LONG-RUN COMOVEMENTS AND SHORT-RUN DYNAMICS BETWEEN CEE AND DEVELOPED COUNTRIES´ EQUITY MARKETS

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ABSTRACT

This paper examines bilateral and multilateral integration of equity markets of nine Central and Eastern European countries, including new EU members, acceding and candidate countries, as well as German, UK and USA equity markets for the period of January 1st, 1996 to February 3rd, 2006. We also conduct series of Granger causality tests in order to determine the direction of short-run interactions between equity markets. Application of the Johansen cointegration procedure on equity market indices denominated in local currencies indicate existence of multilateral integration between equity markets of analyzed CEE economies, as well as between the group of CEE equity markets and developed equity markets using German, UK and USA equity markets as proxies. In addition, by testing equity market indices denominated in local currencies, we intend to show whether exchange rate risk in CEE countries hampers further integration among selected equity markets. This study offers compelling evidence that the forces driving financial integration are quite strong, and that we are likely to witness further developments in the same direction as time passes and once these countries join EMU particularly because evidence from this study suggests that bilateral integration between particular CEE equity markets and developed equity markets is still absent. On the other hand, application of Granger causality test on all possible pairs of observed equity markets points towards evident differences in their short-run coherence. According to their response to short-run dynamics from other markets, three distinguished groups of CEE equity markets emerged. Aforementioned grouping corresponds well with their respective level of equity markets' significance.

Key words: equity markets, financial integration, cointegration, Granger causality test, CEE.

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1. Introduction

There are several ways to define financial integration of equity markets. One definition states that assets of equal risk provide investors with the same expected return across integrated markets, which in turn relates to the fact that integrated equity markets offer fewer opportunities to diversify portfolios. Equity market integration can also be defined by how great is the possibility of asymmetric spill over effects across markets due to equity market interdependence. For the purpose of our study the most useful definition of equity market integration is the one that claims that in integrated markets indices of national markets move together over the long run with possibility of short-run divergence.

Financial integration is subject of perpetual interest to, investors, corporate managers, consumers, policy makers and academics. The latter interest group has provided strong evidence on interaction among international financial markets. With regard to tendency of financial integration, investors are incapable to earn extra returns in long term. Since they are return oriented, full integration of equity markets would cause optimal portfolio diversification to shift from country diversification to sector diversification. Still, cross border diversification presents remarkable opportunity to maximise profits as well as minimise risks. Therefore, corporate managers are facing lower cost of capital due to improved risk diversification opportunities. Consequently, lower risk of capital in integrated financial markets leads to increase in number of positive net present value projects and thereto increase in investments. Consumers as an additional group of interest are able to share their consumption risk through cross border ownership of productive assets in integrated markets. Moreover, improvement in degree of financial market integration is perceived as an important channel of smoothening consumption shocks in Europe and therefore stimulating international risk sharing. Finally, policy makers' interest is partly based on prudence caused by possible spill over effects in case of integrated financial markets. On the other hand, effects of their policy actions in turn depend on degree of financial integration.

Overwhelming evidence has been provided on increase of integration of equity markets within Eurozone (Hardouvelis et. al., 2000., Baele and Vander, 2001.). There are several underlying factors explaining such trend. Firstly, introduction of single currency assured lower currency hedging costs and thereto elimination of currency risk. In addition, currency matching rules faced by many pension funds and insurance companies (at least within the euro zone) came to an end as direct consequence of introduction of euro, hereby removing a direct barrier to international investment. Secondly, monetary policy coordination and business cycle synchronization within Europe should lead to a convergence of real cash flow expectations across the EMU countries, and hence to a more homogeneous valuation of equities. In other words, increased cross-country correlation in returns and their volatilities is expected as domestic returns are prevailingly influenced by common shocks.

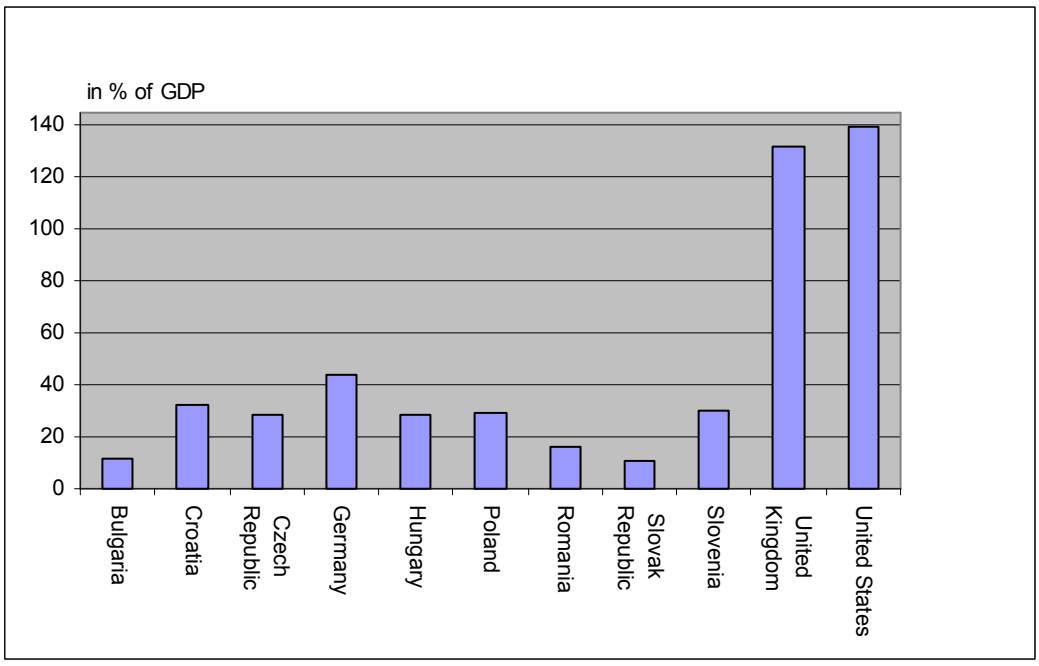
Finally, developed equity markets are more integrated than emerging ones. While strong arguments can be made in case of progressive integration of developed European financial markets, integration between emerging markets as well as between emerging and developed markets is not accompanied with credible empirical evidence results.

Keeping in mind that reduction in currency volatility is recognised as the main driving factor for increased European stock market integration (Baele and Vander, 2001.), intention of this paper is to examine co-movements of Central and Eastern

European emerging equity markets, namely, Polish, Czech, Slovenian, Hungarian, Romanian, Slovakian, Bulgarian and Croatian and German, UK and US equity markets. For this purpose we use Johansen cointegration approach. Moreover, we perform Granger causality test in order to bilaterally examine importance of one market in driving movements on the other market.

Thus, purpose of this paper is to fill the gap of existing literature on long-run trend comovements and coherence of short-run dynamics of CEE equity markets with regard to developments of European and world equity markets. In addition, motivation for this paper stems from the fact that Croatian equity market has never been included in the analysis which focuses on dynamics of financial integration between Central and Eastern Europe and EU and US equity markets probably due to the fact that Croatian equity market has gained significance somewhat later when compared with rest of the equity markets considered in this study. Since, in the meantime, Croatian equity market has achieved substantial level of development, we believe that it should be included in the study. The same argument applies for Bulgaria and Romania (See Figure 1). Hopefully, this research will contribute to the ongoing process of determining just how much are the economies in question integrated and it should help Croatian policy makers to set ground for future processes of joining EU and EMU.

Figure 1: Market capitalization in % of GDP of selected equity markets



Source: World Bank Development Indicators database.

The rest of the paper is organised as follows. After reviewing some of the literature on financial integration in section 2, section 3 presents data and methodology used. Last two sections, 4 and 5, offer discussion of results of the paper and concluding remarks.

2. Literature overview on financial integration

This paper defines financial integration as the international integration of national financial markets. Financial integration of observed equity markets means that assets of equal risk provide investors with the same expected return regardless the domicile. While the case of integrated financial markets confirms price equalization (law of the one price) in long run, in the short run asset diversification is possible due to the existence of arbitrage opportunities. As a result, investors do not have neither national nor regional preferences given the risk and return characteristics of an asset. Moreover, corporations are in position to raise funds across countries without constraints due to absence of effective barriers between national equity markets. Consequently, fully integrated countries should exhibit complete comovement in their equity markets. In the same vein, degree of financial integration may vary in time and thereto short-run coherence among the markets may be detected. On the contrary, segmentation is a result of lack of integration.

There is a wide literature that investigates the phenomenon of financial market integration in general employing various econometric methods.

Studies based on price equalisation for financial market assets have used uncovered interest parity (Fratzschner, 2001.) or capital asset pricing model (Bekaert and Harvey 1995., Dumas and Solnik 1995., Hardouvelis et al. 1999.). More specifically, equity markets are considered to be completely integrated in terms of CAPM if assets with the same risk have identical expected returns irrespective of the market while risk refers to exposure to some common world factor. If a market is segmented from the rest of the world, its covariance with a common world factor may have little or no ability to explain its expected return and therefore asset would be priced in terms of country specific risk factors. While Dumas and Solnik (1995) test whether the global economic risk or the exchange rate risk is a priced factor in stock returns, Bekaert and Harvey (1995) propose a measure of time varying world market integration using a combination of two one-factor asset pricing models. They allow conditional expected returns in any country to be affected by their covariance with a world benchmark portfolio and the variance of country returns.

Hardouvelis et al. (1999) and Baele and Vander (2001) also employ asset pricing models, but focus of these studies is put on integration of European equity markets. Hardouvelis et al. (1999) examine the effect of the Economic and Monetary Union (EMU) on European stock market integration with a weighted average asset pricing model that includes the covariance between stock returns and exchange rate returns. They allow the weights to change with the forward interest differential between country and Germany and conclude that this interest rate differential plays an important role for the degree of integration. Unlike aforementioned study, Baele and Vander (2001) in their paper incorporate a direct link between EMU-related economic factors, namely reduction of exchange rate uncertainty, the increased monetary policy convergence, and the closer economic integration on the one hand and European stock market integration on the other. Furthermore, by including European countries that are not part of EMU, they assess whether not participating in EMU has caused these stock markets to follow a different path towards integration compared to EMU stock markets. Results of the study recognize reduction in currency volatility as a crucial driving factor for increased European stock market integration.

Robert Korajczyk (1995) investigated financial integration between equity markets using multifactor equilibrium Arbitrage Pricing Theory to define risk and to measure

deviations from the 'law of one price'. According to results of the study, the measure of market segmentation tends to be much larger for emerging markets than for developed markets, which is consistent with large barriers to capital flows into or out of the emerging markets. However, the measure shows tendency to decrease over time, which is in line with growing levels of integration. Additional studies conducted in developed and emerging markets strengthen the evidence that removal of legal and non-legal barriers to capital flows induces financial integration. (Bekaert and Harvey 1995.).

Fratzscher (2001) conducts trivariate GARCH model with time-varying coefficients for a set of 16 countries some of which being from Euro area, some of which have not adopted the Euro yet, and five countries from outside the EU. However, study does not include Central and Eastern European countries. Results of the study imply high integration of European equity markets since 1996 as well as considerable increase of importance of Euro area market in world financial markets. Moreover, the integration of European equity markets is mainly attributed to the drive towards EMU, elimination of exchange rate volatility and uncertainty in the process of monetary unification. Finally, the shock transmission across equity markets is found to be asymmetric, i.e. negative shocks are more strongly transmitted, large shocks have a stronger impact than small shocks, and these asymmetry and threshold effects have become larger over time

Cointegration analysis is used to detect degree of integration by measuring the stability of long-run relationships across financial markets in (Dickinson 2000., Richards 1996., Gilmore, Lucey and Mcmanus ,2005. and Voronkova, 2004.).

Gilmore, Lucey and Mcmanus (2005) and Voronkova (2004) examine bilateral and multilateral cointegration properties of the German stock market on the one hand and Polish, Czech and Hungarian stock market on the other hand. Both studies suggest that the process of integration of the Central and Eastern European countries into the EU is leading to a closer integration of their equity markets with those of major EU countries but also in case of Voronkova (2004) with USA equity markets.

International linkages between equity markets can be as well tested with atheoretical VAR models (King and Wadhwani 1990., Koch and Koch 1993., Eum and Shim 1993.). Conducted studies imply rising cross-market correlations and growing regional interdependence.

Huang, Yang and Hu (2000) employ unit root and cointegration techniques that accommodate structural breaks in order to examine lead, lag or feedback relations via the Granger causality among the US, Japan and mambers of South China Growth Triangle. Among other evidence, study implies that US price changes can be used to predict subsequent day price changes in the Hong Kong and the Taiwan stock markets.

3. The data and methodology

The data consist of daily closing price indices for the Slovenian (SBI20 index), Hungarian (BUX index), Czechs (PX50 index), Polish (WIG index), Slovakian (SAX Index), Bulgarian (SOFIX index), Romanian (BET10 Index), Croatian (CROBEX index), German (DAX index), UK (FTSE100) and US (S&P500 Index) stock markets, for the time period covering January 1st, 1996, through February 3rd, 2006. The indices are denominated in local currencies because using a common currency would mitigate the effect of exchange rate changes and uncertainty (Fratzscher, 2001)**.** Data source is Bloombergs database. Regarding employed methodology, long series of data

would be preferable. However, although the data for the some equity market are available for periods prior to 1996, problems occur with limited data range of most CEE equity markets, especially Croatian, Bulgarian and Romanian. Thus, the data range for Croatian equity market is limited to nine years period because data are available only from January 2nd 1997 onwards. As far as Romanian and Bulgarian equity markets are concerned, data are available from September 29th, 1997 onwards and from October 24th, 2000 onwards, respectively.
The economic significance of all equity markets in the sample is presented in Picture 1.

With regard to methodology used, this study employs a three step approach to analysis. The first step is to test each index series for the presence of unit roots, which will show whether the series are nonstationary. Nonstationarity is a precondition for cointegration; additionally, all the series must be integrated of the same order.
The Augmented Dickey-Fuller (ADF) test, an extension of the Dickey and Fuller method, is used. However this test assumes that the errors are statistically independent and have a constant variance. To circumvent these limiting assumptions, Phillips and Perron (1987) developed a generalisation of the Dickey-Fuller test, which is also applied here.
The second step is the well-known methodology of cointegration that models the dynamic co-independence often found in financial market. Cointegration has emerged as a powerful technique for investigating common trends in multivariate time series and provides a sound methodology for modelling both long-run and short-run dynamics in the system with the help of error correction models (when short-run dynamics are being analysed). The fundamental aim of cointegration analysis is to detect any common stochastic trends in the data, and to use these common trends for a dynamic analysis of the correlation in return. Cointegration tests allow us to determine whether stock prices or indices of different national markets move together over the long-run, while providing for the possibility of short-run divergence.
In our analysis we use the Johansen testing procedure for testing the presence of cointegration among the stock indices. This test determines the rank of the coefficient matrix of a vector autogression (VAR) of the series, with the rank indicating whether there is cointegration, as well as the number of cointegrating vectors i.e. relationships.

Cointegration analysis is performed to test the presence of long-run equilibrium relationships in following cases:

- between the German equity market and the sample of equity markets of all Central and Eastern European countries, namely Poland, Czech Republic, Slovenia, Hungary, Slovak Republic, Croatia, Bulgaria and Romania;
- between the UK equity market and the sample of equity markets of all Central and Eastern European countries, namely Poland, Czech Republic, Slovenia, Hungary, Slovak Republic, Croatia, Bulgaria and Romania;
- between the US equity market and the sample of equity markets of all Central and Eastern European countries, namely Poland, Czech Republic, Slovenia, Hungary, Slovak Republic, Croatia, Bulgaria and Romania;
- between all Central and Eastern European equity markets in the sample.

Given that the introduction of the euro implies that one of the most important barriers for investment and financing across the participating countries has been eliminated and as a consequence comovement of their equity markets has been increased. Hence,

Germany is used as a proxy for EU countries that are in the same time members of EMU. Criteria for choosing Germany as a proxy for EU equity market developments are the following:

- dominant share of CEE countries' export directed towards Germany in total exports of those countries to the EU;
- German equity market is one of the largest and most important in EU area and
- since EU markets are considered to be rather well integrated (e.g. Fratzscher 2001, Baele and Vander, 2001), developments on Frankfurt stock exchange are in fact a good representation of global capital market developments in EU.

The Central and Eastern European countries in the sample will be observed as congenial countries although Poland, Czech Republic, Slovenia, Hungary and Slovak Republic present countries members of EU that still have not adopted euro, but are on their way to do so. On the other hand, Croatia, Bulgaria and Romania, although still lacking EU as well as EMU membership, are preparing their economies for becoming part of EU in near future. In addition, our integration analysis includes UK equity market as representative of non-euro European equity market. In case of aforementioned European equity markets outside the euro-zone, we find it interesting to investigate whether all market participants believe that these countries are likely to adopt the euro or not. If market participants expect that they will join the common European currency in the future, we conjecture that one should observe an increase in their market dependence with the euro-zone equity market. Although the increasing dependence is not a sufficient criterion to conclude that these countries will definitely join euro, it does reveal information about the expectations of market participants.
Finally, developments in US equity market are recognised to affect to a great extent European equity markets and generally world trends (Ashanapalli and Doukas, 1993, Kwan et al. 1995). To our mind, it is crucial to examine comovements of UK, German and CEE equity markets on the one hand and US equity market on the other hand in order to acknowledge euro i.e. inherent elimination of exchange rate risk in CEE and EMU as important drive force behind integration of European equity markets.

As a third step we wanted to determine the direction of short-run dynamics i.e. interdependences between all the equity markets in our sample. For this purpose we use Granger causality test that is a traditional concept for analyzing causation in time series. In accordance with statistical properties of selected time series we re-parameterized Granger causality test by augmenting it for error correction term when evidence of bilateral cointegration between equity markets was found. This is done because conventional Granger test is made for series that are integrated of order 0. Such Granger test specifies a bivariate vector autoregressive model with a lag length set as p and has a following form:

$$Yt = c_1 + \sum_{i=1}^{p} \alpha_i Y_{t-i} + \sum_{i=1}^{p} \beta_i X_{t-i} + u_t \quad (1)$$

$$H_0 : \beta_1 = \beta_2 = ... = \beta_p = 0$$

The Granger causality is examined by testing whether all β_i are equal to zero using a standard F-test, also called Wald test. If we can reject the null hypothesis in equation (1) X is said to Granger-cause Y. The above equations are, however, only valid for series that are stationary - that is I(0). Since most time-series in macroeconometrics are found to be non-stationary - that is I(1)- we have to apply differencing and thus convert series into an I(0) to which the Granger Causality tests could be applied:

$$\Delta Yt = c_1 + \sum_{i=1}^{p} \alpha_i \Delta Y_{t-i} + \sum_{i=1}^{p} \beta_i \Delta X_{t-i} + u_t$$

(2)

$$H_0 : \beta_1 = \beta_2 = ... = \beta_p = 0$$

However, later research showed that this procedure is only correct if the two series are not cointegrated. Engle and Granger (1987) and Granger (1988) argue that in the presence of cointegration, causality tests, which ignore the error correction term (ECT) derived from the cointegration relationship are mis-specified and suggest to re-parameterize the model in the equivalent error correction model form (ECM). The causality tests in this case are based on the following equation (Granger, Huang and Yang, 2000):

$$\Delta Y_t = c_1 + \sum_{i=1}^{p} \alpha_i \Delta Y_{t-i} + \sum_{i=1}^{p} \beta_i \Delta X_{t-i} + \delta_1 \left(Y_{t-1} - \gamma_1 X_{t-1} \right) + u_t$$

(3)

$$H_0 : \beta_1 = \beta_2 = ... = \beta_p = 0;$$

$$\delta_1 = 0$$

4. Results

4.1. Unit roots tests

Unit root tests, with and without a deterministic trend, for all data series in levels and first differences were performed following Augmented Dickey-Fuller (ADF) and Phillips and Perron (PP) testing method. The results presented in Table 1 and 2 demonstrate that the null hypothesis of a unit root in the level series without trend is accepted in all cases while the corresponding null hypothesis in the first differences series is universally rejected. Similar results were obtained for series with a deterministic trend, where the results indicate these series are I(1). Results undoubtedly confirm that all indices satisfy the precondition for cointegration testing i.e. all indices contain unit root in levels while their first differences are stationary at 1% confidence level.

Table 1: ADF and PP unit root tests – in levels

	Name of the variable	Time period	ADF		PP	
			t-value (trend included)	t-value (no trend)	t-value (trend included)	t-value (no trend)
1.	FOOTSE	1996:1 -2006:2	-1.755 (3) [0.4032]	-1.779 (3) [0.7149]	-1.869 (3) [0.3470]	-1.890 (3) [0.6599]
2.	S&P500	1996:1 -2006:2	-2.099 (1) [0.2450]	-1.945 (1) [0.6311]	-2.118 (1) [0.2371]	-1.964 (1) [0.6210]
3.	DAX	1996:1 -2006:2	-1.771 (1) [0.3951]	-1.724 (1) [0.7400]	-1.782 (1) [0.3895]	-1.734 (1) [0.7355]
4.	WIG	1996:1 -2006:2	0.431(2) [0.9826]	-1.858 (2) [0.6762]	0.500(2) [0.9849]	-1.952 (2) [0.6275]
5.	SBI20	1996:1 -2006:2	0.979(1) [0.9940]	-0.182 (1) [0.9918]	1.035 (1) [0.9946]	-0.129 (1) [0.9927]
6.	BUX	1996:1 -2006:2	0.365(1) [0.9801]	-0.557 (1) [0.9810]	0.466 (1) [0.9838]	-0.445 (1) [0.9854]
7.	PX50	1996:1 -2006:2	2.842(1) [1.000]	-3.544(1) [1.000]	3.097(1) [1.0000]	1.340(1) [1.000]
8.	CROBEX	1997:1 -2006:2	0.412(1) [0.9819]	-0.972(1) [0.9478]	0.288(1) [0.9768]	-1.063 (1) [0.9350]
9.	SOFIX	2000:10 -2006:2	0.760 (2) [0.9910]	-2.463(2) [0.3465]	0.969(2) [0.9939]	-2. (2) [0.4444]
10.	BET10	1997:9 -2006:2	3.352 (7) [1.0000]	0.869 (7) [1.0000]	4.369 (7) [1.0000]	1.418(7) [1.0000]
11.	SAX	1996:1 -2006:2	1.077 (5) [0.9950]	-0.133 (5) [0.9926]	1.464 (5) [0.9974]	0.086 (5) [0.9950]

Note: ADF - Augmented Dickey-Fuller test; PP – Phillips-Peron test; optimal number of time lags determined with Schwarz-Bayesian Information Criterion and is presented in parenthesis; p-value in brackets, * null hypothesis about existence of unit root rejected at 1 percent level.

Table 2: ADF and PP unit root tests – in differences

	Name of the variable	Time period	ADF		PP	
			t-value (trend included)	t-value (no trend)	t-value (trend included)	t-value (no trend)
1.	FOOTSE	1996:1 -2006:2	-33.178*(2) [0.000]	-33.177 *(2) [0.000]	-50.322*(2) [0.000]	-50.316*(2) [0.000]
2.	S&P500	1996:1 -2006:2	-14.267*(12) [0.000]	-37.761*(1) [0.000]	-52.530*(12) [0.000]	-52.083*(1) [0.000]
3.	DAX	1996:1 -2006:2	-17.236*(8) [0.0000]	-36.932*(1) [0.0000]	-51.419*(8) [0.000]	-51.386*(1) [0.000]
4.	WIG	1996:1 -2006:2	-34.979*(1) [0.000]	-35.005*(1) [0.000]	-39.467*(1) [0.000]	-39.489*(1) [0.000]
5.	SBI20	1996:1 -2006:2	-36.638*(1) [0.000]	-36.673*(1) [0.000]	-49.503*(1) [0.000]	-49.531*(1) [0.000]
6.	BUX	1996:1 -2006:2	-13.285*(12) [0.000]	-14.656*(10) [0.000]	-47.689*(12) [0.000]	-47.688 (10) [0.000]
7.	PX50	1996:1 -2006:2	-34.759*(1) [0.000]	-34.954 *((1) [0.000]	-46.218*(1) [0.000]	-46.393*(1) [0.000]
8.	CROBEX	1997:1 -2006:2	-13.690*(11) [0.000]	-14.482*(10) [0.000]	-52.794*(1) [0.000]	-52.840*(10) [0.000]
9.	SOFIX	2000:10 -2006:2	-11.555*(6) [0.000]	-21.599*(1) [0.000]	-31.653*(6) [0.000]	-31.285*(1) [0.000]
10.	BET10	1997:9 -2006:2	-13.775*(6) [0.000]	-14.241*(6) [0.000]	-41.438*(6) [0.000]	-41.749*(6) [0.000]
11.	SAX	1996:1 -2006:2	-18.984*(4) [0.000]	-19.165*(4) [0.000]	-50.089*(4) [0.000]	-50.246*(4) [0.000]

Note: ADF - Augmented Dickey-Fuller test; PP – Phillips-Peron test; optimal number of time lags determined with Schwarz-Bayesian Information Criterion and is presented in parenthesis; p-value in brackets, * null hypothesis about existence of unit root rejected at 1 percent level.

4.2. Cointegration tests

The results of cointegration tests, presented in Tables 3, 4, 5, and 6, all point to a single conclusion. In all cases where three or more equity markets are being testes using Johansen methodology, we were able to establish at least one cointegrating vector. This result indicates that global factors are crucial in determining trend co-movements, i.e. long-run equilibrium in all equity market indices in our sample. As far as bilateral cointegration is concerned, we tested all possible bilateral pairs of equity market indices. However, neither of bilateral relationships tested for presence of cointegration, not even pairs of indices of three most developed equity markets in the sample, confirmed presence of cointegration vector. The results of this exercise are not presented here since they would consume too much space, but are available upon the request from the authors. This outcome is relevant for our third step of the empirical analysis, since it means that Granger test does not have to be augmented with error correction term in any of 110 pairs of equity market indices being tested. Besides its technical relevance, lack of bilateral integration between any pair of equity markets in our sample implies that long-run interdependence is still a long-term global phenomenon only evident in common equity indices movements across all markets in the sample, while on the country-to-country level, domestic factors preclude two countries equity markets to fully integrate.

Also, since all multilateral specifications involving all sample of CEE equity markets had one cointegrating vector, regardless of developed equity market proxy, we can also conclude that joining EU made no difference in terms of common trend movements of indices in all CEE countries. Long-run equilibrium relationship between equity indices is obviously not affected by domestic exchange rate changes as market participants in all CEE countries expect that they will join the single European currency in the future that in turn does lead to an increase in their market dependence with the euro-zone equity market but without diminishing the importance of long-run comovemnets of CEE equity markets with UK and US equity markets.
The results of Johansen procedure for testing the number of cointegration vectors determined two cointegration vectors only in case of multilateral cointegration between all CEE countries equity markets in the sample, while in all other cases where multilateral cointegration between CEE countries equity market and US, UK and German equity market was tested, only one cointegration vector was found. This could mean that that the level of equity market integration between CEE countries is somewhat more pronounced than integration between all CEE countries equity markets and developed countries equity market. This in turn would signify that investors perceive all equity markets in CEE as one region with same inherent risk. Moreover, since cointegration vectors could be found in cases of cointegration between both, all CEE countries and CEE candidate countries on the one side, and UK, US and German equity market on the other side we can conclude that in terms of joint long-run equilibrium behavior of equity indices in CEE countries, interaction with any of the developed equity markets in the long-run produces the same integrative effect regardless of the inherent exchange rate risk.
However, in the short-run testing the interactions among markets by Granger causality test produces much different result.

Table 3: Testing the integration between DAX and CEE equity markets

Maximum rank	LL	Eigen value	λtrace	5 % critical value	λmax	5 % critical value
0	-57726.813	-	263.4100	192.89	76.8042	57.12
1	-57688.411	0.05421	186.6057	156.00	47.9095*	51.42
2	-57664.456	0.03417	138.6963	124.24	42.4815	45.28
3	-57643.215	0.03036	96.2148	94.15	31.0938	39.37
4	-57627.668	0.02231	65.1209*	68.52	24.8482	33.46
5	-57615.244	0.01787	40.2728	47.21	24.3803	27.07
6	-57603.054	0.01754	15.8925	29.68	9.7458	20.97
7	-57598.181	0.00705	6.1467	15.41	6.0559	14.07
8	-57595.153	0.00439	0.0908	3.76	0.0908	3.76
9	-57595.108	0.00007	-	-	-	-

Note: LL - log likelihood; optimal number of time lags selected using SBIC obtained after VAR estimation of all endogenous variables; maximum likelihood estimation includes a constant in order to account for the trend present in the data; * null hypothesis accepted at 5 percent level.

Table 4: Testing the integration between FTSE and CEE equity markets

Maximum rank	LL	Eigen value	λtrace	5 % critical value	λmax	5 % critical value
0	-57362.817	-	267.3209	192.89	81.4947	57.12
1	-57322.07	0.05743	185.8262	156.00	47.7516*	51.42
2	-57298.194	0.03406	138.0746	124.24	43.9454	45.28
3	-57276.221	0.03139	94.1292*	94.15	31.2456	39.37
4	-57260.598	0.02242	62.8836	68.52	24.9859	33.46
5	-57248.105	0.01797	37.8977	47.21	21.3695	27.07
6	-57237.421	0.01539	16.5282	29.68	10.5745	20.97
7	-57232.133	0.00764	5.9537	15.41	5.9361	14.07
8	-57229.165	0.00430	0.0176	3.76	0.0176	3.76
9	-57229.157	0.00001	-	-	-	-

Note: LL - log likelihood; optimal number of time lags selected using SBIC obtained after VAR estimation of all endogenous variables; maximum likelihood estimation includes a constant in order to account for the trend present in the data; * null hypothesis accepted at 5 percent level.

Table 5: Testing the integration between SP500 and CEE equity markets

Maximum rank	LL	Eigen value	λtrace	5 % critical value	λmax	5 % critical value
0	-55360.881	-	277.8383	192.89	92.7421	57.12
1	-55314.51	0.06509	185.0962	156.00	47.1028*	51.42
2	-55290.959	0.03360	137.9935	124.24	43.4960	45.28
3	-55269.211	0.03107	94.4974	94.15	31.9647	39.37
4	-55253.228	0.02293	62.5327*	68.52	24.2299	33.46
5	-55241.113	0.01743	38.3028	47.21	20.3065	27.07
6	-55230.96	0.01463	17.9963	29.68	11.6671	20.97
7	-55225.126	0.00843	6.3292	15.41	6.3200	14.07
8	-55221.966	0.00458	0.0092	3.76	0.0092	3.76
9	-55221.962	0.00001	-	-	-	-

Note: LL - log likelihood; optimal number of time lags selected using SBIC obtained after VAR estimation of all endogenous variables; maximum likelihood estimation includes a constant in order to account for the trend present in the data; * null hypothesis accepted at 5 percent level.

Table 6: Testing the integration between CEE equity markets

Maximum rank	LL	Eigen value	λtrace	5 % critical value	λmax	5 % critical value
0	-50021.421	-	226.7133	156.00	69.6207	51.42
1	-49986.61	0.04927	157.0926	124.24	46.7603	45.28
2	-49963.23	0.03336	110.3323	94.15	36.8234*	39.37
3	-49944.819	0.02637	73.5089	68.52	30.8963	33.46
4	-49929.37	0.02217	42.6126*	47.21	23.2464	27.07
5	-49917.747	0.01673	19.3662	29.68	13.6020	20.97
6	-49910.946	0.00982	5.7641	15.41	5.7320	14.07
7	-49908.08	0.00415	0.0321	3.76	0.0321	3.76
8	-49908.064	0.00002	-	-	-	-

Note: LL - log likelihood; optimal number of time lags selected using SBIC obtained after VAR estimation of all endogenous variables; maximum likelihood estimation includes a constant in order to account for the trend present in the data; * null hypothesis accepted at 5 percent level.

4.3. Granger Causality tests

The results of Granger causality tests conducted on data in first difference clearly describe how shocks are transmitted across markets. US equity market, being the strongest and the most developed is a leading changes in other two developed equity markets (UK and German equity markets), but is also strongly affecting more developed equity markets in CEE countries (Polish, Slovenian, Czech, Hungarian and Croatian equity markets). German equity market has causal relationship to more developed CEE markets, but can not Granger cause changes in US and UK equity markets on 5 percent significance level.

In terms of its reaction to short-run movements from both developed equity markets and CEE equity markets, CEE equity markets can be divided in three separate groups.

In first group we placed Polish and Hungarian equity market because they respond to developed market movements (Hungary is responsive to short-run developments from all three developed markets, while Poland responds to UK and US stock market changes, while changes in German equity market does not seem to have any affect). Moreover, Poland and Hungary are also involved in short-run interaction with other CEE countries that react to short-run movements of developed markets, but barely have any interaction with Slovakian, Romanian and Bulgarian equity market, meaning that they are quite isolated from developments on those three less developed CEE equity markets.

The second group of countries includes Slovenian, Czech and Croatian equity market. These three markets also respond to short-run dynamics stemming from developed equity markets (although Czech stock exchange seems to be the least responsive, since unlike the other two markets in question it reacts only to US equity market movements). What these three markets differentiates from Polish and Hungarian market is that they have active short-run interaction with Slovakian, Romanian and Bulgarian equity markets, while maintaining interaction among themselves and with Polish and Hungarian equity markets. Those three markets are also the most active ones with one difference, Slovenian and Czech equity markets are leading short-run movements, while Croatian equity market is lagging, i.e. it just receives short-run dynamics without almost any ability to transmit it further.

The last three equity markets, Slovakian, Romanian and Bulgarian equity markets form the last, third group. They do not respond at all to developed equity market short-run dynamics, but instead they are sensitive to short-run movements of equity markets from the second group (Slovenian, Czech and Croatian equity market). Moreover, they also interact among themselves. One other result that differentiates the third group from two other groups of CEE countries is that this group's interaction with second group mainly goes in both directions. More specifically, the null hypothesis of Granger test is rejected in both directions meaning that changes in returns for these countries are determined endogenously. Thus, even though we can not establish the direction of causalities, we can say that activities of the equity markets in question are in the short-run are undoubtedly interdependent[2].

[2] Although it must also be stated that endogeneity of certain indices might be caused by noise potentially present in the data

Table 8: Results of Granger causality test

Countries	FOOTSE	S&P500	DAX	WIG	SBI20	BUX	PX50	CROBEX	SOFIX	BET10	SAX
	chi^2 - value	chi^2 - value	chi^2 - value	chi^2 - value	chi^2 - value	chi^2 - value	chi^2 - value	chi^2 - value	chi^2 - value	chi^2 - value	chi^2 - value
FOOTSE	-	352.41* [0.000]	19.47 [0.078]	7.2526 [0.840]	26.991* [0.008]	10.534 [0.602]	12.039 [0.443]	4.7401 [0.966]	4.9247 [0.960]	2.4668 [0.998]	6.9889 [0.868]
S&P500	28.329* [0.005]	-	19.67 [0.074]	6.4631 [0.891]	12.132 [0.435]	4.2671 [0.978]	8.1299 [0.775]	10.127 [0.605]	6.775 [0.872]	4.3969 [0.975]	8.3157 [0.760]
DAX	24.201** [0.019]	259.71* [0.000]	-	12.662 [0.394]	18.6 [0.099]	12.039 [0.443]	13.505 [0.303]	14.633 [0.262]	4.5168 [0.972]	4.4695 [0.973]	4.9471 [0.960]
WIG	23.392** [0.025]	37.499* [0.000]	17.721 [0.124]	-	23.456** [0.024]	7.9502 [0.789]	16.291 [0.178]	4.3477 [0.976]	7.9303 [0.791]	8.0121 [0.784]	15.713 [0.205]
SBI20	39.664* [0.000]	205.89* [0.000]	30.6* [0.002]	18.87 [0.092]	-	16.05 [0.189]	22.966** [0.028]	17.272 [0.140]	37.003* [0.000]	32.247* [0.001]	10.144 [0.603]
BUX	98.471* [0.000]	379.46* [0.000]	91.41* [0.000]	9.8149 [0.632]	30.597* [0.002]	-	29.657* [0.003]	18.152 [0.111]	17.405 [0.135]	12.08 [0.439]	5.9518 [0.918]
PX50	17.354 [0.137]	114.24* [0.000]	13.116 [0.361]	24.321** [0.018]	70.748* [0.000]	38.313* [0.000]	-	8.5101 [0.744]	29.361* [0.003]	20.23 [0.063]	38.281* [0.000]
CROBEX	25.942** [0.011]	70.21* [0.000]	19.85 [0.070]	11.826 [0.460]	23.839** [0.021]	30.062* [0.003]	20.26 [0.062]	-	37.005* [0.000]	51.478* [0.000]	8.8999 [0.711]
SOFIX	5.9805 [0.917]	14.064 [0.297]	7.5154 [0.822]	14.12 [0.293]	22.73** [0.030]	14.522 [0.269]	32.674* [0.001]	15.676 [0.207]	-	35.982* [0.000]	20.98 [0.051]
BET10	3.5721 [0.990]	7.88 [0.794]	4.3568 [0.976]	33.295* [0.001]	50.069* [0.000]	16.856 [0.155]	47.826* [0.000]	25.562** [0.012]	75.415* [0.000]	-	47.12* [0.000]
SAX	6.3912 [895]	6.2314 [0.904]	6.7106 [0.876]	7.3963 [0.830]	44.313* [0.000]	33.192* [0.001]	69.49 * [0.000]	30.243* [0.003]	35.582* [0.000]	101.49* [0.000]	-

Note: number of lags is 12; p-value in brackets; * null hypothesis rejected at 1 percent level; ** null hypothesis rejected at 5 percent level; *** null hypothesis rejected at 10 percent level; EC term added for pairs of countries shaded with grey colour.

5. Conclusion

This study faces us with evidence that the forces driving financial integration are quite powerful, and we are likely to see substantial further movement in the direction of more capital mobility and financial institutions with greater geographic scope.

There are many factors that have probably speeded up the process of equity market integration of Central and Eastern Europe countries on the one hand and EU and USA on the other. Some of them like:

- liberalisation of capital flow barriers in CEE countries which allowed easier flow of capital across borders;
- potentially higher returns offered by equity markets in transition countries (e.g. Gilmore, Lucey and Mcmanus 2005) made equity markets in Central and East Europe very attractive for EU and US investors;
- entry of old EU member countries banks into banking systems of Central and East Europe countries (e.g. Schmitz 2004) could have made these markets more co-ordinated and integrated especially since banks are the single biggest players in emerging countries equity markets and therefore can enhance risk sharing across countries;

- increasingly strong trade linkages between old EU members on one hand and new EU countries, acceding and candidate countries on the other hand and significant FDI inflows from old EU members to new members and candidate states surly made these countries more co-dependant and equally subjectible to same exogenous shocks;
- unexpected, but increasing level of unofficial euroization in Central and East Europe countries (e.g. Billmeier and Bonato 2002) probably helped subduing exchange rate related risks and uncertainty thus promoting stronger development of particular financial systems and cross border trading (e.g. IMF Occasional Paper 2004),

surly have facilitated and promoted the process of integration between EU and US and Central and East European equity markets measured with common trend movements in equity markets indices. However, results of Granger causality tests point to lack of short-run coherence between developed equity markets and some CEE equity markets. Therefore, we can conclude that spillover effects from developed equity markets to CEE equity markets are incomplete implying that evidence of global long-run comovements is not necessarily suggesting complete integration of aforementioned equity markets. As least developed equity markets among observed sample of CEE equity markets are to gain more significance, short-run developments are expected to become more coherent and interdependent.

The findings of the paper have important implications for both investors and policy makers. For investors, the high degree of integration means that the Europe as a whole has become a more attractive place for investment. However, higher integration also implies that there are fewer opportunities to diversify portfolios within the Euro area, thus providing incentives to focus more on diversifying across sectors or across regions.

For policy-makers, the process of European financial integration poses some challenges. Financial integration has increased competition and market efficiency and, at the same time, continuing financial integration has made individual European markets increasingly interdependent and subjected to spillovers resulting from endogenous and exogenous shocks. Such rising interdependence may thus require prudential supervisors and security market overseers to increasingly adopt a Euro-area-wide approach.

The adoption of the Euro by the new EU Member States and eventually both acceding and candidate countries will be the ultimate final step for policy makers pursuing monetary integration. The process of monetary integration can only be successful if it follows the broader process of economic and financial integration. Although, the economic literature shows that economic and financial integration is a process that will go on after entry into the EMU, a certain degree of economic and financial integration is a prerequisite for first joining ERM II and later for adopting the euro. In line with latter argument, this study clearly demonstrated that some level of multilateral financial market integration between some new EU member states and even acceding and candidate countries already exists which should in turn facilitate smoother euro adoption in these countries.

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