A COMPARATIVE ANALYSIS OF STOCK MARKET BEHAVIOR AFTER EUROPEAN ACCESSION IN ROMANIA AND HUNGARY: SOME HYPOTHESES TESTS

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Abstract

This paper investigates whether important aspects of the Romanian and Hungarian stock market changed subsequent to the country's accession to the European Union in January 2007 and May 2004, respectively. We employ weekly data for both considered stock indices (the Romanian index BET and the Hungarian index BUX) and both weekly and daily observations for volume and trade value for the two equity markets. We are interested whether European accession had an important impact on trade value or transaction volume of the two stock markets and even on variance of returns of the BET and BUX indices and we are conducting different test-statistics appropriate for each null hypothesis. We specify a 95% confidence interval, or a 0.05 level of significance for each test-statistic. We found no evidence of important changes in terms of volatility both on Bucharest Stock Exchange and on Budapest Stock Exchange after January 2007 and May 2004 respectively, but found that stock market mean trade value on both markets increased significantly after each country's European integration. The investigation of a change in trade volume found mixed results.

Key words: European accession, CEE equity markets, test-statistics, descriptive statistics.

1. Introduction

Stock markets in Central and Eastern European countries have a very short history, the starting point for most of them dating back in the early 1990's, the moment and modality of implementation being closely linked to the privatization process. Table 1 summarizes the origins of equity markets in Central and Eastern Europe:

Table 1: The origins of equity markets in Central and Eastern Europe:

Mandatory listing after mass privatization	**Voluntary Initial Public Offerings**	**Mandatory Listings of Minority Packages during Privatization**
Bulgaria	Croatia	Armenia
Czech Republic	Estonia	Azerbaijan
FYR Macedonia	Hungary	Kazakhstan
Lithuania	Latvia	Kyrgyz Republic
Moldova	Poland*	Poland*
Romania	Slovenia	Russia
Slovak Republic		Ukraine
		Uzbekistan

Note: Poland also had mandatory listings of mass-privatized companies and National Investment Funds after 1996.
Source: Claessens, Djankov and Klingebiel (2000)

The accession of ten CEE countries to the European Union in May 1, 2004, as well as the recent accession of Romania and Bulgaria on January 1, 2007, gave a big boost on these markets and attracted the interest of many investors worldwide, who previously refrained from investing in legally open markets because of real or perceived political, liquidity and corporate governance risks.[1]

Empirical research on emerging markets characteristics has revealed three markets features (See Harvey (1995)[2] or Bekaert, Erb, Harvey and Viskanta, 1996)[3]: high average returns, high volatility and low correlation, both across the emerging markets and with developed markets.

Studies by Linne (2002), Bialkowski (2004) and Moore and Wang (2007) have examined the returns and volatility of returns of CEE equity markets indices. Syllignakis and. Kouretas (2008) investigated whether the volatility of stock returns of ten emerging capital markets of the new EU member countries has changed as a result of their accession in the EU. They found that the high volatility of stock returns of all new EU emerging stock markets is associated mainly with the 1997-1998 Asian and Russian financial crisis. Moreover, there seems to be a transition to the low volatility regime as they approach the accession to EU in 2004.

2. Preliminary Statistics

The summary statistics of the two markets indices returns are presented in Table 2. Specifically, information on the mean return, risk, skewness coefficient, kurtosis coefficient, the Jarque-Bera normality test and the Augmented Dickey-Fuller Unit Root Test (ADF) are presented.

Data consists in weekly observations for ln returns for two representative indices of the two equity markets (BET for Bucharest Stock Exchange and BUX for Budapest Stock Exchange) which cover a three years period (January 2005 – February 2008).

Table 2: Descriptive statistics of weekly return series (ln) for BUX (Hungary) and BET (Romania)

Statistics	**Hungary**		**Romania**	
Mean	0.2736		0.1665	
Standard Deviation	3.3484		3.9410	
Skewness	-0.5543		-0.8256	
Excess Kurtosis	0.6168		2.4784	
Jarque-Bera Normality test	**10.6640**		**56.9079**	
ADF test at level	t-stat=-11.785519	p-value=0.000000	t-stat=-6.192515	p-value=0.000002
ADF test first difference	t-stat=-8.215180	p-value=0.000000	t-stat=-6.251616	p-value=0.000002
Minimum	-10.2232		-17.5331	
Maximum	9.8862		8.1144	
Obs	159		154	

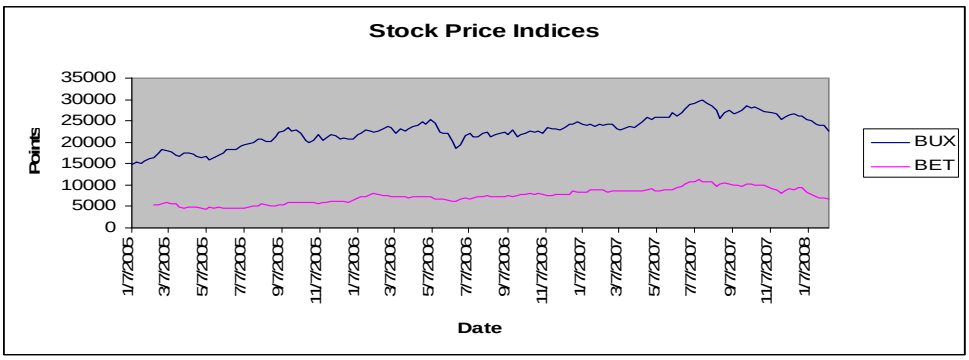
Note: the statistical significant test statistics for a 0.05% confidence level have been bolded

[1] Manolis N. Syllignakis and Georgios P. Kouretas, Switching volatility in emerging stock markets: Evidence from the new EU member countries, 2008;

[2] Harvey, Campbell, Predictable Risk and Returns in Emerging Markets, The review of Financial Studies, 1995

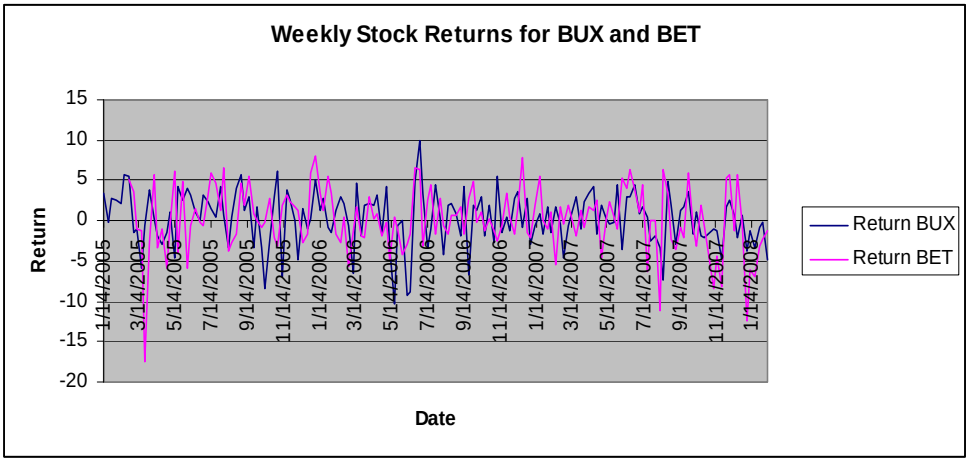
[3] Bekaert, Geert; Claude Erb; Campbell Harvey; Tadas Viskanta. "The behavior of Emerging Market Returns", Duke University, 1996,

We notice that the index returns series are negatively skewed in both cases and also that the excess kurtosis is positive, especially for Romania.
The Jarque-Bera test statistics express the non-normality of the time series, but this is not uncommon to high frequency data. This fact suggests that for Budapest and Bucharest stock exchanges big shocks of either sign are more likely to be present and that the stock returns series may not be normally distributed. As we know, the statistic Jarque-Bera has an asymptotic chi-square distribution with two degrees of freedom. In our case, the calculated values for the JB test for the null hypothesis that the data are from a normal distribution are greater than the critical values, which allows us to accept that return series for the two equity markets are not normally distributed. The null hypothesis is a joint hypothesis of the skewness being zero and the excess kurtosis being zero.
For the Augmented Dickey-Fuller Unit Root Test the null hypothesis is that the series has a unit root. In all considered cases, we can reject this null hypothesis and accept the alternative that historical return series for both BUX and BET have no unit root, which means that there is no serial correlation on the considered stock markets. The lag length used in the unit root tests are based on the Akaike Information Criterion.
Figure 1 provides plots of log stock price indices for each market during a three years period (January 2005-February 2008).



These plots reveal that both markets are characterized by upward sloping trends which end with a historic high reached on the half of 2007, and a decreasing trend after that.

Furthermore, figure 2 plots the weekly stock returns for each market. We notice that the Romanian equity market exhibits more extreme values for volatility, two of these manifestations taking place in March 2005 and in January 2008. These plots show a clustering of larger return volatility around the starting points of downward trends, both short-run and long-run downward trends, as in March 2005 or mid-2007, when was the start of the current downward trend on both markets.



3. Stock market volatility and European integration

For both equity markets included in our analysis, we investigate whether the country's accession to the European Union has had an impact on the volatility of stock returns.
Table 3 presents statistics and hypothesis tests' results conducted on the two stock market indices, for periods of time prior and subsequent to EU accession.
The null hypothesis we test is H_0: $\sigma^2_{before} = \sigma^2_{after}$, versus H_a: $\sigma^2_{before} \neq \sigma^2_{after}$.

F statistics in table 3 for both Romania and Bulgaria are less than the critical value for a 95% confidence level, so we cannot reject the null hypothesis that the variance of returns is the same in the pre-and post-accession periods for both markets. The p-value approach arrives at the same result: calculated p-values are bigger than our chosen level of significance of 0.05 and don't allow us to reject the null hypothesis.
The F-test, however, is highly sensitive to departures from normality. In our case, return series are not normally distributed, as we saw earlier (more so in the case of Romania, where excess kurtosis is very big.). Consequently, we employ also a Levene test for equality of variances, which is less sensitive to departures from normality.

The Levene test is defined as:

$$W = \frac{(N-k)}{(k-1)} \frac{\sum_{i=1}^{k} N_i (\bar{Z}_i - \bar{Z}_.)^2}{\sum_{i=1}^{k} \sum_{j=1}^{N_i} (Z_{ij} - \bar{Z}_i)^2}$$

where:

$$Z_{ij} = |Y_{ij} - \bar{Y}_i|$$

The Levene test rejects the hypothesis that the variances are equal if:

$$W > F_{(\alpha, k-1, N-k)}$$

Where $F_{(\alpha, k-1, N-k)}$ is the upper critical value of the F distribution with k - 1 and N - k degrees of freedom at a significance level of alfa.
The Levene test is not statistically significant in either case, so it does not allow us to reject the null hypothesis. In conclusion, the increase in variance of return after European accession (from 13.69 to 18.79 for Romania and from 7.89 to 10.10 for Hungary) is not statistically significant.

Table 3: The impact of EU accession on stock price volatility in Romania and Hungary – test-statistics

ROMANIA			*HUNGARY*		
Statistics	*After January 2007*	*Before January 2007*	*Statistics*	*After May 1 2004*	*Before May 1 2004*
Mean	-0.3786	0.4648	Mean	0.3589	0.3778
Variance	**18.7937**	**13.6963**	Variance	**10.1038**	**7.8938**
Observations	56	97	Observations	194	115
df	55	96	df	193	114
F	1.3721		F	1.27997	
P(F<=f) one-tail	0.0874		P(F<=f) one-tail	0.07441	
Levene test	1.8764		Levene test	2.2426	
p-value(Levene)	0.1516		p-value(Levene)	0.1351	

4. Stock market liquidity and European integration

- **Investigation of change in the Romanian stock market trade value after January 1, 2007**

Before conducting a t-test to investigate a possible change in mean trade value between the two time-periods (prior and after EU accession) we must investigate the equality/inequality of the samples' variances. Without investigating the sample's distribution, we employ two statistic tests (F- tests and Levene tests). Table 4 shows that both test-statistics failed to reject H_0 of equality between the two sample's variances (both F statistic and the Levene test are smaller than the critical value and therefore are not statistically significant).

Table 4: Bucharest weekly trade value – change in variance after January 1, 2007

Romania	*After January 1, 2007 (mill EURO)*	*Before January 1, 2007 (mill EURO)*
Mean	77.68443848	48.97125464
Variance	707.9432741	607.8024016
Observations	58	97
df	57	96
F	1.164758929	
P(F<=f) one-tail	0.252450439	
Levene test	1.7638	
p-value(Levene)	0.1926	

We must therefore conduct a t-test assuming equal variances.
Table 5 gives the results of our t-test of differences between two samples assuming equal variances. The t-test is known to be a "robust" test, since it continues to work well even if applied to non-normal data. Now, in fact, the Central Limit Theorem shows that the *t*-test can avoid becoming unusually fallible when applied to non-normal datasets: If the control/treatment datasets are sufficiently "large" the *t*-test does not lie outrageously even when applied to non-normal data. Thus we can employ a t-test because our samples are sufficiently large.

We employ weekly data for the Romanian stock market and conduct a t-test for the following null hypothesis:

H_0: $\mu_1 = \mu_2$, versus H_a: $\mu_1 \neq \mu_2$, where μ_1 and μ_2 are the two mean weekly values for the two samples.

Table 5: T-test for mean weekly trade value on Bucharest Stock Exchange assuming equal variances:

Romania	*After January 1, 2007 (mil EURO)*	*Before January 1, 2007 (mil EURO)*
Mean	77.68443848	48.97125464
Variance	707.9432741	607.8024016
Observations	58	97
Pooled Variance	645.1097855	
Hypothesized Mean Difference	0	
df	153	
t Stat	**6.810806653***	
P(T<=t) one-tail	**1.04178E-10**	
t Critical one-tail	1.975590749	
P(T<=t) two-tail	**2.08356E-10**	
t Critical two-tail	2.263677743	

*The statistically significant values are bolded

In our case the calculated t-test is 6.81. The critical value for a 0.025 significance level (two-tailed test) with 153 degrees of freedom is 2.26. Our calculated test statistic of 6,81 is bigger than the rejection point of 2,26, therefore we can reject the null hypothesis and accept the alternative hypothesis that the mean weekly trade value on Bucharest Stock Exchange changed subsequent to the European integration in January 2007. The European accession increased the liquidity of the Romanian Stock Market, as represented by the value of trade from a mean weekly value of 48.97 mil Euro to 77.68 mil Euro. The p-value also supports the evidence, the very small value of 9.3605E-10 showing that we can reject the null hypothesis.

- **Investigation of change in the Hungarian stock market trade value after May 1, 2004**

In the case of Budapest Stock Exchange, we employ daily observations for both trade value and trade volume for the period January 1, 2002- April 9, 2008 or a total of 1573 daily observations. We divide the entire period in two sub-periods: before May 1, 2004 and after May 1, 2004 respectively and employ t-tests to investigate a possible change in trade value and trade volume between the two sub-periods.

The first step in our investigation is to test the difference in samples' variances, conducting, as before, both F and Levene tests.
The results of the test-statistics follow in the subsequent table.

Table 6: Budapest daily trade value – change in variance after May 1, 2004

Hungary	*After May 1 2004*	*Before May 1 2004*
Mean	93162849.64	29145212.11
Variance	5.06739E+15	2.62915E+14
Observations	991	582
df	990	581
F	**19.27388871***	
P(F<=f) one-tail	**2.0607E-228**	
F Critical one-tail (0.025 significance level)	1.157617113	
Levene test	**22.8497**	
p-value(Levene)	**1.3207E-290**	

*The statistically significant values are bolded

We observe that in this case the F-test and the Levene test are statistically significant (the calculated value for the F test and for the Levene test exceed the critical value), which means that the samples' variances are not statistically equal. The p-values are in both cases much smaller than the accepted 0.05 level. We must therefore conduct t-tests assuming unequal variances between daily turnover before and after May 1, 2004. The results are shown in Table 7:

Table 7: T-test for mean daily trade value on Budapest Stock Exchange assuming unequal variances:

Hungary	*Daily Trade Value - After May 1 2004 (EUR)*	*Daily Trade Value - Before May 1 2004 (EUR)*
Mean	93162849.64	29145212.11
Variance	5.06739E+15	2.62915E+14
Observations	991	582
Hypothesized Mean Difference	0	
df	1157	
t Stat	**27.13694738***	
P(T<=t) one-tail	**3.3528E-126**	
t Critical one-tail	1.96201654	
P(T<=t) two-tail	**6.7057E-126**	
t Critical two-tail	2.244323696	

*The statistically significant values are bolded

The calculated t-test (27.13) is also statistically significant, which allows us to reject the null hypothesis that daily trade value on Budapest Stock Exchange is equal between the considered sample periods. The mean daily trade value of 93,162 mill Euro for the period May 3, 2004 – April 9, 2008 increased significantly relatively to the considered period prior to Hungary's European accession (29, 145 mill Euro for the period January 2, 2002- April 30, 2004), and this difference is statistically significant.

- **Investigation of change in the Romanian stock market trade volume after January 1, 2007**

In order to investigate the impact of European accession on trade volume on the Romanian stock market, we conduct a similar test-statistic as for the trade value investigation.
First, we investigate the equality/inequality of the samples' variances (Table 8 shows results for F and Levene tests)

Table 8: Bucharest weekly trade volume – change in variance after January 1, 2007

Romania	*After January 1, 2007 (mill)*	*Before January 1, 2007 (mill)*
Mean	267.6285977	289.2610679
Variance	22559.31304	17939.83396
Observations	58	97
df	57	96
F	1.25749843	
P(F<=f) one-tail	0.160051435	
F Critical one-tail	1.573507546	
Levene test	1.8753	
p-value (Levene)	0.1428	

This time, the F-statistics and Levene test are not statistically significant; therefore we cannot reject the null hypothesis of equality between variances between the two samples. Further, we conduct a t-test assuming equal variances (results are presented in table 9).

Table 9: T-test for mean weekly trade volume on Bucharest Stock Exchange assuming equal variances:

Romania	*After January 1, 2007*	*Before January 1, 2007*
Mean	267.6285977	289.2610679
Variance	22559.31304	17939.83396
Observations	58	97
Pooled Variance	19660.81637	
Hypothesized Mean Difference	0	
df	153	
t Stat	-0.929478514	
P(T<=t) one-tail	0.177052648	
t Critical one-tail	1.975590749	
P(T<=t) two-tail	0.354105296	
t Critical two-tail	2.263677743	

The t-test is not significant at a 0.05 level, so we conclude that trade volume on Bucharest Stock Exchange did not statistically change after January 2007.

- **Investigation of change in the Hungarian stock market trade volume after May 1, 2004**

In our investigation of a possible change in trade volume on Budapest Stock Exchange after the European accession on May 1, 2004, we conduct first test statistics for the variability in trade volume between the considered sub-periods. Table 10 shows the results:

Table 10: Budapest daily trade volume – change in variance after May 1, 2004

Hungary	*Daily Trade Volume - After May 1 2004*	*Daily Trade Volume - Before May 1 2004*
Mean	4861888.412	3262021.186
Variance	6.23474E+12	2.87938E+12
Observations	991	582
df	990	581
F	**2.165308925***	
P(F<=f) one-tail	**7.5838E-24**	
F Critical one-tail (0.025 level of significance)	1.157617113	
Levene test	**18.5421**	
p-value (Levene)	**3.1428E-19**	

*The statistically significant values are bolded

The F test for the equality of daily volume variances between the two sub-periods is statistically significant and so is the Levene test. The results from the t-test assuming unequal variances are presented in Table 11:

Table 11: T-test for mean daily trade volume on Budapest Stock Exchange assuming unequal variances:

Hungary	*Daily Trade Volume - After May 1 2004*	*Daily Trade Volume - Before May 1 2004*
Mean	4861888.412	3262021.186
Variance	6.23474E+12	2.87938E+12
Observations	991	582
Hypothesized Mean Difference	0	
df	1538	
t Stat	**15.0912477***	
P(T<=t) one-tail	**2.14721E-48**	
t Critical one-tail	1.961507223	
P(T<=t) two-tail	**4.29442E-48**	
t Critical two-tail	2.2435961	

*The statistically significant values are bolded

This time the t-test is statistically significant. Daily trade volume on Budapest Stock Exchange increased from a daily mean value of 3.26 mil for the period prior to the European accession to a daily mean value of 4.86 mil after May 1, 2004 and this increase is statistically significant.

In conclusion, our conducted test-statistics found no evidence of important changes in terms of volatility both on Bucharest Stock Exchange and on Budapest Stock Exchange after January 2007 and May 2004 respectively, but found that stock market mean trade value on both markets increased significantly after each country's European accession. The investigation of a change in trade volume after the European accession found mixed

results: trade volume increased significantly on the Hungarian stock market after May 1, 2004, but the change in trade volume was not statistically significant on the Romanian equity market after January 1, 2007.

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