INTEGRATION OF THE SELECTED SEE EQUITY MARKETS: COINTEGRATION APPROACH

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Abstract: The purpose of this paper is to examine the integration of selected Central and Eastern European equity markets for the period of January 2nd, 2005 to December 30th 2008. The cointegration tests according the Johansen methodology suggest: (1) existence of multilateral integration between selected SEE equity markets, and (2) existence of multilateral integration between the group of selected SEE equity markets and the leading European equity index (FTSE).

Error Correction Model is developed to deals with the long-run equilibrium relationships, while providing the possibility of short run divergence. The model allows finding the lead-lag relationships between market indices, or how the turning points in one series precede turning points in the other.

These findings have important applications for investors. Integration of the markets implies that there are fewer opportunities to diversify portfolios within the examined markets. The investors should focus more on diversifying across sectors or across regions.

JEL classification: C32, G15.

Key words: cointegration; error correction model; equity markets; SEE

1. Introduction

In regional and international investment activities, portfolio managers and investors are in continuous search of models that represent the connection and causality between equity markets. These models provide a better approximation of the equity markets co-movements and enable better evaluation of securities. In addition, international portfolio diversification is an excellent opportunity to minimize risk.

Cointegration refers not to co-movement in returns, but to co-movements in equity prices. If spreads are mean-reverting, equity prices are tied together in the long term by a common stochastic trend, and then the prices are cointegrated. Cointegration methodology developed by Engle and Granger (1987) and Johansen (1988) is the most popular approach for investigating common trends in multivariate time series, and provides a sound methodology for modeling both long-run and short-run dynamics in a system.

Cointegration is a two-step process: first any long equilibrium relationships between prices are established, and then a dynamic correlation model of returns is estimated. The error correction models (ECM), so called because short-term deviations from equilibrium are corrected, reveals the Granger causalities that must be presented in a cointegrated system. Thus cointegration may be a sign of market inefficiency (Alexander, 2002).

This paper contributes to the existing literature in the way that there is no other study investigating the financial integration between Macedonian equity market and the other SEE equity markets.

The remainder of the paper is structured as follows. Section 2 provides a brief literature review, focusing on financial integration. The methodology and the data are examined in the Section 3. Empirical results are presented in Section 4, while Section 5 concludes with a summary of the main findings and implications.

2. Literature review

There are various studies that provide evidence of the international equity markets cointegration. But, most of them point out that the arbitrage opportunities are limited.22 However, in the lead-lag relationships, the studies show that U.S. equity markets have leadership on the international capital markets.

King and Wadhwani (1990) and Koch and Koch (1993) using the VAR model found that there is a growing regional interdependence of the equity markets. Dickinson (2000) using the cointegration methodology shows that there is a long-term relationship between equity markets. Korajczuk (1995) found that the degree of integration between the developed markets is higher than the emerging markets.

Voronkova (2004), and Gilmore, Lucey and McManus (2005) investigated the causality between German equity market on the one side and the Polish, Czech and Hungarian equity markets on the other side. Both studies come to the conclusion that the process of integration of the CEE countries leading to greater integration of their equity markets with those of European Union.

Many studies such as Fama and French (1989), Ferson and Harvey (1991) and Jagannathan and Wang (1996) stressed that the degree of the national equity market integration depends on the extent of real and financial sector convergence with other economies. In addition, Erb, Campbell and Viskanta (1994), and Ragunathan, Faff and Brooks (1999) show that the equity markets integration tend to be highest in the periods when countries are in recession.

There are several studies that examine the degree of integration between equity markets from SEE countries and equity markets from the European Union or the United States. Dadić and Čenić (2006) explore bilateral and multilateral integration between equity markets from selected SEE countries and the German equity market. Their results indicate that there is a multirateral integration not only among equity markets of the observed SEE countries, but, there is an evidence of multirateral equity market integration between the entire group of observed CEE equity markets and German equity market. Erjavec and Cota (2007) analyzed the impact of the European (DAX30 and FTSE100) and U.S. indices (DJIA and NASDAQ) on the main Croatian equity market index (Crobex). They found that U.S. indices have a stronger influence on the Croatian index than European ones.

3. Research sample

[22] The studies are: Karfakis and Moshos (1990), Kasa (1992), Smith, Brocato and Rogers (1993), Corhay, Tourani and Urbain (1993), Clare, Maras and Thomas (1995) and Masih (1997).

The paper aims to investigate the interdependence between the selected developing equity markets from South Eastern Europe (SEE). The selected markets are: Slovenian, Croatian, Serbian, Macedonian and Bulgarian. Also, the UK market is included in the analysis, as one of the leading European equity market. These markets are presented by their main indices: SBI20, CROBEX, BELEXline, MBI10, SOFIX and FTSE, respectively.

The data were obtained from the recorded weekly closing prices of the selected indices, for the period January 2nd, 2005 to December 30th 2008.

4. Research and methodology

The examination of the interdependence of the equity markets demands the application of Johansen methodology. It employs a power function with better properties than the Engle-Granger method (Kremers, Ericcson and Dolado, 1992), and has less bias when the number of variables is greater than two (Johansen and Juselius, 1990). The following stages are employed:

A. Application of the Augmented Dickey-Fuller test and Phillip-Peron test to test the stationarity of the data. It is noted that a variable is considered stationary when the mean, as well as the variance of the series remains stable during time. The above tests reveal whether a unit root is present and thus, the time series in non-stationary.
B. The second stage is cointegration analysis to test the presence of long-run equilibrium relationships in following cases:
    - between the selected equity markets from the CEE region;
    - between the Macedonian equity market and UK equity market; and
    - between the selected equity markets from the CEE region and UK equity market.

Cointegration measures long-run co-movements in prices, which may occur even through periods when static correlations appear low. Cointegration tests allow to determine whether stock prices or indices of different national markets move together over long run, while providing for the possibility of short-run divergence.

C. Existence of the cointegration allows implementation of the error correction model (ECM). In the third stage, the ECM is build. The ECM is a dynamic model for first differences of the $I(1)$ variables that were used in the cointegrating regression. Thus, if log prices are cointegrated and the cointegration vector is based on these, the ECM is a dynamic model of correlation in returns (Alexander, 2002).
D. The last stage of the analysis is examination of causality by performing pair wise Granger Causality tests at all pairs of the equity indices included in the sample. This test is used to determine whether time series X affects time series Y. More specifically, it is suggested that X Granger-causes Y, not in the sense that if we make a structural change to one series the other will change too, but in the sense that turning points in one series precede turning points in the other.

5. Empirical results

The investigation of cointegration is based on the methodology of Johansen. The aim is to determine whether a group of nonstationary series is cointegrated or not.

Therefore, the first step is to test each series for the presence of unit root, which will show whether the series are nonstationary.

Table no. 1 presents t-values and p-values of two stationarity tests, Augmented Dickey-Fuller test and Phillips-Peron test. It can be seen that for the two specifications of each test, with trend and without trend, the p-values (shown in parentheses) are larger than the 5% level of significance. This means that the null hypothesis is accepted for the time series of each equity index, individually. The null hypothesis states that a series of weekly log values of the index has a unit root (the series is nonstationary).

Table no. 1: Tests of stationarity applied on weekly log values of the equity indices

Equity index	Augmented Dickey-Fuller test		Philips-Peron test	
	t-value (only intercept)	t- value (with intercept and trend)	t-value (only intercept)	t-value (with intercept and trend)
S&P500	-0.632	0.153	-0.752	0.530
FTSE	-1.314	-0.541	-1.323	0.052
SBI20	-0.904	2.089	-0.903	1.008
CROBEX	-1.320	1.372	-1.572	1.553
BELEXline	-1.284	0.759	-1.603	1.569
SOFIX	-0.593	3.474	-0.875	2.425
MBI10	-2.755	0.906	-2.406	0.141

Nonstationarity is a prior condition for cointegration. In addition, all observed series should be integrated of the same order. Therefore, the Table no. 2 presents the two stationarity tests (Augmented Dickey-Fuller test and Phillips-Peron test) applied to first order differences of equity indices weekly log values. For the two specifications of each test, with trend and without trend, the p-values (shown in parentheses) are lower than the 1% level of significance. This means that the null hypothesis is rejected for the time series of each equity index, individually. The first order differences of the weekly log values of each equity index are stationary.

Because the stationarity tests provide evidence that all equity indices are I (1) process, the cointegration tests according the methodology of Johansen can be implemented. The ultimate goal of cointegration is to determine the presence of common stochastic trends in the data and to use these trends for dynamic analysis of the correlation of returns.

In the first case the cointegration between selected CEE indices (MBI10, SOFIX, BELEXline, CROBEX and SBI20) is examined. The results of Johansen tests are shown in Table no. 3. According to p-values, the null hypothesis is rejected for all $r \leq 1$ with a significance level of 5%. But, the null hypothesis that $r \leq 2$ can't be rejected (the corresponding p-value equals 0.6984). Therefore the conclusion is that there are 2 cointegration vectors in the system. This result is evidence of cointegration between Ljubljana, Zagreb, Belgrade, Skopje and Sofia equity market.

Table no. 2: Tests of stationarity applied on first order differences of equity indices weekly log values

Equity index	Augmented Dickey-Fuller test		Philips-Peron test	
	t-value (only intercept)	t-value (with intercept and trend)	t-value (only intercept)	t-value (with intercept and trend)
S&P500	-8.114	-8.349	-14.351	-14.596
FTSE	-8.228	-15.101	-14.776	-15.128
SBI20	-5.001	-5.207	-13.833	-14.030
CROBEX	-7.217	-7.703	-14.480	-14.976
BELEXline	-4.094	-4.756	-10.512	-11.470
SOFIX	-4.753	-5.288	-11.871	-12.379
MBI10	-7.399	-8.103	-13.202	-13.579

Table no. 3: Tests of cointegration between SBI20, CROBEX, BELEXline, MBI10 and SOFIX

Number of cointegration vectors	Eigen value	Test statistics (Tr)	5% critical value	*p*-value
0	0.192025	91.96650	69.81889	0.0003
At most 1	0.155869	49.74816	47.85613	0.0328
At most 2	0.052535	16.19751	29.79707	0.6984
At most 3	0.027296	5.512432	15.49471	0.7522
At most 4	0.000165	0.032599	3.841466	0.8567

Note: The test use critical values of MacKinnon, Haug and Michellis (1999).[23]

The result that observed CEE indices are cointegrated implies that there are two linear combinations of the five equity indices which force them to have a long-term equilibrium relationship, although in short them they could recede with each other. Also, the result implies that the indices returns are correlated in the long term. Therefore the conclusion for the investors would be that in the long run it is not important does the diversification is done by the portfolio which is consist of all five equity indices or by the portfolio of only one index. However, in the short term these two portfolios differ significantly. The portfolio which is composed by all five equity indices has greater potential for higher returns.

Second case of interest is cointegration between MBI10 and one of the main European equity indices - FTSE. Table no. 4 shows that the null hypothesis is rejected for $r \leq 0$ at the 5% level of significance. The null hypothesis is accepted for $r \leq 1$ (corresponding p-value equals 0.1033). Therefore, the conclusion is that there is only one cointegration vector. This means that MBI10 and FTSE are cointegrated. Long-term movement of the MBI10 is determined by the FTSE. However, it must be said that

[23] Cointegration testing is done in EViews. EViews use the critical values of MacKinnon, Haug and Michellis (1999), which differs from those of Johansen and Juselius (1990).

cointegration between these two indices is weaker than the previously observed among the group of CEE equity indices.

Table 4: Tests of cointegration between MBI10 and FTSE

Number of cointegration vectors	Eigen value	Test statistics (Tr)	5% critical value	*p*-value
0	0.078597	18.86152	15.49471	0.0149
At most 1	0.013313	2.653685	3.841466	0.1033

The third case examines the cointegration between selected CEE indices (MBI10, SOFIX, BELEXline, CROBEX and SBI20) and FTSE index. The results are presented in the Table 5. The null hypothesis of r ≤ 2 can't be rejected (the corresponding p-value equals 0.3982). It means that there are two cointegration vectors between the observed groups of equity indices.

Table 5: Tests of cointegration between SBI20, CROBEX, BELEXline, MBI10, SOFIX and FTSE

Number of cointegration vectors	Eigen value	Test statistics (Tr)	5% critical value	*p*-value
0	0.198865	99.40770	69.81889	0.0000
At most 1	0.162611	55.50591	47.85613	0.0081
At most 2	0.068115	20.36746	29.79707	0.3982
At most 3	0.031637	6.399285	15.49471	0.6483
At most 4	0.000171	0.033936	3.841466	0.8538

The existence of cointegration between the observed equity indices indicates that there are relations of long-term equilibrium. Based on this it is possible to build a error correction model (ECM). The ECM model for the CEE indices has the following form (it is only present the equation where dependent variable is MBI10):

$$\Delta lmbi10_t = c_1 + \sum_{i=1}^{m_1} \phi_{1i} \Delta lmbi10_{t-1} + \sum_{i=1}^{m_2} \phi_{2i} \Delta lsofix_{t-1}$$
$$+ \sum_{i=1}^{m_3} \phi_{3i} \Delta lbelex_{t-1} + \sum_{i=1}^{m_4} \phi_{4i} \Delta lcrobex_{t-1}$$
$$+ \sum_{i=1}^{m_5} \phi_{5i} \Delta lsbi20_{t-1} + \gamma_1 z_{t-1} + \gamma_2 z_{t-2} + u_{1t}$$

Where $lmbi$, $lsofix$, $lbelex$, $lcrobex$ and $lsbi20$ represents logarithms of weekly values of correspondent equity index. The variables in the model are included as a first order differences. The length of time lag is determined by the Wald tests. Table no. 6 shows that significant are the second and third time lag. This means that the influences between the equity markets are transmitted with a delay of two and three weeks. The model contains the error correctors (z_1 и z_2) that allow deviations from long-term equilibrium to be corrected through a series of short-term adoptions:

$$z_1 = lmbi10 - 1.570 lbelex - 1.428 lcrobex + 1.102 lsbi20 + 2.613$$
$$z_2 = lsofix - 7.051 lbelex - 1.860 lcrobex + 17.617 lsbi20 - 3.640$$

Table no. 6: Wald tests

Time lag	$\Delta lmbi10$	$\Delta lsofix$	$\Delta lbelex$	$\Delta lcrobex$	$\Delta lsbi20$	Joint
1	5.710865 (0.335)	8.482461 (0.131)	7.156102 (0.209)	4.090049 (0.536)	5.784529 (0.328)	39.98684 (0.029)
2	10.50784 (0.062)	6.231260 (0.284)	0.406941 (0.995)	9.356772 (0.095)	6.803443 (0.235)	45.14879 (0.008)
3	9.620772 (0.087)	30.55800 (0.001)	26.57750 (0.001)	18.87985 (0.002)	18.74126 (0.002)	66.90907 (0.001)
4	5.517287 (0.356)	11.37665 (0.044)	7.175685 (0.207)	3.139614 (0.678)	3.591475 (0.609)	33.60466 (0.117)

Table no. 7: Estimated values of ECM

	$\Delta lmbi10$	$\Delta lsofix$	$\Delta lbelex$	$\Delta lcrobex$	$\Delta lsbi20$
c	0.004306	-0.001930	-0.000302	0.000164	8.17E-08
$\Delta lmbi10(-2)$	0.079844	-0.068171	0.048968	0.049507	0.033440
$\Delta lmbi10(-3)$	0.096419	0.031552	0.063492	0.021130	0.001504
$\Delta lsofix(-2)$	-0.016948	0.183731	0.019105	0.065647	0.033925
$\Delta lsofix(-3)$	0.155796	0.049517	0.182242	0.112402	0.135545
$\Delta lbelex(-2)$	0.201212	0.121338	0.070994	0.140375	0.115147
$\Delta lbelex(-3)$	0.282488	0.184239	0.132655	0.045339	-0.118790
$\Delta lcrobex(-2)$	-0.152308	-0.022119	0.012659	0.145951	-2.10E-06
$\Delta lcrobex(-3)$	-0.262641	-0.004410	-0.085967	-0.088465	-0.140460
$\Delta lsbi20(-2)$	-0.052414	0.067285	-0.006813	-0.010505	-0.092895
$\Delta lsbi20(-3)$	-0.012423	0.253227	0.078597	0.248154	0.194304
$z_1(-1)$	-0.120117 (0.028)	-0.001995 (0.022)	-0.056284 (0.017)	0.015077 (0.021)	-0.022413 (0.015)
$z_2(-1)$	0.014154 (0.005)	0.000642 (0.004)	0.007855 (0.003)	-0.002767 (0.004)	-0.005861 (0.002)

Estimated values of the coefficients of the ECM model are presented in Table no. 7. In addition, the corresponding p-values are shown in parentheses. Based on the model results can be drawn a conclusion about the dynamics of the observed equity markets. Statistical significance of estimated coefficients of disequilibrium term (γ_1 and γ_2) provides information whether the corresponding dependent variable in equation is endogenous or exogenous. Because all p-values of estimated γ_1 and γ_2 are statistically significant can be said that they are endogenous, which leads to the conclusion that each equity market is the receptor of the influences from the other observed markets.

Granger causality tests are presented in the Table no. 8. Their aim is to determine how the volatility of MBI10 returns are caused by the volatility of the other equity indexes returns. Obtained p-values show that Granger causality (in the sense that turning point in one series precedes the turning points in the other) for the volatility of MBI10 returns are volatility of BELEXline and CROBEX returns. This result is evidence that there is direct influence of Belgrade and Zagreb equity market on

Macedonian equity market. The other two equity markets (Ljubljana and Zagreb) have not direct influence on Macedonian (correspondent p-values are higher than 0.1).

Table no. 9 shows the opposite case, i.e. how the volatility of MBI10 returns influence the other equity indices, separately. The reported p-values implies that the volatility of MBI10 do not have direct influence on the volatility of other equity indices (all p-values are higher than 0.1).

Table no. 8: Granger causality tests, dependent variable $\Delta lmbi10$

Independent variable	Chi-square	p-value
$\Delta lsofix$	1.822229	0.4021
$\Delta lbelex$	7.112214	0.0285
$\Delta lcrobex$	5.253345	0.0723
$\Delta lsbi20$	0.098851	0.9518

Table no. 9: Granger causality tests, independent variable $\Delta lmbi10$

Dependent variable	Chi-square	p-value
$\Delta lsofix$	1.756410	0.4155
$\Delta lbelex$	3.533309	0.1709
$\Delta lcrobex$	0.964898	0.6173
$\Delta lsbi20$	0.800394	0.6702

Table no. 10: Granger causality tests

Dependent variable	Chi-square	p-value
$\Delta lsofix$	11.23634	0.1887
$\Delta lbelex$	17.22489	0.0279
$\Delta lcrobex$	15.41757	0.0515
$\Delta lsbi20$	17.10914	0.0290

Granger causality tests provide other important information about the linkage between the observed equity markets. The second row of the Table no. 10 presents the joint impact of all observed equity indices on the Sofia equity index. The p-value (0.1887) suggests that MBI10, BELEXline, Zagreb and Ljubljana have no direct influence on the volatility of SOFIX. Opposite conclusion can be drawn in the other three cases. There is direct influence of the group of observed indices on BELExline. The same is with the CROBEX and SBI20.

6. Conclusions

This paper investigates short and long run relationships among five SEE equity markets and one developed European market during the period of January 2nd, 2005 to December 30th 2008. The existence of long run co-movements between the observed markets is estimated with the Johansen methodology. The equity market integration in the selected SEE countries is verified. These findings imply that long-run investors who diversify their portfolios across SEE equity markets should expected rather short-run modest portfolio gains, given the volatile behavior of portfolio returns to market shocks.

There are many factors that influenced the process of equity market integration of SEE countries and EU: (1) potentially higher returns offered by equity markets in transition countries; (2) entry of old EU member countries banks into banking systems of SEE made these financial markets more integrated; (3) significant FDI inflows from old EU members to SEE countries; and (4) liberalization of capital flow barriers in CEE countries which allowed easier flow of capital across borders.

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