Impact of the global crisis on the linkages between CAC 40 and indexes from CEE countries

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IMPACT OF THE GLOBAL CRISIS ON THE LINKAGES BETWEEN CAC 40 AND INDEXES FROM CEE COUNTRIES

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ABSTRACT

This paper explores the relationship between CAC 40 Index and other three indexes from Central and East European countries: PX Index, BUX Index and BET-C Index before and during the global crisis. In our investigation we employ daily values of the four indexes from two periods of time: a pre-crisis period, from 3rd January 2005 to 15th September 2008 and a crisis period, from 16th September 2008 to 30th December 2011. We analyze the long-term relations by the Johansen cointegration procedure while for the short-term relations we use the Granger causality procedure. We find that global crisis strengthened the relations among the four indexes.

KEY WORDS: *Stock Markets, Interdependences, Global Crisis, CEE Countries, Cointegration, Causality*

JEL: *F36, G01, G15*

1. INTRODUCTION

After the fall of the communist regimes, in the 1990s the stock exchanges from many of the Central and Eastern European (CEE) countries reopened. At the beginning the difficulties of the transition period affected the evolution of these emerging markets. However, many of them experienced significant growths as long as the national economies recovered and the structural reforms progressed.

Although the emerging markets are usually perceived as riskier than the developed markets, they could attract domestic and foreign investors for some important reasons. First, some stock prices from these markets could have a potential of grow superior to those from the developed markets (Phylaktis and Ravazzolo (2002); Ahmed (2010)). Second, the emerging markets offer opportunities to diversify the portfolio investments in order to reduce the risks associated to the investments in the developed markets (Shachmurove (2000); Arestis *et al.,* 2005; Li *et al.,* 2003). Such opportunities are viable only if the emerging markets follow trends different from those followed by the developed markets (Levy and Sarnat (1970); Kasa (1992); Garrett and Spyrou (1999)). However, as the foreign investors' presence on an emerging market becomes more important its trend becomes closer to the developed markets (Gupta and Donleavy (2009); Bekaert and Harvey (2003)).

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Some empirical researches about the effects of the financial crisis revealed that during the turbulent times the interdependence between the emerging and the developed markets could suffer some changes in comparison with the relative quiet times (Sabri (2002); Schwebach *et al.,* 2002; Marçal *et al.,* 2007). The recent global crisis generated circumstances that could modify the relationships between the emerging and the developed markets.

In this paper we investigate the impact of the global crisis on the relation between CAC 40 Index from Paris Stock Exchange and three indexes from CEE countries: PX of Prague Stock Exchange, BUX of Budapest Stock Exchange, BET – C of Bucharest Stock Exchange. Together with Germany, France plays a leading role in the European Union and in the Eurozone, so the evolution of the Paris Stock Exchange could influence the financial markets of the other European countries. After the adhesion to the European Union the stock markets from the Czech Republic, Hungary and Romania were increasingly financial integrated (Dvorak and Podpiera (2006)). We analyze the relationship between these emerging markets and Paris Stock Exchange on long term, employing the Cointegration Johansen Procedure and on short term, using the Granger Causality Technique.

The rest of this paper is organized as it follows. The second part approaches the specialized literature about the financial integration of the stock markets, the third part describes the data and the methodology employed in our investigation, the fourth part presents the empirical results and the fifth part concludes.

2. LITERATURE REVIEW

The financial integration of the international stock exchanges was highly approached in the financial literature. Solnik (1974) revealed some factors that could influence the financial linkages between the international capital markets. Empirical researches investigated the relationships of the stock exchanges from various regions. Cha and Cheung (1998) found that equity markets from the Asia – Pacific region were influenced by the New York Stock Exchange. Chen *et al.* (2002) analyzed the interdependence among the Latin American countries during the period 1995 – 2000 and they identified a significant long – term relationship until 1999. Chelley – Steeley (2004) found a significant integration between the emerging markets from Asia – Pacific countries.

Some articles approached the relations between the CEE emerging markets and the developed markets. Syriopoules and Roumpis (2009) identified long – term relationships between the emerging markets from the Balkan region and the developed markets from United States and Germany. Gilmore and McManus (2003) examined the relationships between US capital market and three emerging markets from CEE countries: Czech Republic, Hungary and Poland. Their results failed to identify the cointegration evidences for the period 1995 – 2001. Voronkova (2004) found a significant long – term relationship between the stock markets from Germany and Poland. Gilmore et al. (2008) analyzed the relationships between three emerging markets from CEE countries (Czech Republic, Hungary and Poland) and two developed markets from two older members of EU (Germany and UK) between 1995 and 2005 and their results indicated no cointegration. Li and Majerowska (2008) found evidences of a significant influence of the German stock market on the stock markets from Hungary and Poland for the period 1998 – 2005.

After the financial crisis from the last decades some empirical researches approached the interdependence between the emerging and the developed markets during the turbulent times. Arshanapalli *et al.* (1995) found that after the shock from October 1987 the US stock market influence on the equity markets from South – East Asia increased. Sheng and Tu (2000) investigated the relationships between New York Stock Exchange and 11 stock exchanges from Asia – Pacific between 1996 and 1998, identifying stronger linkages during the Asian financial crisis from 1997 – 1998 than before. Similar results were found by Jang and Sul (2002) who examined the interdependences between seven Asian stock exchanges. Choudry *et al.* (2007) analyzed the relationships between capital markets from eight South Asian countries for the period 1988 – 2003 and they found that during the Asian financial crisis the linkages strengthened. Royfaizal *et al.* (2009) investigated the interdependence between the stock markets from US and ASEAN - 5 + 3 for the period 1991 – 2007, identifying long – run relationships only for during and post the Asian financial crisis periods.

3. DATA AND METHODOLOGY

In our investigation we employ daily values of four indexes: CAC 40, from Paris Stock Exchange, PX Index, from Prague Stock Exchange, BUX, from Budapest Stock Exchange, and BET-C, from Bucharest Stock Exchange. Our sample of data covers the period January 2005 – December 2011. In order to reveal the impact of the global crisis, we split this sample into two sub-samples:

- first sub-sample, from January 3, 2005 to September 15, 2008, corresponding to a pre-crisis period;
- second sub-sample, from September 16, 2008 to December 30, 2011, corresponding to a crisis period.

For each index i we compute the return ($R_{i,t}$) using the formula:

$$R_{i,t} = [\ln(P_{i,t}) - \ln(P_{i,t-1})] * 100 \qquad (1)$$

where $P_{i,t}$ and $P_{i,t-1}$ are the closing prices of index i on the days t and t-1, respectively.

We use the following notations for the returns:

- RBET-C, for the returns of BET-C;
- RBUX, for the returns of BUX;
- RCAC, for the returns of CAC 40;
- RPX, for the returns of PX Index.

The Table 1 and the Table 2 provide the descriptive statistics of the returns for the four indexes during the pre-crisis and crisis periods. For all these indexes, the returns decreased and the volatility increased from the first to the second period.

We analyze the long-term relations between the logarithms of the four indexes by the Johansen cointegration procedure (1998). As a preliminary step we evaluate the order of integration for these four variables by testing their stationarity for levels and for the first differences. For this purpose we employ the classical Augmented Dickey-Fuller (ADF) unit root test. The Johansen procedure analyses the cointegration relations between n variables,

all of them integrated of order one, in a framework provided by a (n x 1) vector autoregression (VAR) of order p:

$$y_t = \mu + \sum_{i=1}^{p} A_i y_{t-i} + \varepsilon_t \qquad (2)$$

where ε_t is a (n x 1) vector of innovations.

The VAR(p) model could be transposed in the form of a vector error correction model (VECM):

$$\Delta y_t = \mu + \Pi y_{t-i} + \sum_{i=1}^{p-1} \Gamma \Delta y_{t-i} + \varepsilon_t \qquad (3)$$

where $\Pi = \sum_{i=1}^{p} A_i - 1$ and $\Gamma = -\sum_{j=i+1}^{p} A_j$.

The rank r<n of the coefficient matrix (Π), which is calculated by identifying the eigenvalues, indicates the number of the cointegration relations between the variables. The Johansen procedure analyses the significance of the cointegration relations by two tests:
- The trace test which opposes the null hypothesis of r cointegrating vectors to the alternative hypothesis of n cointegrating vectors;
- The maximum eigenvalue test, which opposes the null hypothesis of r cointegrating vectors to the alternative hypothesis of r+1 cointegrating vectors.

The results of Johansen procedure could be affected by the number of lags (p) taking into consideration. Due to the complex evolutions of the four indexes for the two periods of time we employ four information criteria to choose the optimal lag-length: Akaike Information Criterion (AIC), Final Prediction Error Criterion (FPE), Hannan - Quinn Information Criterion (HQC) and Schwarz Information Criterion (SIC).

In the VAR framework we analyze the short-term relations between the returns of the four indexes using the Granger causality procedure. For two stationary variables we test the null hypothesis that one of them Granger causes the other against the alternative hypothesis of no Granger causality.

4. EMPIRICAL RESULTS

The results of ADF tests for the two periods are presented in the Table 3 and in the Table 4. For both periods we find that all variables are non stationary in levels but stationary in their first differences, so they could be considered as integrated of order one.

For the pre-crisis period the results of Johansen procedure do not support the presence of cointegrating vectors at the 5% significance level (Table 5). The results of cointegration tests for the crisis period are presented in the Table 6. For four lags (chosen based on AIC and FPE) the trace test suggests the presence of a cointegrating vector. In case of two lags (selected by HQC) the trace test indicates a number of three cointegrating

vectors. Considering a single lag (as SIC recommends) both trace test and the maximum eigenvalue test suggest the presence of three cointegrating vectors.

The Table 7 reports the results of Granger causality tests between returns for the pre-crisis period. For a 5% significance level we found that RBUX, RCAC and RPX Granger cause RBET. During the crisis, as the Table 8 reports, we identify the following Granger causalities:

- RBUX Granger-cause RBET-C for lag lengths recommended by all the four information criteria;
- RCAC Granger-cause RBET-C for lag lengths recommended by all the four information criteria;
- RBET-C Granger-cause RPX for lag lengths recommended by AIC, FPE and HQC;
- RPX Granger-cause RBET-C for lag lengths recommended by all the four information criteria;
- RCAC Granger-cause RBUX for lag lengths recommended by AIC and FPE;
- RBUX Granger-cause RPX for lag lengths recommended by all the four information criteria;
- RPX Granger-cause RBUX for lag lengths recommended by AIC, FPE and HQC;
- RCAC Granger-cause RPX for lag lengths recommended by all the four information criteria;
- RPX Granger-cause RCAC for lag lengths recommended by AIC and FPE.

3. CONCLUSIONS

In this paper we investigated the long-term and short-term relations before and during the global crisis between CAC 40 Index from Paris Stock Exchange and other three indexes from Central and East European countries: PX Index, from Prague Stock Exchange, BUX, from Budapest Stock Exchange and BET-C, from Bucharest Stock Exchange. The results of our investigation suggest a strengthening of relations among the four indexes during the global crisis in comparison with the pre-crisis period.

For the long-term horizon, the Johansen procedure found no cointegration among the four indexes before the global crisis. We found, however, evidences of cointegration relations during the global crisis. Such results could be explained by the changes in investors' behaviour during turbulent times when they could become very sensitive to the international financial markets evolutions.

In the case of short-term horizon, the Granger causality tests suggests that before the global crisis returns of CAC 40 Index influenced only returns of BET-C Index, from the Romanian capital market. In fact, BET-C was also Granger caused by the other two indexes from stock exchanges of CEE countries. Such consistent sensitivity to the international financial markets could be explained by the substantial development experienced by Romanian capital market since 2005, when the progress of structural reforms and the ascendant trend of national economy attracted inflows of foreign capitals.

We found also that during the global crisis the returns of all the three indexes from stock exchanges of CEE countries were Granger caused by returns of CAC 40 Index. This situation could be linked to the increasing role of France during the crisis when it was

perceived, along with Germany, as the main pillar of the European Union stability. The results of our investigation indicate also some short-term relations among the stock markets from CEE countries, indicating the strengthening of interdependences. Finally, we found evidences of the Granger causality from returns of PX Index to returns of CAC 40 Index in the context of the global crisis.

Two facts contributed to the increase of Prague Stock Exchange importance among the European capital markets. First, in the last decade, the national economy of Czech Republic experienced a strong growth while the inflation was kept under control. Second, during the recent global crisis the financial sector from this country displayed a relative stability.

Our findings suggest that during turbulent times it is not useful to invest in CEE stocks in order to reduce risks associated to the stocks from Paris Stock Exchange. This investigation could be extended to the relations between CAC 40 Index and other indexes from CEE countries.

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APPENDIX

Table 1

Descriptive Statistics of the daily returns for the pre-crisis period

Variable	RBET-C	RBUX	RCAC	RPX
Mean	0.0427467	0.0159685	-0.000795265	-0.00268161
Median	0.0739005	0.0342249	0.0412878	0.0912825
Minimum	-7.22252	-5.60273	-7.07737	-6.12495
Maximum	5.22213	4.86596	5.83349	8.08362
Std. Dev.	1.49681	1.44424	1.10436	1.28516
Skewness	-0.368004	-0.161576	-0.434774	-0.299329
Ex. kurtosis	2.15018	0.681733	3.48840	2.15018

Table 2

Descriptive Statistics of daily returns for crisis period

Variable	RBET-C	RBUX	RCAC	RPX
Mean	-0.0217339	-0.0298880	-0.0167786	-0.0313080
Median	0.0310337	0.0240642	-0.000987528	-0.0175101
Minimum	-12.1184	-12.6489	-9.47154	-16.1855
Maximum	10.8906	13.1777	10.5946	12.3641
Std. Dev.	2.07610	2.27281	1.96273	2.08846
Skewness	-0.613696	-0.103736	0.241402	-0.309638
Ex. kurtosis	6.42402	4.73728	4.84445	9.99861

Table 3

The results of ADF Tests for the pre-crisis period (logarithms of the daily values)

Index	Level			First difference		
	Lagged differences	Test statistics	P-value	Lagged differences	Test statistics	P-value
BET-C	11	0.132619	0.9976	10	-7.86512	0.00001
BUX	16	-1.82065	0.6949	15	-6.85692	0.00001
CAC 40	20	-0.585703	0.9794	19	-6.30929	0.00001
PX	8	-0.734664	0.9697	7	-9.144	0.00001

Table 4

The results of ADF Tests for the crisis period (logarithms of the daily values)

Index	Level			First difference		
	Lagged differences	Test statistics	P-value	Lagged differences	Test statistics	P-value
BET-C	16	-2.00203	0.5997	15	-5.35958	0.00001

BUX	17	-1.20951	0.9077	16	-6.22566	0.00001
CAC 40	19	-1.22639	0.9043	18	-7.57395	0.00001
PX	16	-1.36796	0.8703	15	-6.36382	0.00001

Table 5

Cointegration Tests Results for the pre-crisis period

Number of lags	Rank	r=0	r≤1	r≤2	r≤3
AIC, FPE, HQC:2	Eigenvalues	0.025498	0.016492	0.013073	0.00015037
	Trace test	49.131	26.376	11.726	0.13249
		[0.1551]	[0.3142]	[0.3360]	[0.7159]
	Maximum eigenvalue test	22.755	14.650	11.594	0.13249
		[0.3563]	[0.5439]	[0.2719]	[0.7158]
SIC:1	Eigenvalues	0.027233	0.018190	0.014754	0.00012533
	Trace test	53.764	29.411	13.220	0.11055
		[0.0656]	[0.1797]	[0.2314]	[0.7395]
	Maximum eigenvalue test	24.353	16.191	13.110	0.11055
		[0.2577]	[0.4139]	[0.1774]	[0.7395]

Note: p-values are within the squared brackets.

Table 6

Cointegration Tests Results for the crisis period

Number of lags	Rank	r=0	r≤1	r≤2	r≤3
AIC, FPE:4	Eigenvalues	0.033223	0.020989	0.017323	0.0026735
	Trace test	57.867	31.851	15.517	.0613
		[0.0271]	[0.1069]	[0.1210]	[0.1511]
	Maximum eigenvalue test	26.016	16.334	13.456	2.0613
		[0.1758]	[0.4025]	[0.1600]	[0.1511]
HQC:2	Eigenvalues	0.034125	0.033001	0.022466	0.0024552
	Trace test	72.151	45.346	19.440	1.8978
		[0.0006]	[0.0025]	[0.0338]	[0.1683]
	Maximum eigenvalue test	26.804	25.907	17.542	1.8978
		[0.1444]	[0.0276]	[0.0412]	[0.1683]
SIC:1	Eigenvalues	0.049593	0.036281	0.024944	0.0031925
	Trace test	89.884	50.565	21.998	2.4717
		[0.0000]	[0.0004]	[0.0135]	[0.1159]
	Maximum eigenvalue test	39.319	28.567	19.526	2.4717
		[0.0022]	[0.0105]	[0.0198]	[0.1159]

Note: p-values are within the squared brackets.

Table 7
Granger causality tests between returns from the pre-crisis period

Null Hypothesis	Number of lags	F-statistic	P-value	Causal inference (for a 5% significance level)
RBET-C do not Granger-cause RBUX	AIC, FPE, HQC, SIC:1	0.1364	0.7120	RBET-C do not Granger-cause RBUX
RBUX do not Granger-cause RBET-C	AIC, FPE, HQC, SIC:1	9.4707	0.0021	RBUX Granger-cause RBET-C
RBET-C do not Granger-cause RCAC	AIC, FPE, HQC, SIC:1	0.0005	0.9816	RBET-C do not Granger-cause RCAC
RCAC do not Granger-cause RBET-C	AIC, FPE, HQC, SIC:1	25.7840	0.0000	RCAC Granger-cause RBET-C
RBET-C do not Granger-cause RPX	AIC, FPE, HQC, SIC:1	0.0185	0.8918	RBET-C do not Granger-cause RPX
RPX do not Granger-cause RBET-C	AIC, FPE, HQC, SIC:1	19.7178	0.0000	RPX Granger-cause RBET-C
RBUX do not Granger-cause RCAC	AIC, FPE, HQC, SIC:1	0.2810	0.5961	RBUX do not Granger-cause RCAC
RCAC do not Granger-cause RBUX	AIC, FPE, HQC, SIC:1	0.0356	0.8503	RCAC do not Granger-cause RBUX
RBUX do not Granger-cause RPX	AIC, FPE:2	1.6925	0.1844	RBUX do not Granger-cause RPX
	HQC, SIC:1	0.8181	0.3659	RBUX do not Granger-cause RPX
RPX do not Granger-cause RBUX	AIC, FPE:2	0.7259	0.4840	RPX do not Granger-cause RBUX
	HQC, SIC:1	0.7542	0.3853	RPX do not Granger-cause RBUX
RCAC do not Granger-cause RPX	AIC, FPE, HQC, SIC:1	1.8981	0.1685	RCAC do not Granger-cause RPX
RPX do not Granger-cause RCAC	AIC, FPE, HQC, SIC:1	1.1662	0.2803	RPX do not Granger-cause RCAC

Table 8
Granger causality tests between returns from the crisis period

Null Hypothesis	Number of lags	Test statistic	P-value	Causal inference (for a 5% significance level)
RBET-C do not Granger-cause RBUX	AIC, FPE:2	0.5321	0.5875	RBET-C do not Granger-cause RBUX
	HQC, SIC:1	0.1084	0.7420	RBET-C do not Granger-cause RBUX
RBUX do not Granger-cause RBET-C	AIC, FPE:2	5.2135	0.0055	RBUX Granger-cause RBET-C

	HQC, SIC:1	10.0718	0.0015	RBUX Granger-cause RBET-C
RBET-C do not Granger-cause RCAC	AIC, FPE:3	0.6583	0.5778	RBET-C do not Granger-cause RCAC
	HQC, SIC:1	0.9132	0.3394	RBET-C do not Granger-cause RCAC
RCAC do not Granger-cause RBET-C	AIC, FPE:3	7.8731	0.0000	RCAC Granger-cause RBET-C
	HQC, SIC:1	23.1861	0.0000	RCAC Granger-cause RBET-C
RBET-C do not Granger-cause RPX	AIC,FPE:4	4.8294	0.0007	RBET-C Granger-cause RPX
	HQC:3	6.4021	0.0003	RBET-C Granger-cause RPX
	SIC:1	0.6287	0.4279	RBET-C do not Granger-cause RPX
RPX do not Granger-cause RBET-C	AIC,FPE:4	5.9580	0.0001	RPX Granger-cause RBET-C
	HQC:3	5.0591	0.0017	RPX Granger-cause RBET-C
	SIC:1	4.5955	0.0322	RPX Granger-cause RBET-C
RBUX do not Granger-cause RCAC	AIC, FPE:3	0.2388	0.8694	RBUX do not Granger-cause RCAC
	HQC, SIC:1	0.6444	0.4222	RBUX do not Granger-cause RCAC
RCAC do not Granger-cause RBUX	AIC, FPE:3	2.8901	0.0343	RCAC Granger-cause RBUX
	HQC, SIC:1	2.9957	0.0837	RCAC do not Granger-cause RBUX
RBUX do not Granger-cause RPX	AIC,FPE:4	4.1156	0.0025	RBUX Granger-cause RPX
	HQC:3	4.8179	0.0024	RBUX Granger-cause RPX
	SIC:1	12.6248	0.0004	RBUX Granger-cause RPX
RPX do not Granger-cause RBUX	AIC,FPE:4	4.5801	0.0011	RPX Granger-cause RBUX
	HQC:3	3.5126	0.0147	RPX Granger-cause RBUX
	SIC:1	0.8517	0.3562	RPX do not Granger-cause RBUX
RCAC do not Granger-cause RPX	AIC,FPE:4	6.4941	0.0000	RCAC Granger-cause RPX
	HQC:3	8.4604	0.0000	RCAC Granger-cause RPX
	SIC:1	24.5985	0.0000	RCAC Granger-cause RPX

RPX do not Granger-cause RCAC	AIC,FPE:4	4.4146	0.0015	RPX Granger-cause RCAC
	HQC:3	2.5936	0.0512	RPX do not Granger-cause RCAC
	SIC:1	2.2095	0.1374	RPX do not Granger-cause RCAC