relationships have been statistically supported. Moreover, some studies discovered that there is no cointegration relationship between the stock markets and foreign exchange rates (Choudhry, 1994; Fratzscher, 2002; Westerman, 2004).

Although stock markets in Central and East Europe have been known for the important growth, the studies related to them are extremely limited, and the results, as well as those previously mentioned, are rather ambiguous and contradictory (Dajčman, 2014). Jochum *et al*. (1999) analyse the East-European stock markets (the Czech Republic, Hungary, Poland) in relation to the United States of America and Russia for the period 1995-1998. Using the Johansen cointegration methodology, the authors find a short-term relationship between the markets during the pre-crisis period, which disappears when the stock market crisis occurs in Russia during the 3rd term of the year 1997, thus, noticing a massive change in the short-term market behaviour. In exchange Gilmore and McManus (2002) do not find any long-term relationship between the stock markets in the Czech Republic, Hungary, Poland, and the American markets; the Granger tests do not reveal causality among the Czech, Hungarian, and Polish markets and the USA market. Voronkova (2004) investigates the existence of some long-term cointegration relationships between the stock markets in the Czech Republic, Hungary, Poland and those from USA, Germany, France, and the UK and discovers that these markets show balance relationships with their mature peers proving that the Central European markets have become more integrated within the global markets. Stavárek (2004) analyses the relationship between the foreign exchange rates and the stock markets in the Czech Republic, Hungary, Poland, and Slovakia, EU countries (Austria, France, Germany, and the UK) and the USA, using monthly data for the period 1994-2004; the author does not find short or long-term relationships between these variables. Fedorova and Saleem (2010) investigate the period 1995-2008, on a weekly basis for the stock markets in Poland, Hungary, Russia, and the Czech Republic, and they reach the conclusions that in Hungary, the Czech Republic, and Russia there are significant effects between the two variables, whereas this does not exist in Poland.

2. Research Methodology

In the present study an autoregressive Bayesian vector, starting from the traditional VAR model will be estimated:

$$y_t=a_0+\sum_{l=1}^{p} A_l\ y_{t-1}+\varepsilon_t \qquad (1)$$

where yt is a vector m X 1 de t=1, ..., T observations of m variable time series, a0 is a vector of order m x 1 of the constants. Al is a m x m matrix of the regression coefficients for the position lag l, with p being the maximum number of lags.

If Y is defined as being the matrix of order T x 1 for which each dependent variable is separately presented in columns:

$$x_t=[1, y_{t-1}, ..., y_{t-p}] \qquad X=\begin{bmatrix} x_i \\ ... \\ x_t \end{bmatrix} \qquad B=\begin{bmatrix} a_0 \\ A_1 \\ ... \\ A_p \end{bmatrix} \qquad (2)$$

and β=vec(B), the traditional VAR model can be re-written under the Bayesian form:

$$y_{mTx1}=X_{Tx(mp+1)}B_{(mp+1)xm}+ET_{xm} \qquad (3)$$

Two time series are cointegrated even if they are not necessarily correlated, but there exists a linear combination between them that has a constant mean and variance; sooner or later they will return to the average value. It could be said that the two time series are in a steady long term relationship. Cointegration is the property of the non-stationary time series. The two integrated first order time series are cointegrated if a linear combination of them is stationary, although none of them is stationary.

If no cointegration relationship between the time series analysed is found, the following BVAR model is estimated for the first differences, each country, and each sub-period:

$$y_t=A_1y_{t-1}+A_2y_{t-2}+\ldots A_py_t\text{-}p+\varepsilon_t \qquad (4)$$

where Y = [Exch, Stock, Eurostock]; A1, Ap are matrices of order 3x3 and εt is an error vector of order 4x1. Exch, stock, and Eurostock are the returns of the logarithm time series of the series: exchange rates, stock exchange indices, and Eurostock50.

In order to apply BVAR, the exchange rate and the national stock are restricted from influencing at the same time the Eurostock50 stock market index, by imposing an exogenous block as follows:

$$A(l)y(t)= \varepsilon(t) \qquad (5)$$

where A(l) is a polynomial matrix of order 3x3 for the lag operator L, and ε(t) is a vector of order 4x1 of Bayesian anomalies.

$$y(t)=\begin{bmatrix} Ex_t \\ St_t \\ ESt_t \end{bmatrix} \quad A(l)=\begin{bmatrix} A_{11}[0][0] \\ A_{21}[A_{22}][0] \\ A_{31}[A_{32}][A_{33}] \end{bmatrix} \quad \varepsilon(t)=\begin{bmatrix} E_{1t} \\ E_{2t} \\ E_{3t} \end{bmatrix} \qquad (6)$$

where the hypothesis says that the errors are not correlated and that the A0 matrix indicators are non-singular. The imposition of an exogenous block is represented by the zero inputs in the matrix A (l), and implies that Eurostock50 is an exogenous variable for the exchange rates and stock indices in terms of simultaneity. These constraints reflect a likely supposition that the mature European markets are not simultaneously affected by the changes occurring within the East European exchange rates and the emerging stock markets is valid since the inverse relation. This is proved by the recent crises that occurred and their way of spreading: dot.com and subprime crisis occurred for the first time in the USA, and then due to the contagion effect they spread to the other countries. If this constraint has not been taken into consideration, it would lead to the non-adequate results of the impulse response function.

3. Long-Term Relations between Stock and Exchange Rates: VEC Model

In this section the different econometric tools used to develop this analysis will be presented. Within the empirical study will be used the daily data of the stock market indices and the foreign exchange rates in 5 countries in Central and East Europe: the Czech Republic (PX and Kruna), Hungary (BUX and Forint), Poland (WIG and Zlot), and Romania (BET and Leu), and as a control variable European Stock Exchange 50. The initial intention was to conduct a study on all the East European countries, but some of these adopted the Euro, whereas others went through different fixed listing regimes.

The daily data that have been analysed were collected from Bloomberg and Datastream covering the period 01.01.2000 - 30.04.2014; the values of the exchange rates, the stock market indices are for the closing and are expressed in the following manner: the exchange rate is presented as 1 Euro for x currency units for one country; and the return of the stock market is $r = (\log(\text{stock index}_t)-\log(\text{stock index}_{t-1})$. All the time series are expressed in logarithms, and in the case of BVAR the first difference operator is also applied to the time series.

The analysis procedure is the following: the test Bai Perron will be applied to identify the structural breaks and the analysis of sub-periods, and then the different descriptive statistics will be undertaken for these sub-periods, the ADF unit root test for the establishment of series stationary, then the Johansen cointegration procedure. From this point on, this analysis is divided into two complementary parts: if it is discovered that the series analysed are cointegrated, the VECM test is applied, and then the impulse response functions are computed; if the series are not cointegrated on a long term, the time series are differentiated, and the Bayesian VAR model is applied through the imposition of constraints for variables, and then the impulse response functions are applied.

Taking into account that the two crises occurred during the studied period, namely, dot.com and the 2007-2009 financial crisis, the existence of structural breaks will be estimated by using the Bai-Perron test. The maximum number of structural breaks is set at 5 and the shortest distance between two breaks is 50. *Table 1* shows the estimation results of the Bai-Perron test in the 5 countries and the 10 time series, respectively, stock market and exchange rate.

As it can be observed in *Table 1*, all the time series for the countries analysed present 4 structural breaks. It can be noticed in Table 1 that all the countries have the first structural break around the months of February and October of the year 2002, which suggests the end of the effects of the dot.com crisis. The second structural break is presented during the months of January - September 2005 (corresponding to the period following the EU adherence). The third structural break and the most important one is found during the period June - December

2008, which shows the contagion of these markets with the international markets, caused by the Lehman failure in mid-September. The last structural break belongs to the post-crisis period of recovery of stock markets occurring during the interval July 2010 - October 2011, when the national markets succeeded in getting back on track. The analysed series will be shared by using these structural breaks in 5 distinct sub-periods, namely, the dot.com crisis and its recovery (January 2000 - October 2002); the growth period and EU adherence (October 2002 - September 2005); the boom period of the markets just before the crisis (September 2005 - June 2008); the crisis and contagion period of the markets (June 2008 - July 2010), and the last period of recovery and post-crisis adjustment of the markets (July 2010 - April 2014).

Table 1. The estimation results of the Bai-Perron test for the returns of stock market and exchange rate series in Eastern European countries

	Break Test	F-statistic	Repartition	Break Test	F-statistic	Repartition
the Czech Republic	PX			KRUNA		
	0 vs. 1 *	5769.569	8/16/2002	0 vs. 1 *	11726.13	2/22/2002
	1 vs. 2 *	3798.596	1/25/2005	1 vs. 2 *	2492.024	8/08/2005
	2 vs. 3 *	230.0173	9/15/2008	2 vs. 3 *	2855.857	1/11/2008
	3 vs. 4 *	202.7550	8/09/2011	3 vs. 4 *	95.65965	2/14/2012
	4 vs. 5	0.000000		4 vs. 5	0.000000	
Hungary	BUX			HUF		
	0 vs. 1 *	15862.21	10/29/2002	0 vs. 1 *	5774.295	3/01/2002
	1 vs. 2 *	632.2976	2/14/2005	1 vs. 2 *	1448.743	2/22/2006
	2 vs. 3 *	462.5594	6/20/2008	2 vs. 3 *	176.8162	12/15/2008
	3 vs. 4 *	73.53987	8/09/2011	3 vs. 4 *	197.8955	9/14/2011
	4 vs. 5	0.000000		4 vs. 5	0.000000	
Poland	WIG			ZLOT		
	0 vs. 1 *	11707.85	7/23/2003	0 vs. 1 *	785.4316	10/16/2002
	1 vs. 2 *	3070.747	3/23/2006	1 vs. 2 *	1016.581	9/01/2005
	2 vs. 3 *	271.3232	6/10/2008	2 vs. 3 *	1678.830	12/11/2008
	3 vs. 4 *	1031.056	7/22/2010	3 vs. 4 *	125.3071	9/02/2011
	4 vs. 5	0.000000		4 vs. 5	0.000000	
Romania	BET			RON		
	0 vs. 1 *	9412.791	9/12/2002	0 vs. 1 *	5337.220	7/16/2002
	1 vs. 2 *	2584.061	1/05/2005	1 vs. 2 *	8155.057	2/08/2005
	2 vs. 3 *	1640.385	7/11/2008	2 vs. 3 *	3085.081	12/08/2008
	3 vs. 4 *	406.0316	7/26/2010	3 vs. 4 *	930.4885	10/14/2011
	4 vs. 5	0.000000		4 vs. 5	0.000000	
EUROSTOCK 50	0 vs. 1 *	2674.178	4/25/2002			
	1 vs. 2 *	1084.544	9/06/2005			
	2 vs. 3 *	2987.242	9/04/2008			
	3 vs. 4 *	15.98764	8/01/2011			
	4 vs. 5	0.000000				

Source: authors' calculations using Eviews7.

Table 2 presents the descriptive statistics for the exchange rates and stock market returns. It can be observed that during the 1st and 4th periods (recovery after crisis and crisis) the returns of the stock indices are negative for all the countries analysed, whereas during the growth periods the returns are positive. The returns of the exchange rates have the same features: positive values in times of growth and negative values during the crisis. Due to the strong variations between the daily values, the highest returns are found during the crisis period. As for the distribution, the time series are not normally distributed having the highest values of the Jarque Bera test during the crisis periods.

In order to set the time series stationary, the Augmented Dickey Fuller test (ADF) is used; its results are presented in *Table 3*. The series analysed in a logarithmic value for all the sub-periods are non-stationary in level 1, but they become stationary after applying the first difference operator. Therefore, all the series taken into consideration are I (1).

Table 2. Descriptive statistics for returns of exchange rate and stock markets in Eastern European countries

		Mean	Max.	Min.	Std. Dev.		Mean	Max.	Min.	Std. Dev.
Czech Republic	PX1	-0.00013	0.041785	-0.05909	0.014552	KRUNA1	-0.00029	0.014437	-0.02048	0.003253
	PX2	0.001288	0.037330	-0.06	0.011049	KRUNA2	-0.00416	0.013190	-0.0157	0.003640
	PX3	0.000103	0.080836	-0.06125	0.012755	KRUNA3	-0.0227	3.164956	-1.53308	0.327657
	PX4	-0.00024	0.123641	-0.16186	0.022894	KRUNA4	-0.00170	0.024815	-0.03275	0.005728
	PX5	-0.00029	0.042593	-0.06135	0.011451	KRUNA5	0.000153	0.040512	-0.01792	0.003708
Hungary	BUX1	-0.0003	0.060043	-0.06874	0.015427	HUF1	-0.00635	0.033069	-0.01949	0.003566
	BUX2	0.001410	0.043611	-0.05603	0.011878	HUF2	2.56E-05	0.047751	-0.01519	0.005023
	BUX3	0.000220	0.048660	-0.0538	0.014048	HUF3	-0.00462	0.019366	-0.02055	0.005075
	BUX4	-0.00615	0.131777	-0.12649	0.022752	HUF4	0.000174	0.050693	-0.03389	0.008611
	BUX5	-0.00024	0.055149	-0.06984	0.013898	HUF5	0.000207	0.019167	-0.03368	0.006269
Poland	WIG1	-0.00043	0.074041	-0.08468	0.015295	ZLOT1	-0.00724	0.041205	-0.02872	0.007701
	WIG2	0.001117	0.035059	-0.02954	0.010147	ZLOT2	2.05E-05	0.029931	-0.01768	0.005409
	WIG3	0.000555	0.044638	-0.06306	0.013397	ZLOT4	0.000391	0.041636	-0.0368	0.009891
	WIG4	-0.00031	0.060837	-0.08289	0.018371	ZLOT3	-0.00024	0.021280	-0.0189	0.004307
	WIG5	0.000305	0.041047	-0.06244	0.010821	ZLOT5	-0.00130	0.018197	-0.02791	0.004786
Romania	BET1	0.001768	0.145765	-0.09398	0.019420	RON1	0.000896	0.295866	-0.30465	0.019654
	BET2	0.001953	0.060578	-0.0514	0.011306	RON2	0.000310	0.021002	-0.02118	0.004329
	BET3	0.000290	0.053167	-0.11902	0.017159	RON3	-0.00013	0.109367	-0.0935	0.010776
	BET4	-0.00023	0.105645	-0.13117	0.026459	RON4	0.000361	0.032841	-0.03905	0.005558
	BET5	0.000224	0.061414	-0.08764	0.010550	RON5	5.30E-05	0.022763	-0.01347	0.003504
EUROSTOCK 50		-0.00041	0.064058	-0.0662	0.015370					
		-0.00098	0.070783	-0.06332	0.016255					
		3.33E-05	0.062584	-0.07593	0.011182					
		-0.00022	0.104376	-0.08208	0.020020					
		0.000131	0.058978	-0.06318	0.014216					

Source: authors' calculations using Eviews7, data from Datastream.

Table 3. ADF Results for returns of exchange rate and stock markets

		1	2	3	4	5
Czech Republic	PX	-23.37021	-27.50028	-26.68147	-25.21214	-21.919083
	KRUNA	-25.72113	-17.65318	-26.81389	-24.79320	-26.90839
Hungary	BUX	-24.80899	-26.25303	-26.67718	-20.77114	-24.96193
	HUF	-23.24669	-24.65699	-29.35046	-26.73925	-25.72256
Poland	WIG	-27.14196	-24.65668	-24.73482	-20.33318	-27.79038
	ZLOT	-20.34153	-28.62471	-27.82613	-20.62609	-30.21619
Romania	BET	-20.50497	-21.20325	-25.70127	-22.05196	-26.27264
	RON	-17.74633	-22.58455	-25.44160	-20.54502	-36.74621
EUROSTOCK 50		-10.855061	-13.441357	-12.866287	-8.569358	-9.836505

Source: authors' calculations using Eviews7.

Taking into account that all the series are I (1), the cointegration relationships in a long-term of using the Johansen procedure are tested. In order to examine the long-run compatibility between the returns of the stock market indices and the exchange rates, the cointegration relationships between the two variables will be verified. If the exchange rates influence the stock returns in a cointegration relationship, the Vector Error Correction Model (VECM) can be used to test this correlation. If the time series are not cointegrated, this implies that the two variables may vary in such a way that there is no correlation between them on a long term, and that the forecasts for the two markets can be significantly different. The Johansen cointegration test enables testing the cointegration relationship with an unknown number of cointegration vectors estimating both the cointegration vectors and the number of cointegration relationships. As there is a system of two series I (1), the results will show a cointegration relationship at the most.

Table 4 presents p-value and the number of cointegration equations for the Johansen test within the equation system between the exchange rates and the stock markets indicators for each country and each sub-period. As it can be noticed, there are no cointegration relationships on a long term between the two variables analysed in Poland (a potential explanation could be a strong and relatively independent economy of this country); there are cointegration relationships in the other countries: a single cointegration relationship during the crisis in the Czech Republic; two cointegration relationships during the crisis and post-crisis in Hungary; three cointegration relationships before the crisis, during the crisis, and post-crisis in Romania. It can be observed that during the first periods P1 and P2, there are no cointegration relationships between the indicators under study, since the markets behaved independently during the growth periods.

The results obtained from the Eastern European countries are similar to those obtained by Climent and Meneu in 2003 and Guo *et al* in 2011, using as a basic research study the USA and the Asian countries; when the stock markets are in full crisis, the returns will be smaller and the volatility will be higher, whereas the correlation between markets tends to be higher. In other words, the correlations between the foreign exchange and the stock markets are strengthened during the unstable periods.

Table 4. Johansen Cointegration between returns of exchange rate and stock market series

	1		2		3		4		5	
	No. EqC	p-value	No. EqC	p-value	No. EqC	p-value	No. EqC	p-value	No. EqC	p-value
Czech Republic	None	0.7425	None	0.1293	None	0.4668	None *	0.0306	None	0.2081
Hungary	None	0.7589	None	0.3620	None	0.2493	None *	0.0023	None *	0.0426
Poland	None	0.9154	None	0.2702	None	0.1536	None	0.3026	None	0.1484
Romania	None	0.4013	None	0.0629	None *	0.0247	None *	0.0221	None *	0.0175

Notes: Trace test indicates 1 cointegrating equation(s) at the 0.05 level. * denotes rejection of the hypothesis at the 0.05 level. **MacKinnon-Haug-Michelis (1999) p-values.

Source: authors' calculations using Eviews7.

The analysis will continue with the development of some VECM models for the countries and sub-periods, for which cointegration relationships have been found. *Table 5* presents the results of the models developed. The VECM estimation for the analysed series leads to the conclusive results: the estimated coefficients used to reveal the long-term balance are statistically significant in all the models and for all the sub-periods; the foreign exchange rates and the stock markets are connected in a long-term equilibrium relationship, and the changes in the exchange rates transfer to the stock markets and the other way round; the relationship between the national and European markets is in all cases negative (one's

increase leads to another one's decrease); the relationship between the stock exchange and the foreign exchange rates is either positive (for Hungary and Romania during the 3rd and 4th periods), or negative (for the Czech Republic during the crisis period and for Romania during the post-crisis period: the decline of the stock market leads to the increase of the foreign exchange rates).

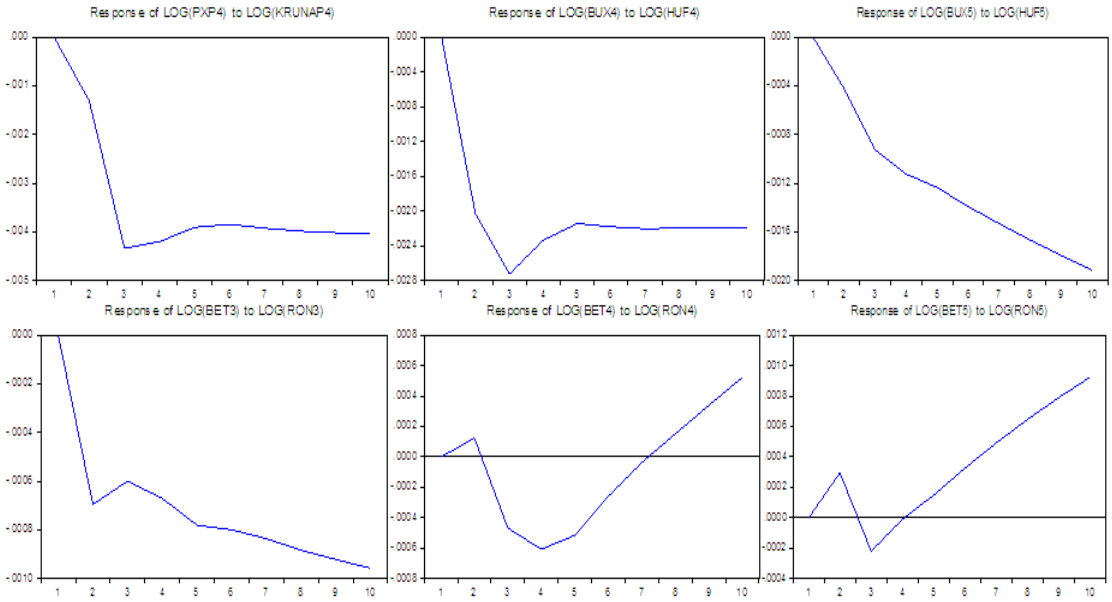
Table 5. Results of the VEC Model for returns of exchange rate and stock market series

		Stock $_{t-1}$	Stock $_{t-2}$	Exch $_{t-1}$	Exch $_{t-2}$	EuroStock $_{t-1}$	EuroStock$_{t-2}$	R^2
Czech Republic	PX4	-0.10945 (0.05302)	-0.15525 (0.05155)	-0.08832 (0.16193)	-0.52976 (0.15930)	0.290433 (0.06168)	0.055552 (0.06199)	0.07801
	KRUNA4	0.057690 (0.01347)	0.011415 (0.01310)	0.001731 (0.04114)	0.079849 (0.04047)	-0.0617 (0.01567)	0.007819 (0.01575)	0.04942
	EST4	-0.09191 (0.04682)	-0.09892 (0.04553)	-0.04012 (0.14301)	-0.18571 (0.14069)	0.042297 (0.05447)	-0.02652 (0.05475)	0.05853
Romania	BET3	0.111335 (0.03432)	-0.04625 (0.03367)	-0.04541 (0.05468)	0.013917 (0.05465)	0.190394 (0.05601)	0.081340 (0.05606)	0.06731
	RON3	-0.02254 (0.02098)	-0.03673 (0.02058)	-0.34129 (0.03343)	-0.21661 (0.03341)	0.012264 (0.03424)	-0.01488 (0.03427)	0.12451
	EST3	0.007556 (0.02178)	-0.033 (0.02137)	-0.01772 (0.03470)	-0.02721 (0.03468)	-0.11827 (0.03555)	0.058642 (0.03558)	0.02123
	BET4	-0.06679 (0.04697)	-0.03705 (0.04489)	0.150974 (0.20615)	-0.20051 (0.20580)	0.378272 (0.05571)	0.086455 (0.05753)	0.08598
	RON4	0.010442 (0.01006)	0.022819 (0.00962)	0.107745 (0.04416)	-0.00463 (0.04408)	-0.02788 (0.01193)	-0.00527 (0.01232)	0.04924
	EST4	0.002604 (0.03904)	-0.04876 (0.03731)	0.174676 (0.17135)	-0.24245 (0.17106)	-0.02886 (0.04630)	-0.10271 (0.04782)	0.04222
	BET5	0.090787 (0.03326)	0.003282 (0.03340)	0.055369 (0.10085)	-0.16619 (0.10098)	-0.09515 (0.02582)	-0.02601 (0.02593)	0.09589
	RON5	-0.02188 (0.01125)	0.010459 (0.01130)	-0.22745 (0.03413)	-0.01081 (0.03417)	0.007096 (0.00874)	0.008893 (0.00878)	0.06274
	EST5	-0.07394 (0.04541)	0.018765 (0.04559)	0.167093 (0.13768)	0.194242 (0.13784)	0.024782 (0.03525)	-0.07044 (0.03540)	0.01234
Hungary	BUX4	0.004701 (0.05162)	-0.0704 (0.05114)	-0.26637 (0.11308)	-0.16075 (0.11179)	0.049801 (0.06151)	-0.14738 (0.06073)	0.04654
	HUF4	-0.03234 (0.01932)	0.004254 (0.01914)	-0.02382 (0.04233)	-0.01508 (0.04184)	-0.02724 (0.02302)	0.069408 (0.02273)	0.06850
	EST4	0.053603 (0.04364)	-0.01515 (0.04323)	-0.21004 (0.09560)	-0.13629 (0.09451)	-0.11116 (0.05200)	-0.13113 (0.05134)	0.05701
	BUX5	0.054715 (0.04906)	0.084792 (0.04921)	-0.04206 (0.09152)	-0.11062 (0.09086)	-0.01894 (0.04668)	-0.15033 (0.04666)	0.04246
	HUF5	-0.055 (0.02235)	-0.01036 (0.02242)	-0.04388 (0.04169)	0.026261 (0.04139)	-0.00696 (0.02126)	0.029935 (0.02125)	0.02172
	EST5	0.072621 (0.05236)	0.024968 (0.05251)	0.015916 (0.09767)	-0.12084 (0.09697)	-0.04888 (0.04982)	-0.07402 (0.04979)	0.01822

Source: authors' calculations using Eviews7.

The impulse response function as an econometric technique was used to investigate the short-term impact (up to one year), caused by the autoregressive vector when it received some impulses. The impulse response function describes the response of errors to the endogenous variables, more precisely the future responses of the endogenous variables to the disturbing influence term. The impulse response function shows that the Kruna variations in the Czech Republic have a negative immediate effect on the PX stock market index which reaches a maximum on the third day (-0.04) and it remains negative until the 10th day (-0.004). The variations of the Forint in Hungary during the period 4 lead to the stock market decline for 3 periods, when it reaches the minimum of -0.002, after which it has growth

effects, and from the period 8 the impact is also positive; during the period 5 the Forint variations lead to the continuous drop of the stock market. The Leu variations in Romania during the period 3 lead to continuous decreases of the BET stock index; during the period 4 the Leu variations initially lead to BET increases until the 2nd day, then to the decrease with a minimum of -0.00061 on the 4th day, and then again increases, so that on the 8th day it becomes positive again; during the period 5 there is initially a BET increase to 0.000296, until the 2nd day, then it drops the following day at a minimum of -0.00022, and afterwards an increase occurs reaching a positive value on the 4th day.



Source: authors' calculations using Eviews7.

Figure 1. **VECM Impulse Responses for Returns of Exchange Rates and Stock Markets**

5. Short-Term Relations between Stock and Exchange Rates: a Bayesian VAR

The relationship between the two variables by means of the Bayesian VAR will be analysed for the sub-periods, when no long-term cointegration relationships occur between the stock markets and foreign exchange rates.

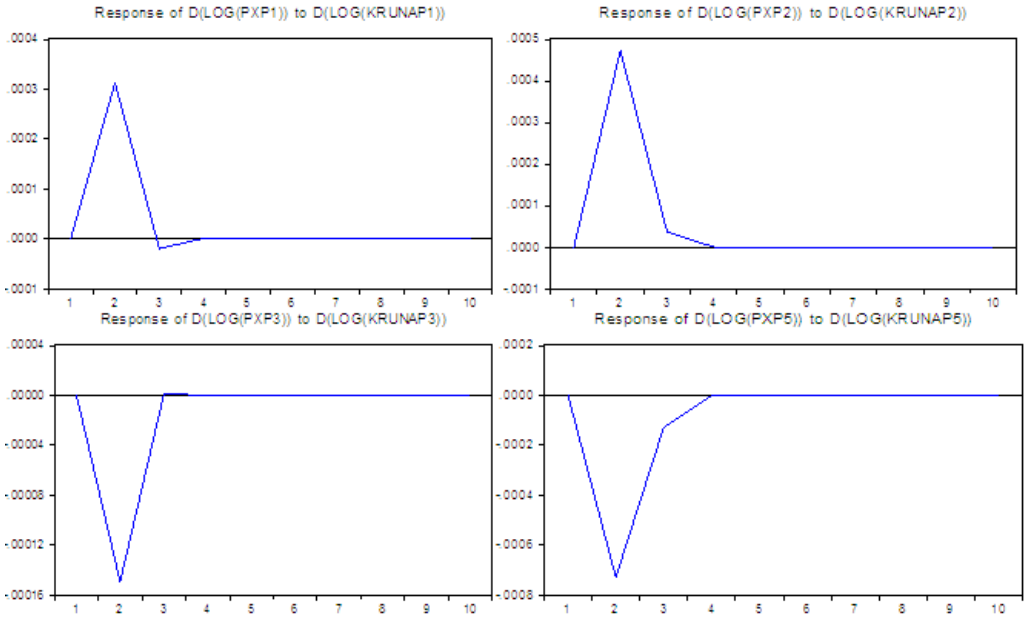
The relationship between the analysed indicators in the Czech Republic is positive for the first two periods: the stock markets and the foreign exchange rates vary in the same direction; the relationship is negative for the periods 3 and 5: the decrease in the foreign exchange rate leads to the increase of a stronger stock market during the recovery period rather than during the crisis period. Hungary manifests stock market increases at the Forint variation during two periods, followed by stock market drops and for another period the inverse variation relationships. The Zlot variations in Poland during the crisis period 1, 4, and 5 lead to the drops of the stock market index, while during the growth periods 2 and 3 the exchange rates and the stock markets vary in the same direction.

As it can be noticed from the following figures, each East European country under analysis manifests during the respective sub-periods; the two types of behaviours specific to the markets: the first one is characterized by the premise that a shock in the national currency variation leads to the increase of the stock market (this is in compliance with the "portfolio" type approach of the relationship between stock markets and foreign exchange rates, which

suggests that the stock market leads the foreign exchange with a positive correlation), and the second type which is characterized by a shock in the variation of the national currency leading to an initial drop of the stock market, followed by subsequent positive changes (this is in accordance with the traditional approach of the relationship between the two variables suggesting that the foreign exchange rates lead the stock market).

Despite all this, the sign of the correlation can exist in one way or the other, in accordance with the real position of the respective country at the moment of the shock occurrence, namely, depending whether it is a net currency exporter or importer. The net effect on the aggregate stock index cannot be a priori determined, and as a consequence the sign can be positive or negative (Granger *et al*., 2000). The results that have been obtained so far are similar to the ones obtained by other authors researching developed markets (Granger *et al*., 2000; Goldstein *et al*., 2000; Caporale, 2014) or even East-European markets (Stavárek, 2004; Poshakwale, Murinde, 2001; Fedorova, Saleem, 2010).

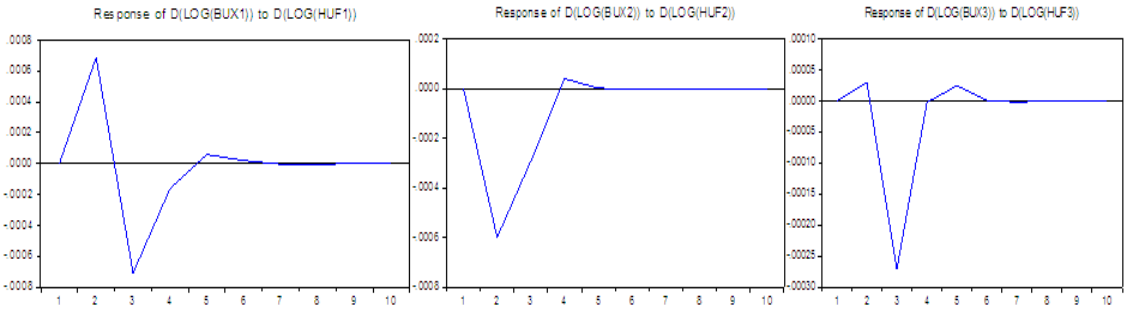
The impulse response function for the Czech Republic in the 1st and 2nd period shows that the Kruna variations have an immediate positive impact on the PX stock market index which reaches its maximum on the second day (0.000311), and then it drops until the 4th day, when it reaches the level zero and with no effects in the future. IRF for the periods 3 and 5 implies that the Kruna variations have an immediate negative effect on the stock market reaching minima of -0.00014 and -0.0007 on the second day, and then the shock effects are mitigated and the stock market recovers on the 3rd and 4th day.



Source: authors' calculations using Eviews7.

Figure 2. **Impulse Responses for Returns of Czech Kruna, and PX**

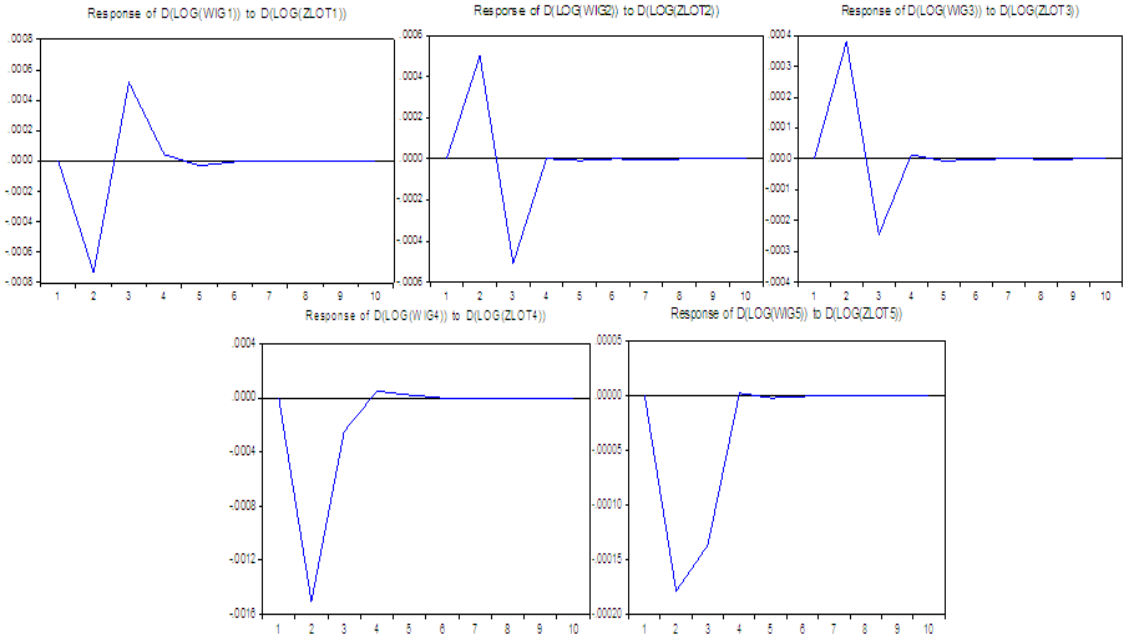
The Forint and BUX vary positively together in ***Hungary*** on the first two days during the 1st and 3rd period, and then on the 3rd day it drops to negative values of -0.00071 and -0.00027, so that the stock markets should start growing and obtain positive values on the 5th day (5.95E-05 and 2.47E-05), the initial shock manifesting itself towards zero on the following days. The 2 growths, the exchange rate, and the capital market varies in the opposite direction during the periods: initially due to the Forint shock, BUX starts to drop until the 2nd day to -0.0006, and afterwards it starts to recover and grow.



Source: authors' calculations using Eviews7.

Figure 3. **Impulse Responses for Returns of Hungarian Forint and BUX**

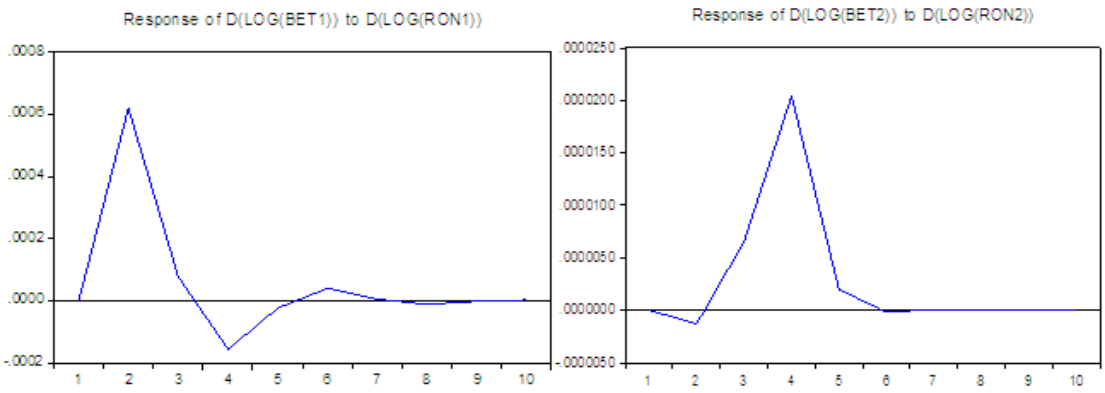
The Zlot variations in ***Poland*** during the crisis period 1, 4, and 5 lead to decreases of the stock market index, while during the growth periods 2 and 3 the exchange rates and the stock market vary in the same direction.



Source: authors' calculations using Eviews7.

Figure 4. **Impulse Responses for Returns of Polish Zlot and WIG**

In ***Romania*** during the periods 1 and 2, to an initial RON shock, there is a BET growth until the 2nd day, and the 4th day, respectively, and then decreases until negative values take place on the 4th day or null values on the 6th day.



Source: authors' calculations using Eviews7.

Figure 5. **Impulse Responses for Returns of Romanian Leu and BET**

Conclusions

The study provides new empirical results in the analysis of the interaction between the exchange rate and the capital market for 4 East European countries, namely, the Czech Republic, Hungary, Romania, and Poland taking into consideration the period of 15 years: January 2000 – April 2014. The used method in the analysis was the Bayesian VAR, so that better results should be obtained in the estimation of regression by means of imposing constraints based on economic phenomena.

The analysis started with testing of the existence of some structural breaks, taking into account the occurrence of the 2008 financial crisis; the data series were distributed in four specific lags corresponding to a certain phenomenon at a global level.

The results of this research are similar to those obtained by the other authors (Climent, Meneu, 2003). The main discovery is that during the crisis the exchange rate and stock market tend to be cointegrated for 3 of the 4 considered countries. Poland is the country for which the two variables are not cointegrated, which can be explained by the strength of its economy and stock market.

In the case of the Czech Republic, Hungary, and Romania, the Bayesian VAR model was tested, for which the following condition has been imposed: the lack of contemporary reaction of the European markets to the shock of the local stock market. The results are similar to those obtained by the other authors (Guo *et al*., 2011): the variations of the stock market cause instantaneous shocks on the exchange rate, either positive or negative, and on growth or recovery after the crisis, according to the economic period studied. In their turn, these variations do not last more than three days in all Eastern European countries; after this period the markets recover and assimilate the initial shock.

The main findings are as follows: in the countries where the economy and the stock market are less developed and external shocks have influence, there exists cointegration relationships between the exchange rate and stock market; in the countries that have a strong economy such relationship does not exist because the stock market is not sensible to external shocks. Moreover, in tranquil times the "stock approach" theory manifests for the analysed countries, meanwhile in periods of economic crisis the "flow approach" theory is accepted.

References

Aggarwal, R. (1981), "Exchange-rates and stock-prices-A Study of the United-States Capital-Markets under Floating exchange-Rates", *Akron Business and Economic Review*, Vol. 12, No 3, pp.7-12.

Ajayi, R.A., Friedman, J., Mehdian, S.M. (1999), "On the relationship between stock returns

and exchange rates: tests of Granger causality", *Global Finance Journal*, Vol. 9, No 2, pp.241-251.

Amihud, Y. (2002), "Illiquidity and stock returns: cross-section and time-series effects", *Journal of financial markets*, Vol. 5, No 1, pp.31-56.

Andries, A.M., Ihnatov, I., Tiwari, A.K. (2014), "Analyzing time-frequency relationship between interest rate, stock price and exchange rate through continuous wavelet", *Economic Modelling*, Vol. 41, pp.227-238.

Bahmani-Oskooee, M., Sohrabian, A., (1992), "Stock prices and the effective exchange rate of the dollar", *Applied economics*, Vol. 24, No 4, pp.459-464.

Busch, T., Christensen, B.J., Nielsen, M.Ø. (2011), "The role of implied volatility in forecasting future realized volatility and jumps in foreign exchange, stock, and bond markets", *Journal of Econometrics*, Vol. 160, No 1, pp.48-57.

Butt, B.Z., Rehman, K.U., Azeem, M. (2010), "The causal relationship between inflation, interest rate and exchange rate: the case of Pakistan", *Transformation in Business & Economics*, Vol. 9, No 2, pp.95-103.

Choudhry, T. (1994), "Stochastic trends and stock prices: an international inquiry", *Applied Financial Economics*, Vol. 4, No 6, pp.383-390.

Climent, F., & Meneu, V. (2003). "Has 1997 Asian crisis increased information flows between international Markets". *International Review of Economics & Finance*, *12*(1), pp.111-143.

Corhay, A., Tourani Rad, A., Urbain, J.P. (1993), "Common stochastic trends in European stock markets", *Economics Letters*, Vol. 42, No 4, pp.385-390.

Dajčman, S., Kavkler, A., Festić, M. (2013), "Long-range dependence in the returns of three Central and Eastern European stock markets-a time-varying analysis", *Transformation in Business & Economics*, Vol. 12, No 1, pp.206-220.

Dickinson, D.G. (2000), "Stock market integration and macroeconomic fundamentals: an empirical analysis, 1980-95", *Applied Financial Economics*, Vol. 10, No 3, pp.261-276.

Dominguez, K.M., Frankel, J.A. (1993), "Does foreign-exchange intervention matter? The portfolio effect", *The American Economic Review*, Vol. 83, No 5, pp.1356-1369.

Dornbusch, R., Fischer, S. (1980), "Exchange rates and the current account", *The American Economic Review*, Vol. 70, No 5, pp.960-971.

Fedorova, E., Saleem, K. (2010), "Volatility spillovers between stock and currency markets: Evidence from emerging Eastern Europe", *Czech Journal of Economics and Finance*, Vol. 60, No 6, pp.519-531.

Fratzscher, M. (2002), "Financial market integration in Europe: on the effects of EMU on stock markets", *International Journal of Finance & Economics*, Vol. 7, No 3, pp.165-193.

Gilmore, C.G., McManus, G.M. (2002), "International portfolio diversification: US and Central European equity markets", *Emerging Markets Review*, Vol. 3, No 1, pp.69-83.

Granger, C.W., Huangb, B.N., Yang, C.W. (2000), "A bivariate causality between stock prices and exchange rates: evidence from recent Asianflu", *The Quarterly Review of Economics and Finance*, Vol. 40, No 3, pp.337-354.

Guo, F., Chen, C. R., & Huang, Y. S. (2011). Markets contagion during financial crisis: A regime-switching approach. *International Review of Economics & Finance*, *20*(1), pp95-109.

Hardouvelis, G.A., Malliaropulos, D., Priestley, R. (2006), "EMU and European Stock Market Integration", *The Journal of Business*, Vol. 79, No 1, pp.365-392.

Jochum, C., Kirchgässner, G., Platek, M. (1999), "A long-run relationship between Eastern European stock markets? Cointegration and the 1997/98 crisis in emerging markets",

Weltwirtschaftliches Archiv, Vol. 135, No 3, pp.454-479.

Jorion, P. (1991), "The pricing of exchange rate risk in the stock market", *Journal of Financial and Quantitative Analysis*, Vol. 26, No 3, pp.363-376.

Kanas, A. (2000), "Volatility spillovers between stock returns and exchange rate changes: international evidence", *Journal of Business Finance & Accounting*, Vol. 27, No 3-4, pp.447-467.

Kim, S.J., Moshirian, F., Wu, E. (2005), "Dynamic stock market integration driven by the European Monetary Union: An empirical analysis", *Journal of Banking & Finance*, Vol. 29, No 10, pp.2475-2502.

Lin, C.H. (2012), "The comovement between exchange rates and stock prices in the Asian emerging markets", *International Review of Economics & Finance*, Vol. 22, No 1, pp.161-172.

Lupu, D., Asandului, M. (2014), "Exchange rate and trade: J-curve in European Union", *Acta Universitatis Danubius. OEconomica*, Vol. 10, No 3, pp. 136-145.

Ma, C.K., Kao, G.W. (1990), "On exchange rate changes and stock price reactions", *Journal of Business Finance & Accounting*, Vol. 17, No 3, pp.441-449.

Moore, T., Wang, P. (2007), "Volatility in stock returns for new EU member states: Markov regime switching model", *International Review of Financial Analysis*, Vol.16, No 3, pp.282-292.

Pan, M.S., Fok, R.C. W., Liu, Y.A. (2007), "Dynamic linkages between exchange rates and stock prices: Evidence from East Asian markets", *International Review of Economics & Finance*, Vol. 16, No 4, pp.503-520.

Pavlova, A., Rigobon, R. (2007), "Asset prices and exchange rates", *Review of Financial Studies,* Vol. 20, No 4, pp.1140–1181.

Phylaktis, K., Ravazzolo, F. (2005), "Stock market linkages in emerging markets: implications for international portfolio diversification", *Journal of International Financial Markets, Institutions and Money*, Vol. 15, No 2, pp.91-106.

Poshakwale, S., & Murinde, V. (2001). "Modelling the volatility in East European emerging stock markets:

evidence on Hungary and Poland". *Applied Financial Economics*, *11*(4), pp.445-456.

Smyth, R., Nandha, M. (2003), "Bivariate causality between exchange rates and stock prices in South Asia".

Applied Economics Letters, Vol. 10, No 11, pp.699-704.

Stavarek, D. (2004), "Linkages between stock prices and exchange rates in the EU and the United States", *Economics Working Paper Archive,* pp.1-36.

Syriopoulos, T. (2007), "Dynamic linkages between emerging European and developed stock markets: has the EMU any impact?", *International Review of Financial Analysis*, Vol. 16, No 1, pp.41-60.

Voronkova, S. (2004), "Equity market integration in Central European emerging markets: A cointegration analysis with shifting regimes", *International Review of Financial Analysis*, Vol. 13, No 5, pp.633-647.

Westermann, F. (2004), "Does the Euro affect the dynamic interactions of stock markets in Europe? Evidence from France, Germany and Italy", *The European Journal of Finance*, Vol. 10, No 2, pp.139-148.