Journal of Applied Finance & Banking, vol. 3, no. 2, 2013, 109-121
ISSN: 1792-6580 (print version), 1792-6599 (online)
Scienpress Ltd, 2013

Regional and International Causal Linkages. Evidence from CEE Stock Markets

Ovidiu Stoica[1] and Delia-Elena Diaconașu[2]

Abstract

This study examines the dynamic linkages between nine Central and Eastern European (CEE) emerging markets and the developed ones, i.e. Austrian, French, German, British and American stock markets. To investigate the nature of transmission of information we employ two econometric models which are estimated in framework of maximum likelihood, GARCH, and vector autoregression. Our findings suggest that there exist some reaction from CEE markets to the arrival of price innovations from the developed markets, but the nature of these reactions and responses is mixed. However, U.S. and Austrian markets exert a higher impact over the CEE analyzed ones, meaning that the shocks from international and regional leaders are greater than those from continental leaders over the CEE emerging markets. In addition, we found that the national market price innovations account for more of the error variance while developed markets' price innovations account for less of the forecast error variance.

JEL classification numbers: G14, F21
Keywords: price innovation, emerging stock markets, market linkages, Central and Eastern Europe

[1]Faculty of Economics and Business Administration, "Alexandru Ioan Cuza" University of Iasi, Romania,
e-mail: ostoica@uaic.ro
[2]Faculty of Economics and Business Administration, "Alexandru Ioan Cuza" University of Iasi, Romania,
e-mail: delia_diaconasu@yahoo.com

Article Info: *Received :* November 3, 2012. *Revised :* November 30, 2012.
Published online : March 1, 2013

1 Introduction

National financial systems, whether are based on financial markets or banks suffer in the context of globalization various mutations, by strengthening the linkages between financial markets internationally, the development of the latter occurring in the same time but in different degrees The importance of how markets influence one another is important in the determination of pricing, hedging, trading strategies and regulatory policy of financial markets, on the one hand and is important for governments, businesses and investors to manage the ripple effect of a global financial crisis, on the other hand.

The purpose of this paper is to investigate the dynamic linkages between several Central and Eastern European (CEE) emerging stock markets and the regional, continental and international leaders, namely, the Austrian, German, French, British and U.S. stock markets. The CEE emerging markets analyzed in this paper are: Czech Republic, Hungary, Poland, Slovakia, Slovenia, Bulgaria, Romania, Republic of Croatia and Republic of Macedonia.

The first motivation for choosing these markets is the progress in regional integration of capital markets at European level under various aspects: strategy of establishing links (NOREX) strategies for mergers (Euronext) and acquisitions (CEESEG) and progress in terms of strengthening the global position of the European markets (NYSE-Euronext and NASDAQ-OMX). Secondly, Vienna Stock Exchange is the largest financial market in the region in terms of liquidity, NYSE Euronext Paris and Deutsche Börse are the largest financial market in Europe in terms of capitalization and London Stock Exchange and New York Stock Exchange are the largest international financial centers. Thirdly, we have chosen the markets that joined EU in 2004 along with the ones that joined EU in 2007 and the EU candidates to analyze the difference between three categories of European stock markets. The analysis interval is between July 1, 2001 and December 31, 2010 for all indices.

Should not be overlooked the fact that CEE suffered profound economic transformations during the last two decades. After the collapse of communist equity exchanges have been re-established in the region beginning with Ljubljana Stock Exchange on March 29, 1990, and continuing with other markets, by now these markets displaying considerable growth in their size and in their degree of sophistication. In addition, the accession to EU of these countries on May 1, 2004 and on January 1, 2007, gave a big boost to these markets, attracted more and more interest and in present they play an important role in the international financial environment. Therefore even if these markets are small compared to the stock exchanges of the worldwide largest countries, in terms of listed companies, market capitalization and turnover value, it is important to understand the relationship between these, since the contribution of emerging markets to internationally diversified portfolios has grown substantially.

The results suggest that the CEE emerging markets are poorly integrated with the developed ones. However, we found that U.S. and Austrian market exercise a higher impact over the CEE analyzed ones, than French, German or British markets.

The rest of the paper proceeds as follows. Section 2 consists of literature review. Section 3 explains the data and the methodology used. Section 4 discusses the empirical results. Section 5 concludes.

2 Literature Review

In the literature in the field the relations between stock markets is very large. Some studies (Ozdemir, 2009) show that causality runs from S&P500 to stock prices of the 15 emerging markets, but not vice-versa. In the same direction Diamandis (2009) demonstrated that there is one long-run relationship between four Latin America stock markets and the US, while the relationship between other developed markets than US is emphasized by Chong et al. (2008). Studies such as ones by Baur and Jung (2006), Edwards and Susmel (2001) and Rezayat and Yavas (2006) have found that the US equity market is most dominant equity market in the world, affecting both the developed and developing markets. Phylaktis and Ravazzolo (2005) suggest that the relaxation of the restrictions might have strengthened international market interrelations.

Closely with EMU, Wälti (2011) demonstrate on a panel of fifteen developed economies over the period 1975–2006, that monetary integration leads to stronger stock market synchronization, both through the elimination of exchange rate volatility and through the common monetary policy and the convergence of inflation expectations. Cifarelli and Paladino (2005) found that in euro stock markets return behavior is changing and stock markets within the Euro zone are starting to drift apart. In contrast, Syriopoulos (2007) highlight the fact that in both a pre- and a post-EMU sub-period there is evidence of market co movements towards a stationary long-run equilibrium path.

An important place is occupied by studies on the CEE markets' linkages. In this sense, Serwa and Bohl (2005) find modest evidence of significant instabilities in cross-market linkages after the crises and the fact that Central and Eastern European stock markets are not more vulnerable to contagion than Western European markets.

Syllignakis and Kouretas (2010) reveal that the financial linkages between the CEE markets and the world markets increased with the beginning of the EU accession process Syriopoulos and Roumpis (2009) support this idea that the Balkan stock markets are seen to exhibit time-varying correlations as a peer group, although correlations with the mature markets remain relatively modest. Also in this regard, Li and Majerowska (2008) demonstrate limited interactions among the markets; the emerging markets (Warsaw and Budapest) are weakly linked to the developed markets (Frankfurt and the U.S), while Gilmore, Lucey and McManus (2005) found no robust co integration relationship between the UK, the German and Central European stock markets (Hungary, Poland, Czech Republic). Not least, Égert and Kocenda (2009) find very little systematic positive correlation between German and French markets and emerging stock markets and the fact that Hungary exhibits higher correlation with the developing markets and the emerging markets and its dynamics show an increasing trend.

In contrast, Lucey and Voronkova (2008) found the long-term financial integration of second-round acceding and candidate countries' with the European Union and the US stock markets during the Accession Process. Voronkova (2004) concludes that the emerging markets have become increasingly integrated with the world markets and shows the existence of long-run linkages between the UK, the German, and the French and Central European stock markets (Hungary, Poland, Czech Republic) using daily data for the period 1993–2002. Harrison and Moore (2009) find that there are spillover effects between the U.K. and Germany European equity markets, but they observe that these western equity markets influence Central and Eastern European with different degree. Büttner and Hayo (2010) demonstrate that the highest correlations exist between Hungary and Poland in foreign exchange and stock markets. Related to Russian crisis, Olgun and

Ozdemir (2008) found that the Hungarian market was the most sensitive to the Asian and Russian crises, and the Czech market the least, an outcome that may be explained by the fact that the Hungarian market had the highest foreign share ownership level and the Czech market the lowest, while Lim (2009) notes that EU equity shocks have had an increased influence on CEE markets since 1998, but that the Russian market remains isolated from EU influences.

Our study, as far as we know, takes into account for the first time the markets that joined EU in 2004 along with the ones that joined EU in 2007 and the EU candidates and emphasize the differences in interdependencies between these and the developed ones, on one hand, and the influence of regional CEE, continental and international leaders over the above mentioned, in order to highlight the difference in the degree of regional integration or globalization on these, on the other hand.

3 Data and Methodology

3.1 Hypothesis

Using daily indices of fourteen markets i.e., five leaders (regional, continental and international) and nine CEE emerging markets, we want to check which of the developed markets exert a higher impact on the emerging ones. The main hypothesis is that the price innovation from regional, continental and international leaders on capital markets has the same impact on the CEE emerging markets. This issue derives from the fact that some recent studies are contradictory in the sense that some points the existence of strong links between CEE emerging capital markets and the world leaders - Özdemir et al. (2009); Syriopoulos (2007); Syllignakis and Kouretas (2010), while other emphasizes the existence of strong correlations at regional level - Li and Majerowska (2008), Gilmore et al. (2005); Égert and Kocenda (2010), but still all highlights a growing interdependence over time.

3.2 Data

The regional leader took into account is Wiener Börse, the continental leaders are Euronext Paris, Deutsche Börse and London Stock Exchange, while de international leader is New York Stock Exchange. The analyzed CEE markets are: Warsaw Stock Exchange, Bratislava Stock Exchange, Budapest Stock Exchange, Ljubljana Stock Exchange, Prague Stock Exchange, Bucharest Stock Exchange, Bulgarian Stock Exchange-Sofia, Macedonian Stock Exchange, and Zagreb Stock Exchange. The data consist of daily stock market indexes in local currency and were collected from Global Financial Data, the sample period being from July 1, 2001 to December 31, 2010.

3.3 Methodology

The daily returns are calculated as:

$$R_{it} = \ln\left({}^{P_{it}}/_{P_{it-1}}\right) * 10 \quad (1)$$

where:

R_{it} refers to the daily return of index *i* on day *t*, with *i*=1, 2, 3, 4, 5;
P_{it} is closing values of index *i* on day *t*;
P_{it-1} is closing values of index *i* on day *t-1*.

We performed the augmented Dickey-Fuller unit root tests on each series (the results are not given here but are available by the authors upon request) to determine whether they need to be transformed before models estimation. The test doesn't reject the non-stationary null hypothesis for the stock price index in the level, but in the first difference. In addition, this result is reliable because the Durbin-Watson statistics is near 2, and a value near 2 indicates non-autocorrelation. That means the series don't have autocorrelation problem.
The descriptive statistics of the daily returns for each analyzed stock index (the results are available by the authors upon request) emphasized the fact that the Romanian offers, on average the highest return (0.077782) and the highest standard deviation (1.676326), but all the analyzed markets exhibit higher volatility over the sample period. Most of the equity index series are negatively skewed (except from France and Germany), the negative being found in Slovakia, meaning that there is a higher probability for investors to get negative returns rather than positive returns. The kurtosis values of all indices returns are much larger than the value of normal distribution (the kurtosis of the normal distribution is 3), indicating that the returns indices have peaks relative to the normal distribution and the fact that big shocks are more likely to be present for this markets. The Jarque–Bera test rejects normality in all cases, in other words signifying that all indices exhibit significant departures from normality. These results are in line with the evidence of all previous studies in the literature, that daily stock returns are not normally distributed.
The correlation matrix of national stock indices among the twelve analyzed markets is not given here but is available by the authors upon request. The correlations of returns from the analyzed countries are significantly different from zero at the 1% level. However, these correlation coefficients are not very large in magnitude, indicating weak (short-term) contemporaneous interactions between these markets. Indeed as expected, the largest correlation coefficient are registered between developed markets, reminding U.S.-G.B., and Germany-G.B. pairs, followed by the correlation coefficients between CEE emerging markets, among them the largest being Slovenia-Austria, Hungary-Austria pairs.
Following Ajayi, Mehdian and Perry (2010), in order to examine the interdependency among equity markets under study, we use for the beginning the following model and estimate it using least squares approach:

$$R_{et} = C_0 + \sum_{i=1}^{n} a_i R_{k(t+i)} + \sum_{j=0}^{m} b_i R_{k(t-j)} + \varepsilon_t \qquad (2)$$

Where R_{et} is the daily return on each CEE stock markets on day t, R_k is the daily return on Austria, France, Germany, Great Britain, US stock markets, C_0 is the constant term, a_i and b_i are lead and lag coefficients up to three days correspondingly, and ε_t is a random error term.
To see which market, Austria, France, Germany, Great Britain or US has a greater impact on CEE markets, the above equation is modified by including the first mentioned as additional independent variables, as follows:

$$R_{it} = a_0 + \sum_{i=1}^{n} a_i R_{A(t+i)} + \sum_{j=0}^{m} f_i R_{A(t-j)} + \sum_{i=1}^{n} b_i R_{F(t+i)} + \sum_{j=0}^{m} g_i R_{F(t-j)} + \\ + \sum_{i=1}^{n} c_i R_{G(t+i)} + \sum_{j=0}^{m} h_i R_{G(t-j)} + \sum_{i=1}^{n} d_i R_{UK(t+i)} + \sum_{j=0}^{m} m_i R_{UK(t-j)} + \\ + \sum_{i=1}^{n} d_i R_{US(t+i)} + \sum_{j=0}^{m} n_i R_{US(t-j)} + \varepsilon_t \tag{3}$$

The second model which emphasize the presence of volatility spillover from the analyzed developed markets to CEE, is the GARCH (1,1) model:

$$R_{it} = \gamma_0 + \sum_{i=1}^{n} \gamma_i L_i R_{ecet} + \in_t; \tag{4}$$

$$\in_t \left| \Phi_{t-1} \sim N(0, h_t) \right.$$

$$h_t = \alpha_0 + \alpha_1 \in_{t-1}^2 + \beta_1 h_{t-1} + \delta_G R_A \tag{5}$$

$$h_t = \alpha_0 + \alpha_1 \in_{t-1}^2 + \beta_1 h_{t-1} + \delta_G R_F \tag{6}$$

$$h_t = \alpha_0 + \alpha_1 \in_{t-1}^2 + \beta_1 h_{t-1} + \delta_F R_G \tag{7}$$

$$h_t = \alpha_0 + \alpha_1 \in_{t-1}^2 + \beta_1 h_{t-1} + \delta_G R_{UK} \tag{8}$$

$$h_t = \alpha_0 + \alpha_1 \in_{t-1}^2 + \beta_1 h_{t-1} + \delta_G R_{US} \tag{9}$$

where L is the lag operator, h_t is the conditional variance corresponding CEE stock market returns, α, β, γ,δ, are vectors of parameters to be estimated.
The last model we used is the Vector Autoregressive one in order to examine the dynamics of interdependency between the developed and CEE countries, the return of national stock index not being only a function of its own lagged returns but also a function of lagged returns of Austrian, French, German, English and American stock markets.

4 Empirical Results

In the table below is presented the results of estimating first model (equation no. 2) over the entire period, using the returns that are calculated as the subsequent log differences of closing price of all fourteen analyzed indices.

Table 1: Estimates of Equation 2

Countries	c_0	a_3	a_2	a_1	b_0	b_1	b_2	b_3	DW
BGAU	.047	**.077**	.015	.009	.038	037	008	-.03	1.73
FR	.059	**.044**	.001	-.02	.019	.019	.011	.-.02	1.72
DE	.057	.001	-.01	.023	.004	-.03	-.02	.021	1.72
GB	.058	**.055**	-.01	.024	.011	**.053**	-.02	.036	1.71
US	.059	.007	.016	.031	**.074**	**.048**	**.049**	-.01	1.73

CZ	AU	.042	.042	-.01	-.02	-.01	**.062**	.007	.029	1.89
FR		.042	.024	.032	.005	.016	.009	**-.07**	-.01	1.89
DE		.046	**.067**	.021	.032	**.043**	-.01	.011	.014	1.89
GB		.047	-.01	.016	**.138**	.044	.021	-.01	**-.05**	1.89
US		.046	**.056**	**.148**	**.098**	**.082**	**.241**	**.177**	.042	2.00
HU	AU	.030	-.01	-.01	.012	.033	-.01	-.01	**.076**	1.85
FR		.034	-.03	-.01	**.043**	.003	.004	-.03	-.03	1.83
DE		.034	-.02	-.01	**.**003	-.01	-.03	.012	.026	1.82
GB		.033	.001	.023	**.069**	.043	-.01	**.071**	**.083**	1.83
US		.034	**-.05**	.029	.026	-.01	**.049**	-.01	.017	1.81
HR	AU	.030	-.01	-.01	.012	.033	-.01	-.01	**.076**	1.85
FR		.034	-.03	-.01	**.043**	.003	.004	-.03	-.03	1.83
DE		.034	-.02	-.01	**.**003	-.01	-.03	.012	.026	1.82
GB		.033	.001	.023	**.069**	.043	-.01	**.071**	**.083**	1.83
US		.034	**-.05**	.029	.026	-.01	**.049**	-.01	.017	1.81
MK	AU	.056	.030	-.02	-.02	-.01	**-.04**	-.01	-.01	1.14
FR		.054	-.01	.024	.004	-.01	-.01	.019	-.01	1.14
DE		.054	.016	-.01	-.01	.002	-.02	.025	.019	1.14
GB		.053	-.04	-.04	.014	.048	.023	.012	.001	1.15
US		.053	-.01	.049	.013	**-.06**	-.03	**.054**	-.01	1.14
PL	AU	.030	.034	-.02	.030	-.01	-.01	**.064**	.014	1.90
FR		.036	-.03	**.066**	.006	.028	.017	.015	.010	1.90
DE		.034	.019	**.**022	.029	.023	-.02	.015	**.041**	1.90
GB		.035	-.03	.008	.001	.036	.029	.038	-.01	1.90
US		.033	-.02	**.091**	.034	**.079**	**.077**	**.054**	.028	1.92
RO	AU	.062	**.188**	**.059**	-.01	.021	**.054**	.024	**.104**	1.82
FR		**.080**	.029	.010	.022	-.01	**.**002	**.063**	**.049**	1.74
DE		**.078**	**.060**	.006	-.01	.018	.001	-.01	-.01	1.73
GB		**.078**	**.057**	**.062**	-.01	-.03	**-.05**	-.02	-.03	1.74
US		**.077**	.009	**.**023	.002	.036	-.02	.034	-.01	1.73
SK	AU	.036	.007	**.039**	-.02	.009	-.03	-.01	.009	2.00
FR		.036	-.01	-.02	-.01	-.01	.013	.007	-.01	2.00
DE		.037	-.01	.006	.001	-.01	.007	.012	.033	2.01
GB		.036	.007	.005	.007	-.02	.029	-.03	-.02	2.00
US		.036	**-.04**	-.02	.006	-.01	.016	-.02	-.01	2.00
SI	AU	.025	.013	.014	**-.01**	**.039**	**.028**	**-.03**	-.02	1.51
FR		.027	**.037**	**.042**	**.031**	-.01	-.01	.004	.016	1.53
DE		.025	-.01	-.01	-.01	.023	.010	.005	.005	1.52
GB		.026	**.033**	.011	**.039**	.003	.008	**.078**	**.039**	1.53
US		.026	**-.02**	.038	**.012**	.063	.029	**.022**	**.023**	1.52

All CEE markets analyzed show statistically significant reaction to lead and lag price innovations from Austria, France, Germany, Great Britain and US. The exceptions are the cases of Slovakian and Macedonian markets, in which the only significant coefficients emphasize the lead, and respectively the lag influence from US and Austria. On the other hand, the larger number of significant lead and lag coefficients is observed in Slovenia and Romania, meaning that it exhibits the highest responsiveness to contemporaneous and

lagged innovations from the analyzed developed markets. The largest numbers of price shocks comes from the U.S. market, followed by Austrian market. However, the independent variable (return of developed markets) explains in very small proportions the dependent variable (daily return trend of CEE emerging markets), the responses to other factors being more important (due to adjusted r-square pretty small).
We performed the Wald test in order to see if the influence of analyzed developed markets is different on CEE markets. From the table above we can observe that we cannot reject the null hypothesis that cumulative lead and lag coefficients are the same for Austria, France, Germany, Great Britain and U.S., meaning that there are statistically significant differences between the relative impacts of the last reminded on CEE emerging markets. There are two exceptions namely, Czech Republic and Republic of Croatia, which are significant at 5% level, in these cases being recorded differences between the impacts of mentioned developed markets.

Table 2: Test of the Relative Influence of Austria, France, Germany, Great Britain and U.S. on CEE Markets

	Austria vs. France vs. Germany vs. Great Britain vs. U.S. (F-statistic)
Bulgaria	1.82
Czech Republic	13.84*
Hungary	1.47
Republic of Croatia	2.79*
Republic of Macedonia	1.41
Poland	1.06
Romania	1.39
Slovakia	1.72
Slovenia	1.13

*significant at 5%

Table 3 provides the maximum likelihood estimates of GARCH (1,1) models with price shocks from the Austria, France, Germany, Great Britain and US. The α and β coefficients (ARCH and GARCH effects, respectively) were found to be positive and statistically significant in all of the equity markets, indicating volatility persistence, because their sums in all case are extremely close to unity. In this regard, this means that between analyzed developed markets and CEE emerging ones it is registered volatility spillovers. The fact that GARCH parameters are considerably larger than the corresponding ARCH coefficients indicates the fact that the variance of the prices is more influenced by their lagged values, rather than by lagged innovations. In addition, the volatility spillover coefficients are in general smaller than the GARCH coefficients, but they are statistically significant for all countries except for Slovakia, Macedonia and Romania. This support Syriopoulos and Roumpis (2009) study in the sense that Balkan stock markets are seen to exhibit time-varying correlations as a peer group, although correlations with the mature markets remain relatively modest, thus indicating 'reactive' and 'persisting' volatility dynamics. The volatility spillover from US seems to be slightly greater that the others.

Table 3: Estimates of GARCH(1,1)

	α_1	β_1	δ_{AU}	δ_{FR}	δ_{DE}	δ_{GB}	δ_{US}	$\alpha_1+\beta_1$
BG	.263**	.736**						.999
	.265**	.733**	.011					.998
	.266**	.733**		.023**				.999
	.264**	.735**			.012			.999
	.264**	.733**				-.022		.987
	.260**	.736**					-.022	.986
CZ	.126**	.852**						.978
	.128**	.851**	-.02**					.979
	.126**	.852**		.003				.978
	.126**	.852**			.031**			.978
	.126**	.853**				.023		.979
	.128**	.851**					.088**	.979
HU	.099**	.873**						.972
	.100**	.872**	.057**					.972
	.099**	.874**		.007				.973
	.099**	.873**			.030*			.972
	.099**	.874**				.043*		.973
	.099**	.873**					-.031	.972
HR	.099**	.890**						.978
	.088**	.891**	.006					.979
	.089**	.889**		-.005				.978
	.098**	.879**			-.03**			.977
	.089**	.888**				.023		.977
	.088**	.890**					.029	.978
MK	.281**	.718**						.999
	.283**	.715**	-.014					.998
	.281**	.718**		.003				.999
	.283**	.716**			.008			.999
	.282**	.716**				-.002		.998
	.281**	.718**					.001	.999
PL	.048**	.944**						.992
	.048**	.943**	-.001					.991
	.049**	.944**		.026				.993
	.048**	.944**			.016			.992
	.049**	.943**				.019		.992
	.048**	.942**					.064**	.990
RO	.198**	.784**						.982
	.196**	.786**	.029					.982
	.197**	.786**		-.004				.983
	.204**	.778**			.023			.982
	.196**	.786**				-.007		.982
	.198**	.784**					-.001	.982
SK	.039**	.955**						.994
	.039**	.955**	.004					.994

	.040**	.955**		-.002				.995
	.040**	.955**			-.001			.995
	.042**	.951**				-.039		.993
	.039**	.955**					-.003	.994
SI	.383**	.611**						.994
	.386**	.610**	.019*					.996
	.385**	.612**		.005				.997
	.386**	.612**			.018*			.998
	.378**	.619**				.018*		.997
	.383**	.613**					.021*	.996

**Significant at the 1 % level.
* Significant at the 5% level.

Table 4 provides a quantitative measure of the short-run dynamic interdependences of the CEE emerging stock markets and the developed ones.

Table 4: Forecast Error Variance Decomposition of Daily Market Return

	Days	Own	Austria	France	Germany	G.B.	U.S.
BG	3	95.69	1.58	0.05	0.06	0.27	0.06
	5	92.89	1.60	0.14	0.15	0.63	0.11
	10	91.03	1.61	0.17	0.19	0.71	0.12
CZ	3	89.18	0.56	0.52	0.04	0.02	4.85
	5	86.16	0.58	0.53	0.05	0.37	5.98
	10	81.60	0.72	0.53	0.09	0.39	6.11
HU	3	95.26	0.92	0.33	0.47	0.35	0.17
	5	93.74	1.22	0.35	0.51	0.40	0.45
	10	92.82	1.26	0.39	0.53	0.44	0.47
HR	3	97.30	0.13	0.26	0.30	0.21	0.19
	5	91.44	3.61	0.55	0.42	0.80	0.30
	10	89.03	4.47	0.61	0.45	0.94	0.32
MK	3	98.08	0.22	0.10	0.11	0.01	0.41
	5	96.96	0.23	0.11	0.17	0.02	0.45
	10	96.04	0.25	0.15	0.23	0.11	0.47
PL	3	97.54	0.48	0.13	0.07	0.14	0.43
	5	95.79	0.50	0.15	0.15	0.50	0.72
	10	95.13	0.68	0.17	0.23	0.52	0.74
RO	3	96.69	0.67	0.40	0.10	0.50	0.25
	5	92.53	1.49	0.52	0.11	0.65	0.29
	10	90.54	1.54	0.73	0.27	0.77	0.33
SK	3	98.32	0.01	0.01	0.11	0.24	0.15
	5	96.63	0.01	0.02	0.30	0.34	0.16
	10	95.85	0.02	0.04	0.40	0.35	0.25
SI	3	94.09	0.72	0.13	0.10	0.96	0.04
	5	89.37	0.89	0.23	0.10	1.05	0.06
	10	85.36	1.73	0.44	0.15	1.21	0.21

Therefore Table 4 suggests that in all analyzed countries, the national market price

innovations account for more of the error variance while Austrian, French, German, British and American price innovations account for less of the forecast error variance, the last reminded influence on all the analyzed CEE states being very small, almost inexistent. The highest shocks that affects the series in the system is observed on the basis that about 0.01-4.47% of the variation in the returns of analyzed indices is caused by Austrian market. The extent of influence of the developed markets on the returns of the emerging markets in CEE is small, indicating a weak integration of the emerging markets with the developed ones in the area. In this sense, Li and Majerowska (2008) highlighted the fact that the emerging markets are weakly linked to the developed markets and that the Balkan equity markets exhibit significant dynamic correlations as a peer group.

5 Conclusion

As several CEE states have joined the EU recently, several are candidates and along with the increasing in globalization process, the examination of dynamic interdependencies of stock markets remains an important issue. In this paper, we analyzed possible interdependences between nine emerging stock markets in Central and Eastern Europe and the Austrian, French, German, British and American stock markets over the period 2001-2010.

To investigate the nature of transmission of information, the effect of external price innovations and shocks across the equity markets under study and the interdependency of the national stock markets, we employ two econometric models. These models are estimated in framework of maximum likelihood, namely GARCH, and vector autoregression (VAR).

Our findings suggest that there exist some reaction from CEE markets to the arrival of price innovations from the developed markets, but nature of these reactions and responses seems to be mixed. Moreover, we couldn't delimit the degree of integration of CEE countries with the developed ones depending on group accession (on 2004, 2007 or candidates), since in all the cases Slovakia (which is a UE member) and Macedonia (UE candidate) were found to be the countries that in general have held on their dependency and have avoided integration. In addition, we found that U.S. and Austrian market exercise a higher impact over the CEE analyzed countries, meaning that the shocks from international and regional leaders are greater than those from continental leaders (Great Britain, Germany and France) over the CEE emerging ones.

However, the extent of the linkages is weak, as the variance decompositions by orthogonalised approaches demonstrate limited interactions between any pair of emerging and developed markets under study. The implication of the low level of the linkages is that expected returns of the investment in the emerging stock markets would be determined mainly by the country-specific risk factors (Li and Majerowska, 2008). Therefore, we found that on the short run the national market price innovations account for more of the error variance while Austrian, French, German, British and American price innovations account for less of the forecast error variance.

References

[1] Z. A. Ozdemir, Linkages between international stock markets: A multivariate long-memory approach, *Physica A*, **388**, (2009), 2461- 2468.

[2] P. F. Diamandis, International stock market linkages: Evidence from Latin America, *Global Finance Journal*, **20**, (2009), 13–30.

[3] T.-L. Chong, Y.-C. Wong and K.-M. Yan, International linkages of the Japanese stock market, *Japan and the World Economy*, **20**, (2008), 601–621.

[4] D. Baur, R. C. Jung, Return and volatility linkages between the US and the German stock market, *Journal of International Money and Finance*, **25**, (2006), 598-613.

[5] S. Edwards, R. Susmel, Volatility dependence and contagion in emerging markets, *Journal of Development Economics*, **66**, (2001), 502–532.

[6] F. Rezayat, B. F. Yavas, International portfolio diversification: A study of linkages among the U.S., European and Japanese equity markets, *Journal of Multinational Financial Management*,**16**, (2006), 440–458.

[7] K. Phylaktis, F. Ravazzolo, Stock market linkages in emerging markets: implications for international portfolio diversification, *Journal of International Financial Markets, Institutions and Money*, **15**, (2005), 91–106.

[8] S. Wälti, Stock market synchronization and monetary integration, *Journal of International Money and Finance*, **30**, (2011), 96–110.

[9] G. Cifarelli, G. Paladino, Volatility linkages across three major equity markets: A financial arbitrage approach, *Journal of International Money and Finance*, **24**, (2005), 413-439.

[10] T. Syriopoulos, Dynamic linkages between emerging European and developed stock markets: Has the EMU any impact?, *International Review of Financial Analysis*, **16**, (2007), 41– 60.

[11] D. Serwa, M. T. Bohl, Financial contagion vulnerability and resistance: A comparison of European stock markets, *Economic Systems*, **29**, (2005), 344–362.

[12] M. N. Syllignakis, G. P. Kouretas, German, US and Central and Eastern European Stock Market Integration, *Open Econ Rev*, **21**, (2010), 607–628.

[13] T. Syriopoulos, E. Roumpis, Dynamic correlations and volatility effects in the Balkan equity markets, *Journal of International Financial Markets, Institutions and Money*, **19**, (2009), 565–587.

[14] H. Li, E. Majerowska, Testing stock market linkages for Poland and Hungary: A multivariate GARCH approach, *Research in International Business and Finance*, **22**, (2008), 247–266.

[15] C.G. Gilmore, B. Lucey and G.M McManus, The dynamics of Central European equity market integration, IIIS, *Dublin IIIS Discussion paper*, **69**, (2005).

[16] B. Égert, E. Kocenda, Time-varying synchronization of European stock markets, *Empirical Economics*,**2**, (2009), 393-407.

[17] B. M. Lucey, S. Voronkova, Russian equity market linkages before and after the 1998 crisis: Evidence from stochastic and regime-switching cointegration tests, *Journal of International Money and Finance*, **27**, (2008), 1303–1324.

[18] S. Voronkova, Equity market integration in Central European emerging markets: a cointegration analysis with shifting regimes, *International Review of Financial Analysis.*, **13**, (2004), 633–747.

[19] B. Harrison, W. Moore, Spillover effects from London and Frankfurt to Central and Eastern European stock markets, *Applied Financial Economics*, **19**(18), (2009), 1509-1521.
[20] D. Büttner, B. Hayo, News and correlations of CEEC-3 financial markets, *Economic Modelling*, **27**, (2010), 915–922.
[21] H. Olgun, Z.A. Ozdemir, Linkages between the center and periphery stock prices: Evidence from the vector ARFIMA model, *Economic Modelling*, **25**, (2008), 512-519.
[22] L. K. Lim, Convergence and interdependence between ASEAN-5 stock markets, *Mathematics and Computers in Simulation*, **79**, (2009), 2957–2966.
[23] Z. A. Ozdemir, H. Olgun, and B. Saracoglu, Dynamic linkages between the center and periphery in international stock markets, *Research in International Business and Finance*, **23**(1), (2009) 46-53.
[24] R. Ajayi, S. Mehdian, M. Perry, The relative influence of the East and the West on Middle Eastern Emerging: An Empirical Investigation, *Applied Financial Economics*, **20**, (2010), 407-415.