The Review of Finance and Banking
Volume 04, Issue 1, Year 2012, Pages 045–053
S print ISSN 2067-2713, online ISSN 2067-3825

GLOBAL CRISIS AND RELATIVE EFFICIENCY: EMPIRICAL EVIDENCE FROM CENTRAL AND EASTERN EUROPEAN STOCK MARKETS

ALEXANDRU TODEA AND DORINA LAZĂR

Abstract. This study investigates the effects of the Global crisis on the relative efficiency of ten Central and Eastern European emerging stock markets, using the Generalized Spectral test of Escanciano and Velasco (2006) in a rolling window approach. This test is robust to the distributional assumptions, to the presence of time-varying volatility, being able to detect a wide range of linear and non-linear dependencies in conditional mean. The results suggest that the degree of markets inefficiency varies through time, providing empirical support for the Adaptive Market Hypothesis rather than for a clear trend towards higher efficiency as postulated by the classical Efficient Market Hypothesis. Surprisingly, during the crisis period there has been registered an improvement of the degree of efficiency in the case of seven markets out of ten.

1. Introduction

A number of studies, as Smith and Ryoo (2003), Dragota and Mitrică (2004), Cajueiro and Tabak (2006), Smith (2009) among others, have investigated the weak form version of Efficient Market Hypothesis (EMH) in the Central and Eastern Europe (CEE) stock markets. Generally, the conclusions vary depending on the methodology and the period covered. These investigations are important for investors and also for regulatory authorities and academics, having implications for financial theories and investment strategies. The common denominator of these studies is the fact that the rejection/acceptance of random walk (RW) hypothesis is equivalent to the hypothesis of inefficiency/efficiency. On the other hand, as Campbell et al. (1997) noted, a market cannot be perfectly efficient informationally because this is an unreachable benchmark. Therefore, a more accurate approach would be to assess the degree of informational efficiency rather than investigate the absolute efficiency which is limited to two possibilities: efficiency versus inefficiency. In this respect, the concept of relative efficiency is introduced, that is the efficiency of one market measured against another.

The main feature of most studies regarding absolute efficiency is represented by the fact that conclusions are drawn upon the entire studied sample, without taking into account possible variations of the degree of market efficiency in time. A rejection of the hypothesis of efficiency over the whole sample could either mask subperiods of efficiency, or the fact that markets are becoming more efficient over time. Identifying subperiods of efficiency/inefficiency and ranking the relative market efficiency is most often accomplished using the time-varying or rolling window approach. Thus, Cajueiro and Tabak (2004) estimate Hurst exponents in each

Received by the editors December 13, 2011. Accepted by the editors March 3, 2012.
Keywords: Relative efficiency; European emerging stock markets; Global crisis Stochastic processes; Martingale.
JEL Classification: C12, C15, G14, G15.

Alexandru Todea (corresponding author), Ph.D., is Professor in the Department of Finance, Faculty of Economics and Business Administration, Babes-Bolyai University, Cluj-Napoca, Romania. E-mail: alexandru.todea@econ.ubbcluj.ro.
Dorina Lazăr, Ph.D., is Professor in the Department of Statistics, Babes-Bolyai University, Cluj-Napoca, Romania. E-mail: dlazar@econ.ubbcluj.ro.

This paper is in final form and no version of it will be submitted for publication elsewhere.

©2012 The Review of Finance and Banking

window to test for long-term linear dependence and use the median as a statistical measure when ranking the markets. Lim (2007) and Lim and Brooks (2010) used the rolling bicorrelation test statistic that focuses on nonlinear dependence, arguing that a more appropriate indicator for relative efficiency would be the percentage of time windows in which the market exhibited significant nonlinear dependence. Recent studies use other methodologies such as the algorithmic complexity theory by Giglio et al. (2008), the symbolic time series analysis approach or the Shannon entropy by Risso (2009).

The global crisis has seriously affected the liquidity and the market capitalization of CEE stock markets, being expected to have an impact also on how information is incorporated into security prices and, by default, on their degree of informational efficiency. The existing literature presents sufficient arguments according to which, even if a financial crisis does not occur, the investors do not always respond instantaneously to new information as predicted by EMH (see Lim and Brooks 2010 for more details). Their delayed reaction will lead to a nonlinear incorporation of information into security prices, generating nonlinear dynamics and the rejection of the martingale hypothesis. More so, during crisis, it is expected that the panic and the chaotic financial environment will lead to the formation of nonlinear dynamics, and thus causing a decrease in the degree of efficiency.

In the literature there are few studies investigating the impact of a financial crisis on the potential of predictability and implicitly on the degree of efficiency of financial markets; these studies are focused on the Asian crisis in 1997. Thus, Holden et al. (2005) examined and highlighted the existence of calendar effects on the Thai Stock Market Index before, during and after the Asian crisis. At the same time, they showed that the behaviour of returns is influenced by the Asian crisis and the inclusion of calendar effects in models improves the forecast accuracy. Hoque et al. (2007) apply different versions of the variance ratio test on eight Asian markets in pre-crisis period (1990-1997) and post-crisis period (1998-2004). In the case of most markets, there is no improvement in the degree of efficiency in post-crisis period, except for Taiwan. Using the rolling bicorrelation test, Lim et al. (2008) reported that the crisis adversely affected the efficiency of most Asian stock markets, but in contrast to the results of the previous study, an improvement in the degree of efficiency in post-crisis period in case of most markets was discovered. Based on the same methodology, Lim (2008) also highlights the negative impact of the Asian crisis over seven of the eight economic sectors in the Malaysian stock market. Kim and Shamsuddin (2008) used new multiple variance ratio tests based on the wild bootstrap in a rolling windows framework for a large group of Asian capital markets. The results of this study show that the developed stock markets (Hong Kong, Japan, Korea, Singapore, Taiwan) are weak-form efficient, while the emerging stock markets (Indonesia, Malaysia, Philippines) are inefficient in crisis-period. At the same time, there was found evidence that the financial liberalizations following Asian crisis improved market efficiency of Thai and Singaporean markets.

The objective of this article is to empirically investigate the effects of the recent Global crisis on the relative efficiency of ten Central and Eastern stock markets using Generalized Spectral (GS) test of Escanciano and Velasco (2006). This study contributes to the existing literature on EMH with several distinct features.

Firstly, in the most of earlier studies conducted on CEE emerging markets, there were used tests that had high performance in the presence of linear dependencies and less in case of nonlinear ones. We refer here primarily to the different versions of the variance ratio test which perform poorly under nonlinear dependencies. In contrast, the GS test has the null hypothesis of martingale with the alternative of nonmartingale, being able to detect a wide range of linear and non-linear dependence in conditional mean, allowing for a general form of unknown conditional heteroscedasticity. Furthermore, the GS test is a nonparametric test and does not depend on distributional assumptions. Through Monte Carlo simulations, Charles et al. (2010) compare the power properties of this test with other competitors and highlight its superiority especially against nonlinear dependence. Moreover, its good asymptotic properties recommend it in a rolling window approach.

Secondly, the stock index time series present one or more structural changes for various reasons, such as institutional changes, the liberalization process or the Global crisis. These structural changes can alter the results of variance ratio tests. Thus, Lee et al. (2006) showed that the presence of a break in drift can generate a spurious rejection of the RW hypothesis. The implementation of the GS test also in a rolling window approach allows us to obtain inferential outcomes robust to possible structural changes.

Thirdly, this study aims at evaluating the impact of the Global crisis on relative efficiency of CEE emerging markets, using as statistical indicator the percentage of time windows in which the GS test rejects the martingale hypothesis. Therefore, the article aims at monitoring any improvement in the degree of efficiency in time and also to analyse the relative efficiency of markets in pre-crisis and crisis periods.

The structure of the article is as follows. Section 2 describes the sample data and provides descriptive statistics. Section 3 outlines the methodology. Empirical results are presented in Section 4. The conclusions are drawn in Section 5.

2. The data and its properties

The data consists of daily closing values of market value-weighed equity indices for ten Central and Eastern European stock markets, respectively: the Czech Republic (PX 50), Estonia (OMXT), Hungary (BUX), Latvia (OMXR), Lithuania (OMXV), Poland (WIG), Romania (BET), Russia (RTS), the Slovak Republic (SAX) and Turkey (ISE-100). In brackets is indicated the index considered representative for each of these markets. All the closing values of these indices collected from Datastream are denominated in their respective local currency units. The time series cover the sample period from January 1999 to December 2009, except the three Baltic countries, for which the time series begin in January 2000.

Table I provides the descriptive statistics for the continuously compounded percentage returns, computed as $Y_t = 100 \ln \frac{P_t}{P_{t-1}}$, where P_t and P_{t-1} denote the closing price of the index on two consecutive trading days; the statistics are computed for pre-crisis and crisis periods. The division in these two periods requires the identification of the date when the crisis started in each market. But, identifying this exact date represents a difficult and arbitrary step. Being a crisis of liquidity, the moment when markets enter a strong downward trend is a sign of the imbalance between the supply and the demand of capital, as a result of crisis's manifestation. Thus, in this study, the date is considered to be the next day after the index has reached the maximum value. The downward trend started in most cases during the year 2007, exceptions being the Slovak Republic and Russia, where it started in the first half of 2008.

Table I. Descriptive statistics of returns for pre-crisis and crisis periods

(a) *Pre-crisis period*

Market	Period	Mean (%)	St. Dev.(%)	Skewness	Excess Kurtosis
Pre-crisis period					
Czech Republic	1/4/1999-10/15/2007	0.0713	1.2464	-0.2507	2.2150
Estonia	1/4/2000-2/6/2007	0.1116	0.9855	0.1977	7.3549
Hungary	1/4/1999-7/23/2007	0.0731	1.4734	-0.0281	3.2827
Latvia	1/4/2000-10/5/2007	0.1006	1.5263	-1.2547	21.7048
Lithuania	1/4/2000-10/8/2007	0.0913	0.9074	-0.7182	10.8739
Poland	1/4/1999-06/07/2007	0.0801	1.4099	-0.0838	4.0162
Romania	1/4/1999-7/24/2007	0.1571	1.5987	-0.0231	6.2699
Russia	1/5/1999-5/19/2008	0.1597	2.2721	-0.3005	4.9017
Slovak Republic	1/7/1999-3/26/2008	0.0718	1.2887	-0.5888	7.5481
Turkey	1/4/1999-10/15/2007	0.1407	2.7463	0.0988	5.2537

(b) *Crisis period*

Market	Period	Mean (%)	St. Dev.(%)	Skewness	Excess Kurtosis
Crisis period					
Czech Republic	10/16/2007-2/30/2009	- 0.0968	2.4691	-0.3401	7.6670
Estonia	3/7/2007-12/30/2009	- 0.1307	1.5451	0.1915	7.2584
Hungary	7/27/2007-12/31/2009	- 0.0575	2.3536	-0.0470	4.6931
Latvia	11/8/2007-12/30/2009	- 0.1833	1.9758	0.3296	3.4103
Lithuania	11/8/2007-12/30/2009	- 0.1496	1.8415	0.3236	8.1338
Poland	09/07/2007-2/31/2009	- 0.0843	2.6976	-0.2953	29.4754
Romania	7/25/2007-12/24/2009	- 0.1378	2.5137	-0.3997	2.7537
Russia	6/20/2008-12/31/2009	- 0.1336	3.8826	-0.1652	5.1605
Slovak Republic	3/28/ 2008-12/31/2009	- 0.1274	1.4228	-0.1986	21.2807
Turkey	10/17/2007-2/31/2009	- 0.0178	2.3008	0.0712	2.8391

During the pre-crisis period there have occurred significant increases of the market indices, especially for Russia, Romania and Turkey. The markets' performance has been deeply affected by the crisis, in this period all indices recorded negative mean returns; the highest decreases in prices were recorded for the Baltic countries, Romania and Russia. The Global crisis had a significant impact also on volatility, the standard deviation of returns series recording an increase from pre-crisis to crisis period. The highest increases of volatility are found in the case of Russia, Poland, Romania, the Czech Republic and Hungary. In general, the daily returns are negatively skewed, which means that large negative returns are more probable than positive ones. The excess kurtosis is positive for all indexes, irrespective of the period, which indicates an increased number of returns around the average, comparative to the normal law. The Jarque-Bera test (whose statistics are not reported here, but can be obtained on request), rejects the null hypothesis of returns' normality in pre-crisis and crisis periods for all stock markets.

3. Methodology. Generalized Spectral test of Escanciano and Velasco (2006)

This section provides a brief description of the Generalized Spectral (GS) test, designed to detect the presence of linear and nonlinear dependencies in a stationary time series. The full theoretical description of the test is given in Escanciano and Velasco (2006). The Monte-Carlo experiments, performed by the authors in order to examine the finite sample performance of the test, show that for almost all considered nonlinear alternatives the GS test has more empirical power than the other competing tests, also having good properties for linear models. The GS test considers dependence at all lags, is robust to conditional heteroskedasticity and, as the authors demonstrated, is consistent against a large class of uncorrelated non-martingale sequences. Charles et al. (2010), performing a Monte Carlo study to compare small sample properties of alternative tests for martingale difference hypothesis (MDH), conclude that the generalized spectral GS test performs most desirably under nonlinear dependence.

Let $\{Y_t\}_{t=1}^{n}$ be the stationary time series of returns. The null hypothesis of martingale difference sequence of the returns series is tested by applying a spectral based test. Escanciano and Velasco (2006) propose to test the MDH hypothesis using a pairwise approach. That is, the null of MDH becomes $H_0 : m_j(y) = 0$, $j \geq 1$ almost surely, where $m_j(y) = E[Y_t - \mu \mid Y_{t-j} = y]$ and μ is the mean, against the alternative $H_A : P(m_j(Y_{t-j}) \neq 0) > 0$ for some $j \geq 1$. A nonlinear measure of dependence is considered $\gamma_j(x) = E[(Y_t - \mu)e^{ixY_{t-j}}]$ where x is a real number, this exponential weighing function being used to measure the conditional mean dependence in a nonlinear time series framework. The above null hypothesis is consistent with the following $\gamma_j(x) = 0$, $\forall j \geq 1$ almost everywhere.

The authors use the generalized spectral distribution function:

$$H(\lambda, x) = \gamma_0(x)\lambda + 2\sum_{j=1}^{\infty}\gamma_j(x)[\sin(j\pi\lambda)/j\pi], \lambda \in [0,1] \tag{1}$$

with the sample estimate as following: $H\hat{}(\lambda, x) = \gamma_0(x)\lambda + 2\sum_{j=1}^{\infty}(1-j/n)^{1/2}\hat{\gamma_j}(x)\frac{\sin(j\pi\lambda)}{j\pi}$, where $(1-j/n)^{1/2}$ is a finite sample correction factor, $\hat{\gamma_j}(x) = (n-j)^{-1}\sum_{t=1+j}^{n}(Y_t - Y_{n-j}^{-})e^{ixY_{t-j}}$ and $(n-j)^{-1}\sum_{t=1+j}^{n} Y_t$. Under the null of MDH the generalized spectral distribution function becomes $H(\lambda, x) = \gamma_0(x)\lambda$, and the test is based on the difference between $H\hat{}(\lambda, x)$ and $H\hat{}_0(\lambda, x) = \hat{\gamma_0}(x)\lambda$, as following:

$$S_n(\lambda, x) = \left(\frac{n}{2}\right)^{1/2}[H\hat{}(\lambda, x) - H\hat{}_0(\lambda, x)] = \sum_{j=1}^{\infty}(1-j/n)^{1/2}\hat{\gamma_j}(x)\frac{\sqrt{2}\sin j\pi\lambda}{j\pi} \tag{2}$$

To evaluate the distance of $S_n(\lambda, x)$ to zero, for all possible values of λ and x, the Cramer-von Mises norm is used:

$$D_n^2 = \int_R\int_0^1 |S_n(\lambda, x)|^2 W(dx)d\lambda = \sum_{j=1}^{n-1}(n-j)\frac{1}{(j\pi)^2}\int_R \left|\gamma\hat{}(x)\right|^2 W(dx) \tag{3}$$

where the weighing function $W(.)$ satisfies some mild conditions. If the standard normal cumulative distribution functions is settled as the weighing function, the following statistics results:

$$D_n^2 = \sum_{j=1}^{n-1}\frac{(n-j)}{(j\pi)^2}\sum_{t=j+1}^{n}\sum_{s=j+1}^{n}(Y_t - Y_{n-j}^{-})(Y_S - Y_{n-j}^{-})\exp[-0.5(Y_{t-j} - Y_{s-j})^2] \tag{4}$$

The null hypothesis of MDS is rejected for large values of D_n^2.

As the asymptotic distribution of the test depends on the data generating process in a complicated way, the authors propose implementing the test using a wild bootstrap procedure. The validity of the bootstrap procedure was proved, allowing approximating the critical values. The p-values for the test statistic D_n^2 are obtained by the following steps (Escanciano and Velasco, 2006): a) compute the statistics D_n^2 for the observed data $\{Y_t\}_{t=1}^{n}$; b) simulate a sequence $\{w_t\}_{t=1}^{n}$ of independent random variables with zero mean, unit variance and bounded support, independent of the observed sequence; c) compute $\hat{\gamma_0}^*(x) = (n-j)^{-1}\sum_{t=1+j}^{n}(Y_t - Y_{n-j}^{-})\hat{\Phi}_{t-j}(x)w_t$, than S_n^* and D_n^{*2}, where $\hat{\Phi}_{t-j}(x) = e^{ixY_{t-j}} - (n-j)\sum_{t=j+1}^{n} e^{ixY_{t-j}}$; d) repeat the above b) and c) steps sufficiently many times, and obtain a bootstrap distribution of the test statistic. The p-value of the test is estimated as the proportion of D_n^{*2} greater than the D_n^2.

In our study, the number of bootstrap iterations is set to 1000. In the rolling window approach, the p-value of the test is computed for a window of 300 observations, subsequently the sample is rolled one point forward eliminating the first observation and including the next one for re-estimation of the p. For each index is determined the percentage of time windows for which p is less than 0.05, as a statistical indicator of relative efficiency. This indicator was proposed by Lim (2007) so as to assess the relative efficiency but, as Lim (2009) noted, the research to find the best statistical measure should continue.

4. Empirical results

The p-value for each time window is computed using a routine[1] implemented in MATLAB software. Table II reports p-values of GS test for entire, pre-crisis and crisis periods. Over the

[1] The Matlab program for GS test was kindly provided by Professor Escanciano, and was improved for the rolling window approach.

entire period, we observe that the martingale hypothesis is clearly rejected on the vast majority of markets, except for Poland and Turkey, at 0.05 significant level. In general, the high degree of predictability and implicitly of inefficiency of the CEE stock markets is observed also in the two subperiods, except for Latvia and Turkey in pre-crisis period and the Czech Republic, Poland and the Slovak Republic in crisis period. The pre-crisis period results are similar to those obtained by Smith (2009), who applies alternative variance ratio tests, except for Poland where the martingale hypothesis is rejected.

Table II. The p-values for GS test

Market	The entire period	Pre-crisis period	Crisis period
Czech Republic	0.0095	0	0.205
Estonia	0	0	0
Hungary	0.005	0	0.021
Latvia	0.033	0.077	0.042
Lithuania	0	0	0.004
Poland	0.123	0	0.118
Romania	0	0	0.012
Russia	0	0	0.002
Slovak Republic	0	0.005	0.493
Turkey	0.076	0.09	0

The use of GS test on the whole sample and the two subperiods is in line with the classical approach of studying the EHM, that of absolute efficiency. This framework limits the comparisons between markets and the ability to establish whether there was a change of the degree of efficiency over time. In fact, there is expected a change of the degree of efficiency of CEE markets in time due to financial liberalization measures, institutional and technological changes, changes in regulatory framework or global financial crisis. Depending on the methodology used, we distinguish two groups of studies that have investigated dynamically the efficiency of CEE markets. The first group (Zalewska-Mitura and Hall, 1999; Rockinger and Urga, 2000; Tsukuda et al. 2006) applied the Kalman Filter framework that allows for time-varying parameters and a GARCH structure for the residuals. Generally, these studies argue in favor of a continuous improvement of the degree of efficiency of CEE markets. These results are in contradiction with the second group of studies which applies various statistical tests in the rolling windows approach and supports the alternation of efficiency periods with those of inefficiency. In this respect, Cajueiro and Tabak (2006) use the Hurst exponent to capture the time-varying long term linear dependence, while Todea and Zoicaş-Ienciu (2008) use the bicorrelation test to highlight the episodic behavior of nonlinear dependencies.

In this study, the time varying stock markets inefficiency is highlighted for the CEE stock markets, through the GS test applied in a rolling windows framework. Since it is impossible to report the computed p-values for each rolling time window, the results are presented graphically in Figure 1 for all CEE indices. The vertical axis shows the p-values of the GS test in each window, while the horizontal axis is labeled with time periods. Graphically, the martingale hypothesis is rejected, in a time window, if the p-value is below the threshold line, suggesting market inefficiency during that time period. The horizontal lines in each graph correspond to a 0.05 significant level. Shaded regions correspond to the crisis period. Figure 1 shows that all the CEE stock markets are characterized by an alternation of martingale subperiods with those of nonmartingale, respectively of efficiency and inefficiency. Therefore, we are not dealing with a continuous improvement of the informational efficiency degree for the CEE stock markets as predicted by the Efficient Market Hypothesis. Such behavior provides rather empirical support in favor of the Adaptive Market Hypothesis (AHP) developed by Lo (2004). According to AHP there are arbitrage opportunities from time to time, the profit opportunities occurring in an episodic way and not disappearing definitively.

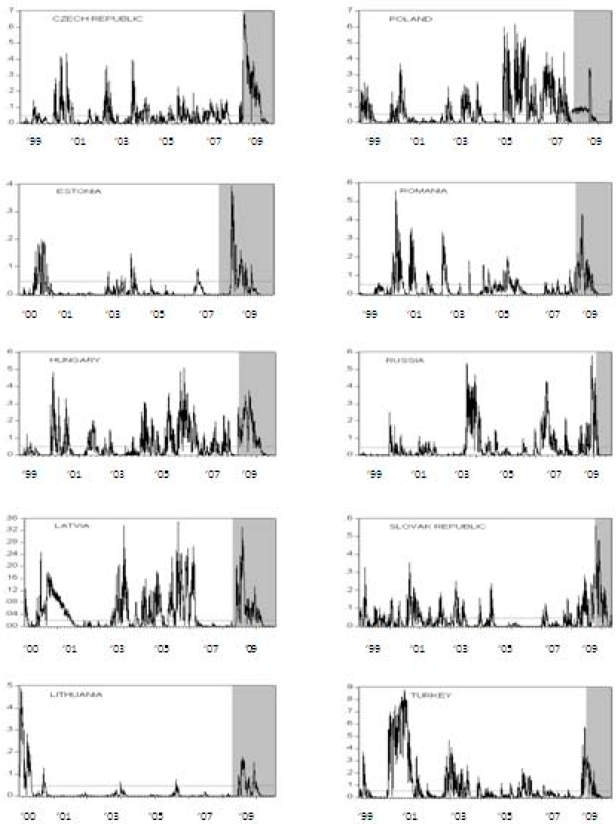

Fig. 1. Time series plots for p-values of rolling GS test over full sample period

The length and the occurrence frequency of subperiods where the martingale hypothesis is rejected vary from one market to another, denoting significant differences between markets in terms of time varying inefficiency. In the case of the Czech Republic, Hungary, Latvia, Poland, the Slovak Republic and Turkey, the subperiods where the martingale hypothesis is rejected occur with a lower frequency than in the case of markets such as Estonia, Lithuania, Romania and Russia. Focusing on the issue of whether the Global crisis led to a change in the degree of efficiency of CEE markets, the empirical results suggest a surprising increase of the degree of efficiency in the crisis period. In the shaded region, corresponding to Global crisis, a peak area is observed in most markets.

As a summary indicator of the Global crisis impact on the relative efficiency is considered the proportion of time windows for which the martingale hypothesis was rejected; these proportions are calculated for pre-crisis and crisis periods. The results in Table III confirm the visual analysis of Figure 1. They show an increased degree of efficiency in the crisis period compared to pre-crisis period, exceptions being Latvia, Russia and Turkey. To reinforce these results, we tested and presented in the last column of Table III the statistical significance of the difference between the two percentages, estimated in pre and crisis periods. This improvement in market efficiency in crisis period is mainly evident in the case of the Slovak Republic, the Czech Republic, Hungary and Poland, where the percentage of time windows for which the martingale hypothesis is rejected fell below 50%. Although this increase is reflected also in the case of Estonia, Lithuania and Romania, these markets continue to register a low degree of efficiency in the crisis period, too. A different result is obtained in the case of Russia and Turkey, where the Global crisis led to an increase of predictability and implicitly to a decrease of the degree of efficiency. Of the 10 markets examined, these two are ranked as first and second positions in terms of market capitalization and turnover and yet they exhibit surprisingly high percentages, as measures of relative efficiency.

Table III. Rolling GS test results for pre-crisis and crisis periods

Market	% of windows for which p≤ 0.05		Equality test for %
	Pre-crisis period	Crisis period	
Czech Republic	71.79	40.94	-10.17**
Estonia	93.65	77.00	-10.36**
Hungary	67.14	41.75	-8.72**
Hungary	67.58	69.84	0.71
Lithuania	93.16	75.61	-9.1**
Poland	59.19	49.15	-3.03**
Romania	80.15	59.93	-7.92**
Russia	75.55	100.00	5.9**
Slovak Republic	77.08	26.43	-13.75**
Turkey	68.22	74.80	2.11*

Note: * and ** denote significance at the 5% and 1% levels respectively.

5. Conclusions

This study investigates the effects of the Global crisis on the relative efficiency of ten CEE stock markets, using the Generalized Spectral test of Esacanciano and Velasco (2006) in a rolling window approach. This test was chosen due to its high performances in case of linear and especially nonlinear dependencies and its good asymptotic properties. Our results suggest that the degree of the markets' inefficiency varies in time, being unable to provide an empirical support for a clear trend towards higher efficiency, as postulated by the classical Efficient Market Hypothesis. The empirical results are rather in favor of the Adaptive Market Hypothesis of Lo (2004). According to the evolutionist principles of this theory, profit opportunities in the CEE stock markets appear in an episodic way and do not disappear definitively.

Although the Global crisis has strongly affected the liquidity and market capitalisation of the CEE markets, it led to a decrease of predictability and hence to an improvement of relative efficiency for seven of the ten investigated markets. This improvement in market efficiency in the crisis period is more pronounced in case of the Slovak Republic, the Czech Republic, Hungary and Poland, where the percentage of time windows in which the martingale hypothesis is rejected, has significantly decreased. On the other hand, an opposite result, that of a decrease of efficiency‘s degree in the crisis period, was observed for Russia and Turkey, despite their top positions in terms of liquidity and market capitalisation. As a matter of fact, the possibility that the two measures of the degree of development of a capital market might not be decisive factors of deviation from efficiency is supported by Lim and Brooks (2010) in a recent study conducted on 50 stock markets. The analysis of determining the factors of deviation from efficiency, as well as the identification of some indicators that help to anticipate the appearance of inefficiency periods represent future research directions.

References

[1] Cajueiro, D., & Tabak, B. (2004). Ranking efficiency for emerging markets. Chaos, Solitons and Fractals, 22, 349-52.
[2] Cajueiro, D. O., & Tabak, B. M. (2006). Testing for predictability in equity returns for European transition markets. Economic Systems, 30, 56—78.
[3] Campbell, J. Y., Lo, A. W., & MacKinlay, A. C. (1997). The Econometrics of Financial Markets, Princeton University Press, Princeton.
[4] Charles, A., Darné, O., & Kim, J.H. (2010). Small sample properties of alternative tests for martingale difference hypothesis. Economics Letters, doi: 10.1016/j.econlet.2010.11.018.
[5] Dragota, V., & Mitrica, E. (2004). Emergent capital markets efficiency: The case of Romania. European Journal of Operational Research, 155, 353-360.

[6] Escanciano, J.C., & Velasco, C. (2006). Generalized spectral tests for the martingale difference hypothesis. Journal of Econometrics, 134, 151-185.
[7] Giglio, R., Matsushita, R., & DaSilva S. (2008). The relative efficiency of stock markets. Economics Bulletin, 7, 1-12.
[8] Hoque, H.A.A.B., Kim, J.H., & Pyun, C.S. (2007). A comparison of variance ratio tests of random walk : a case of Asian emerging stock markets. International Review of Economics and Finance, 16, 488-502.
[9] Holden, K., Thompson, J., & Ruangrit, Y. (2005). The Asian crisis and calendar effects on stock returns in Thailand. European Journal of Operational Research, 163, 242-252.
[10] Kim, J. H., & Shamsuddin, A. (2008). Are Asian stock markets efficient? Evidence from new multiple variance ratio tests. Journal of Empirical Finance, 15, 518—32.
[11] Lim, K. P. (2007). Ranking market efficiency for stock markets: a nonlinear perspective. Physica A, 376, 445-454.
[12] Lim, K. P., Brooks, R.D., & Kim, J.H. (2008). Financial crisis and stock market efficiency: Empirical evidence from Asian countries. International Review of Financial Analysis, 17, 571-591.
[13] Lim, K. P. (2008). Sectoral efficiency of the Malaysian stock market and the impact of the Asian financial crisis. Studies in Economics and Finance, 25, 196-208.
[14] Lim, K.P. (2009). Efficiency tests of the UK financial futures markets and the impact of electronic trading systems: a note on relative market efficiency. Applied Economics Letters, 16, 1129—1132.
[15] Lim, K.P, & Brooks, R.D. (2010). Why do emerging stock markets experience more persistent price deviations from a random walk over time? A country-level analysis. Macroeconomic Dynamics, 14, 3-41.
[16] Lee Y. S., Kim T. H., & Newbold, P. (2006). Spurious rejections by variance ratio tests in the presence of a break in drift. Working paper, Durham University.
[17] Lo, A. W. (2004). The adaptive markets hypothesis: market efficiency from an evolutionary perspective. Journal of Portfolio Management, 30, 15-29.
[18] Risso, W. A. (2009). The informational efficiency: the emerging markets versus the developed markets. Applied Economics Letters, 16, 485-487.
[19] Rockinger, M., & Urga, G. (2000). The Evolution of Stock Markets in Transition Economies. Journal of Comparative Economics, 3, 456—472.
[20] Smith, G., & Ryoo, H. J. (2003). Variance ratio tests of the random walk hypothesis for European emerging stock markets. The European Journal of Finance, 9, 290—300.
[21] Smith, G. (2009). Martingales in European emerging stock markets: Size, liquidity and market quality. The European Journal of Finance, 15, 249—62.
[22] Tsukuda, Y., Miyakoshi, T., & Shimada, J. (2006). Dynamic efficiency in the East European emerging markets. Asia-Pacific Financial Markets, 12, 159—79.
[23] Todea, A., & Zoicaş-Ienciu, A. (2008). Episodic dependencies in Central and Eastern Europe stock markets. Applied Economics Letters, 15, 1123-1126.
[24] Zalewska-Mitura, A., & Hall, S.G. (1999). Examining the stages of market performance: A test for evolving market efficiency. Economics Letters, 64, 1—11.

Acknowledgement. *Dorina Lazar acknowledges the financial support of the CNCSIS UEFISCSU, Project number PNII IDEI 2366/2008.*