Does the Recent Global Financial Crisis Affect Efficiency of Capital Markets of EU Countries and Turkey?

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Abstract
Efficient market is one in which prices fully reflect all available information. However, financial crisis has created big volatility in prices of financial assets, which induces some barrier in reflection of full information and multiplies the effectiveness of a crisis in a country according to third generation crisis theory. In this sense, this study aims to question whether the recent global financial crisis has affected efficiency of markets of new European Union (EU) countries and Turkey differently. Therefore, this study focuses on Turkish and EU stock markets and their stock market performances comparing the efficiencies of new member countries and Turkey since Turkey is in the process of accession to EU and thus, the study wants to project that if or not Turkey will prospectively be the part of EU according to stock market performance. Thus the paper employs the appropriate GARCH(1,1) models and use data of stock exchange market indices of related countries. Test results potentially present that with Hungary and Slovakia, Turkey also performs better after the crisis, in terms of weak-form of market efficiency, than most of the newly joined EU countries.

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JEL codes: *C22, C58, G01, G14, G15*

1. Introduction

Financial Crises are a severe phenomenon in both developed and developing countries. Their explanation and more important their prediction is an important field of macroeconomic theory which faces the problem that booms and crises are partly linked to economic fundamentals of markets but also to a "non-fundamental or random component" (Chari and Kehoe, 2003). Fundamentals help to predict financial crises but they are no reliable source since "crises may occur even when the fundamentals are sound or may not occur even when they are weak" (Cipriani and Guarino, 2008). However, financial crisis has created big volatility in prices of financial assets, which induces some barrier in reflection of full information and multiplies the effectiveness of a crisis in a country according to third generation crisis theory. This situation brings a challenge for Efficient Market Hypothesis.

Efficient Market Hypothesis (EMH), defined as a market in which prices always reflect available information, has received a great deal of attention in finance literature for years (Fama, 1970). According to EMH, stock prices must always show a full reflection of all available and relevant information and should follow a random walk process. Random walks in stock returns are crucial to the formulation of rational expectations models and the testing of weak-form market efficiency. In an efficient market, the prices of stocks fully incorporate all relevant information and hence stock returns will display unpredictable (or random walk) behavior. In stock prices not characterized by a random walk the return generating process is dominated by a temporary component and therefore future returns can be predicted by the historical sequence of returns. A market following a random walk is consistent with equity being appropriately priced at an equilibrium level, whereas the absence of a random walk infers distortions in the pricing of capital and risk. This has important implications for the allocation of capital within an economy and hence overall economic development.

According to Worthington and Higgs (2003), increasing number of studies have examined random walks in the world's stock markets: Korea (Ayadi and Pyun, 1994, Ryoo and Smith, 2002), China (Lee et al. 2001), Hong Kong (Cheung and Coutts 2001), Slovenia (Dezlan 2000), Spain (Regúlez and Zarraga 2002), the Czech Republic (Hajek 2002), the United Kingdom (Poon 1996) and Turkey (Zychowicz et al. 1995, Buguk and Brorsen 2003). Others have elected instead to focus on emerging markets, particularly on a regional basis. Markets in Asia (Huang 1995, Groenewold and Ariff 1998), Latin America (Urrutia 1995, Ojah and Karemera 1999. Grieb and Reyes 1999, Karemera et al. 1999), Africa (Smith et al. 2002, Appiah-Kusi and Menyah 2003) and the Middle East (Abraham et al. 2002) have been addressed in this manner.

To the Turkey case, Istanbul Stock Exchange Market established in 1986, having affected from volatilities in the World capital markets, has also closely followed capital markets in developing countries. Since capital liberalization period of 1989, financial sector in Turkey has undergone a lot of reforms aimed at liberalizing and opening up access to long-run capital for investments. Due to the ISE's vibrant role in raising domestic and international capital for economic development recent reforms has focused on enhancing institutional development. In spite of the macroeconomic challenges facing the country, the performance of the ISE has been impressive in recent times. These include efficient and wider dissemination of information through the operation of an electronic trading system. Thus, at this point, EMF guides us to analyze how this evolvement has affected the efficiency of capital market.

Besides, examination of the existing empirical literature concerning random walks reveals that European stock markets have received rather less attention. This is an important omission in the European context for two additional reasons. First, capital provision in Europe in general, and in the newly expanded European Union in particular, relies upon a relatively large number of smaller developed markets and an increasing proportion of emerging markets. Knowledge of random walks and market efficiency in this instance yields valuable insights into the ability of these markets to provide appropriately priced and efficiently allocated equity capital, especially for the purposes of national (regional) development in the smaller European (European Union) nation (Member) states. Second, there has been increasing pressure for the consolidation of European equity markets over the past decade. Given that market liquidity, breadth and depth are thought to be closely associated with market efficiency, the failure to attain some nominal level of efficiency in a given market provides a strong rationale for technological and regulatory reform, and the creation of institutional linkages in the form of collaborative partnerships, even mergers (Worthington and Higgs, 2003).

Therefore, this paper focuses on Turkish and newly joined 11 EU stock markets (since 1 May 2004) and comparing the efficiencies of new member countries and Turkey. Turkey has been in the process of accession to EU since 1999 and thus, the study wants to project that if or not Turkey will prospectively be the part of EU according to stock market performance, by comparison of stock markets performance in an efficiency manner . In the literature, EMH mostly focuses on one market. This study differs from common literature in terms of focusing newly joined European countries' market's efficiency. In this sense, this study also aims to question whether the recent global financial crisis has affected efficiency of markets of newly joined 12 EU countries[1] and Turkey differently. This paper is organized as follows: Section 2 provides a brief literature on random walks and efficient

[1] The data consist of daily closing stock market indices for Turkey and 11 new member (joined the Union since 2004 in which (Turkey had been announced as a candidate in 1999) countries of EU – Czech Republic, Cyprus, Estonia, Latvia, Lithuania, Hungary, Malta, Slovenia, Slovakia, Bulgaria, and Romania.

market hypothesis. Section 3 describes the data and the research method employed; section 4 shows the empirical evidence GARCH test, and finally section 5 provides the conclusion.

2. Literature Review

A fundamental question concerning capital market is to measure their efficiency. A market is efficient with respect to a set of information if it is impossible to make economic profits by trading on the basis of this information set (Ross, 1987). According to Samuelson (1965) and Fama (1970), under the ‘efficient market hypothesis’, stock market prices must always show a full reflection of all available and relevant information and should follow a random walk process. Successive stock price changes (returns) are therefore independently and identically distributed (iid). Based on the information set, Fama (1970) categorizes the three types of efficient markets as weak-form, semi-strong form, and strong-form efficient if the set of information includes past prices and returns only, all public information, and any information public as well as private, respectively (Magnus, 2008).

However, EMH is controversial in the literature. According to detail background about market efficiency issue presented by Magnus (2008), for developed countries, some empirical studies done by Niederhoffer and Osborne, 1966; Fama and French 1988; Poterba and Summers, 1988; Lo and MacKinlay 1988 emphasized market inefficiency *in Stock Exchange Market:* and Hakkio and Rush, 1989 *in Foreign Exchange Market:* on the contrary the studies of Fama 1965, 1970; Samuelson 1965, Cooper 1974, Brown and Easton, 1970 emphasized market efficiency *in Stock Exchange Market*:; and *in Interbank Money Market*: Fildes and Fitzgerald, 1980; *in Foreign Exchange Market*: Lajaunie, McManis Naka, 1996). In addition to developed countries, EMH is *disputable* in emerging markets aswell. As the same of developed markets, there are some practical evidences indicated by the studies of Alam and at all, 1997; Magnusson and Wydick, 2002) supporting the efficiency hypothesis *in Stock Exchange Market*, while Kusi and Menyah, 2002; Smith, Jefferis and Ryoo, 2002;Gupta and Basu, 2007 do not *in Stock Exchange Market*, and Sarwar, 1997 *in Foreign Exchange Market*:. When we compare the result of studies in developed and emerging countries, it is clear that studies in developed markets show stronger evidence of efficiency than emerging markets.

For Turkey case, difference from the literature mentioned above; Yalama and Celik (2008) provides enough background about EMF hypothesis by testing the semi strong form (Metin and Muradoğlu, 1996; Muradoğlu, Önkal, 1992; Balaban, Candemir, Kunter, 1996) or weak form efficiency (Aga and Kocaman, 2008; Buguk and Brorsen, 2003) in Turkish Stock Exchange Market (TSEM). The results of most studies show the weak form efficiency in TSEM (Buguk and Brorsen 2003, Ozdemir, 2008). For example; Ozdemir (2008) tests weak form efficiency in Istanbul Stock Exchange Market using weekly data for the period 1990-2005. As employing different techniques (ADF test, unit root with two structural breaks, run test and variance ratio test), he accepts weak form efficiency in Istanbul Stock Exchange Market. But different from the supporting literature, some studies reject semi strong form efficiency (Balaban and Kunter, 1996; Balaban, Candemir and Kunter, 1996). For instance; Balaban and Kunter (1996) test semi strong form efficiency in Foreign Exchange Market, Interbank Money Market and Istanbul Stock Exchange Market with respect to changes in Currency in Circulation for the period 1989-1995 using direct Granger Causality test. They conclude that financial markets are not semi strong form efficient. It is seen that few studies, in the literature, concentrate on Foreign Exchange Market (FEM) and Interbank Money Market (IMM). For example Dowla (1995) and Culbertson (1989) present some evidence supporting weak form efficiency in FEM, additionally Abaan (1991) demonstrates some evidence which does not support semi strong form efficiency in IMM. As a result of literature review, it can be said that EMH studies’ mostly focuses on one market rather than multiple markets and this study differs from general literature in terms of focusing on the market efficiency of 12 newly joined EU countries along with facilitating GARCH model.

3. Research Method

Many statictical tests for random walks (or EMH) have been used in the literature. In this study, we use the basic Random Walk (RW) model and a GARCH (1,1) model. GARCH (1,1) model is also used to capture the main characteristics of financial time series such as stationarity, fat-tails, and volatality clustering. The GARCH model will further be used to find presence of nonlinear autoregressive conditional heterocedasticity (ARCH) effects which contradicts the random walk concept.

Abdmoulah (2009) uses GARCH-M (1,1) approach to test weak-form of efficiency for 11 Arab stock markets for periods ending in March 2009. All markets show high sensitivity to the past shocks and are found to be weak-form inefficient, as negativley reacts to contemporaneous crises. Vyrost and Baumöhl (2009) deals with estimation of both general GARCH as well as asymmetric EGARCH and TGARCH models, used to model leverage effect of goods news and bad news on market volatility.

3.1 Model and Data

The recent global financial crisis in 2008 caused both huge collapses and large volatility of the stock markets all around the world and European countries, as well. The interesting point is that most of the stock markets could have not achieved resuming their increasing or stable trend so far since the global crisis. Given the higher volatility in stock market indices after the crisis, it is presumably assumed that the efficiencies of these markets have been performed worse. Given the fact that exploring the best model of GARCH specification for each country makes more sense, however this study applies GARCH (1,1) method which is both generally accepted and used in most previous studies mentioned above. The data consist of daily closing stock market indices for Turkey (that had been announced as a candidate in 1999) and 12 new members; Bulgaria, Czech Republic, Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Romania, Slovakia, Slovenia, that have joined the Union since 2004.

Within our sample of new 11 members of European Union and Turkey, thus, in order to capture the impact of the crisis, in terms of financial market efficiency, two different periods, before and after the crisis periods, are used to see the effect. The study employs the stock market indices data collected from the relevant countries' stock market web pages. Data covers daily closing prices of the stock markets of the countries for the period between 2000 and 2011 for most countries as indicated in Table 1. Both the exact date of beginning of the recent global crisis and its time of contagion to European countries are not known accurately. Moreover, crisis periods may vary from country to country. Therefore the beginning date of the crisis period for every country assumed to be occurred with the observation of the beginning of huge fluctuations in daily percentage change in returns of their stock market, as given in Table 1 and the Figures in the Appendix.

Therefore, in order to capture the effect of the 2008 global crisis on the stock markets, data are analyzed by two different periods. The crisis period includes the period between the beginning of the sample for each country and September of 2011. The second period excludes the crisis that begins with the beginning of the sample for each country and ends with the period of crisis defined for each country. For the sake of focusing just on the impact of the 2008 crisis, covered period of each country is selected according to data availability and the criterion that excludes the effect of unknown reason of high volatility in the very early beginning of the periods rather than the 2008 crisis.

Table 1 displays the summary statistics of the 12 countries stock markets returns on a daily basis. Therefore, the analysis will be made by the daily returns formulated below by using daily closing prices of the stock markets of the countries

$$R_t = \log\left(P_t / P_{t-1}\right) \qquad (1)$$

Where R_t and P_t represent the daily returns and daily prices of the stock market for a given country.

Table 1: Returns Summary Statistics

	Bulgaria	Czech Republic	Cyprus	Estonia	Hungary	Latvia	Lithuania	Malta	Romania	Slovakia	Slovenia	Turkey
Mean	0.000482	0.000241	-0.000482	0.000471	0.000223	0.000444	0.000433	-4.97E-05	-1.92E-05	0.000368	-0.000228	0.000415
Median	0.000563	0.000630	-0.000208	0.000582	0.000332	0.000191	0.000430	0.000000	0.000407	0.000000	0.000106	0.001024
Max	0.210733	0.123641	0.169583	0.120945	0.131777	0.101798	0.110015	0.390271	0.178026	0.118803	0.083584	0.160688
Min.	-0.204119	-0.161855	-0.121353	-0.070459	-0.126489	-0.147052	-0.102164	-0.439491	-0.178411	-0.148101	-0.084311	-0.139940
Std. Dev.	0.018847	0.015517	0.025412	0.012184	0.016745	0.015997	0.011596	0.014786	0.024726	0.012610	0.012338	0.024587
Skewness	-0.461341	-0.479122	0.184200	0.123137	-0.088575	-0.596040	-0.148309	-2.988541	-0.404291	-0.935803	-0.482477	-0.255236
Kurtosis	25.92733	14.84442	6.562874	10.81110	8.752759	16.49013	17.44323	474.5142	16.49330	19.30897	11.29921	7.409680
Jarque-Bera	59167.01	17274.51	878.3063	7596.077	4050.987	22711.60	25634.68	26701893	12851.52	32136.12	4720.772	2392.619
Prob.	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	1.300104	0.708305	-0.792671	1.405052	0.655053	1.318888	1.277790	-0.143358	-0.032475	1.053771	-0.370577	1.210224
Sum of Sq. Dev.	0.957629	0.706667	1.060325	0.442951	0.822636	0.760332	0.396270	0.629821	1.031355	0.454945	0.246900	1.760981
Obs.	2697	2936	1643	2985	2935	2972	2948	2882	1688	2862	1623	2914
Period Coverage	23/10/2000 to 14/09/2011	05/01/2000 to 09/09/2011	03/01/2005 to 31/08/2011	03/01/2000 to 09/09/2011	04/01/2000 to 16/09/2011	03/01/2000 to 09/09/2011	03/01/2000 to 09/09/2011	04/01/2000 to 09/09/2011	03/01/2005 to 16/09/2011	07/01/2000 to 16/09/2011	10/03/2005 to 12/09/2011	04/01/2000 to 09/09/2011
Beginning Date of the Crisis	18 September 2008	19 August 2008	09 August 2008	23 September 2008	19 September 2008	03 October 2008	06 October 2008	18 September 2008	22 September 2008	17 September 2008	07 October 2008	29 July 2008
Data Source	Market's Site	Market's Site	Market's Site	Market's Site	Market's Site	Market's Site	Market's Site	Market's Site	Market's Site	Market's Site	Market's Site	Market's Site

In summary of the Table 1, the historical distribution of returns in the stock returns of all countries' market is non-normal, with relatively large kurtosis suggests that distribution of the return series is leptokurtic and negatively skewed distribution which is an indication of a non-symmetric series. These distributional results may prove the presence of a non-constant variance or volatility clustering.

Next, we run the ADF unit root test to detect stationarity of these series and concluded that though all level series have unit root, daily return series, which is defined as the logarithmic difference of the stock prices, are stationary at the 1% significant level.[2]

In order to detect the presence of ARCH effect in the residuals, we performed the ARCH LM Test and shown the results in Appendix A, indicating presence of ARCH effect by rejecting the null hypothesis of no ARCH effect for all countries. As Engle (1982) argues, these results suggest the magnitude of residuals seemed to be related to the magnitude of recent residuals. As the Table 5 in the Appendix indicates there is an ARCH effect in the residuals of all countries' return series and allow us to continue to model an ARCH/GARCH models coupled with ARMA(1,0) specification for modeling the sample countries' stock markets.

Engle (1982) and Bollerslev (1986) firstly introduce the autoregressive conditional heteroscedasticity (ARCH) and the generalized ARCH (GARCH) models respectively. As Bollerslev (1986) indicates a standard GARCH(1,1) model with no regressors in the mean and variance equations are follows:

$$
\begin{aligned}
R_t &= c + \varepsilon_t \\
\sigma_t^2 &= \omega + \alpha\,\varepsilon_{t-1}^2 + \beta\,\sigma_{t-1}^2
\end{aligned}
\qquad (2)
$$

By the specification of GARCH (1,1), with ARMA(1,0), we use Random-Walk model to test the weak-form of market efficiency in which AR(1) term captures the information for predicting of future prices from the previous day's price.

$$
\begin{aligned}
r_t &= \upsilon + \phi r_{t-1} + \varepsilon_t \\
\varepsilon_t &\sim N\left(0, \sigma_t\right) \\
\sigma_t^2 &= \omega + \alpha\,\varepsilon_{t-1}^2 + \beta\,\sigma_{t-1}^2
\end{aligned}
\qquad (3)
$$

where r_t stands for the returns which is described in Equation (1). υ is the intercept and ϕ is the slope coefficients of mean equation while ϕ is an AR(1) term reflecting the GARCH character of the model. ω is the intercept, α is the constant and α and β are the slope coefficients of the variance equation. Returns volatility, σ_t^2 is measured by ε_{t-1}^2 that is the news about volatility from the previous period (the ARCH term), and σ_{t-1}^2 that is the conditional variance that is the last period forecast variance (the GARCH term). On the other hand, the sum of α and β represents the degree of volatility persistence.

As Magnus (2008) and Abdmoulah (2009) point out, if the AR(1) parameter, ϕ in the mean equation is different from zero, in other words if the parameter is statistically significant, then we reject the weak-form of efficient market hypothesis. The magnitude of $\alpha + \beta$ shows persistence in volatility clustering, and also gives signal of efficiency of the market. If $\alpha + \beta \geq 1$, this indicates market inefficiency. Moreover, as the sum of $\alpha + \beta$ converges to 1, the degree of departing from market efficiency increases. This measure will be used as second criteria of market inefficiency that may confirm the efficiency results given by the AR(1) parameters of the GARCH(1,1) model for the selected markets.

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[2] In order to save space in the article, the ADF unit root test results are not reported here but will be provided by upon request.

4. Methodology and Results

Table 2 shows the estimated GARCH (1,1) models for the 12 stock exchange markets for the pre-crisis and post crisis periods. The models are estimated using Quasi-Maximum Likelihood assuming Gausian normal distribution. The coefficients of variance equation for all countries and both pre-defined crises periods are statistically significant at 1% level implying the models are strongly valid.

Table 2: Estimated GARCH (1,1) Models

	PRE-CRISES						**POST-CRISES**					
	Mean Equation		**Variance Equation**				**Mean Equation**		**Variance Equation**			
	υ	ϕ=[ar(1)]	ω	α	β	$\alpha+\beta$	υ	ϕ=[ar(1)]	ω	α	β	$\alpha+\beta$
Czech Republic	0.0011	0.0526	4.4E-06	0.0812	0.8927	0.97	0.0009	0.0417	4.5E-06	0.1313	0.8519	0,98
	(0.0020)	(0.0938)	(0.0048)	(0.0000)	(0.0000)		(0.0000)	(0.0409)	(0.0000)	(0.0000)	(0.0000)	
Cyprus	0.0019	0.0722	3.3E-06	0.1231	0.8830	1,00	0.0014	0.0835	2.5E-06	0.1016	0.9047	1,00
	(0.0002)	(0.0534)	(0.0000)	(0.0000)	(0.0000)		(0.0016)	(0.0019)	(0.0009)	(0.0000)	(0.0000)	
Estonia	0.0004	0.2232	1.0E-06	0.1267	0.8813	1,00	0.0005	0.2044	1.3E-06	0.1359	0.8734	1,00
	(0.0105)	(0.0000)	(0.0000)	(0.0000)	(0.0000)		(0.0037)	(0,0000)	(0.0000)	(0.0000)	(0.0000)	
Latvia	0.0009	-0.0453	1.7E-05	0.2932	0.5623	0,85	0.0009	-0.0648	8.1E-06	0.1968	0.7709	0,96
	(0.0000)	(0.1473)	(0.0000)	(0.0000)	(0.0000)		(0.0000)	(0.0047)	(0.0000)	(0.0000)	(0.0000)	
Lithuania	0.0008	0.1679	1.9E-05	0.2089	0.5838	0,79	0.0008	0.1728	1.2E-05	0.2038	0.6969	0,90
	(0.0003)	(0.0000)	(0.0000)	(0.0000)	(0.0000)		(0.0001)	(0,0000)	(0.0000)	(0.0000)	(0.0000)	
Hungary	0.0006	0.0333	8.0E-06	0.0864	0.8746	0,96	0.0006	0.0249	7.0E-06	0.0959	0.8774	0,97
	(0.0181)	(0.1455)	(0.0000)	(0.0000)	(0.0000)		(0.0159)	(0.2007)	(0.0000)	(0.0000)	(0.0000)	
Malta	-0.0005	0.2185	1.0E-05	0.2259	0.6259	0,85	-0.0002	0.2147	1.2E-05	0.2126	0.5922	0,80
	(0.7700)	(0.0000)	(0.0000)	(0.0000)	(0.0000)		(0.1351)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	
Slovenia	0.0008	0.2890	1.0E-05	0.4609	0.5334	0,99	0.0002	0.2524	8.4E-06	0.3206	0.6398	0,96
	(0.0168)	(0.0000)	(0.0000)	(0.0000)	(0.0000)		(0.3503)	(0,0000)	(0.0000)	(0.0000)	(0.0000)	
Slovakia	0.0005	-0.0168	3.3E-06	0.0661	0.9125	0,97	0.0002	-0.0160	1.3E-06	0.0320	0.9611	0,99
	(0.0265)	(0.5151)	(0.0000)	(0.0000)	(0.0000)		(0.1982)	(0.3989)	(0.0000)	(0.0000)	(0.0000)	
Bulgaria	0.0011	0.1514	2.1E-06	0.1717	0.8403	1,01	0.0006	0.1647	3.9E-06	0.2428	0.7789	1,02
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)		(0.0025)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	
Romania	0.0011	0.1179	1.7E-05	0.2655	0.7252	0,99	0.0008	0.0438	1.0E-05	0.2828	0.7454	1,02
	(0.0308)	(0.0004)	(0.0000)	(0.0000)	(0.0000)		(0.0134)	(0.0648)	(0.0000)	(0.0000)	(0.0000)	
Turkey	0.0013	0.0424	1.6E-05	0.0837	0.8667	0,95	0.0012	0.0397	1.6E-05	0.1066	0.8455	0,95
	(0.0186)	(0.1949)	(0.0004)	(0.0000)	(0.0000)		(0.0019)	(0.1084)	(0.0000)	(0.0000)	(0.0000)	

Note: *p*-values are in the parentheses.

As a determinant of conditional variance, the lagged values of daily returns, ϕ, for he countries of Estonia, Lithuania, Malta, Slovenia, and Bulgaria are significant in both pre and post-crisis periods indicating inefficiency structure of these countries' stock markets do not change through the crisis. On the other hand, the coefficient for Czech Republic, Cyprus, and Latvia were insignificant in the pre-crisis period but significant after the crisis. This might be evidence of negative impact of the crisis on these countries' stock market efficiency, suggesting departing from the weak-form market efficiency, at the 5% significant level. Finally, the same coefficients of AR(1) term for the rest of the countries, Hungary, Slovakia, Romania and Turkey do not seem different from zero in both before and after the crisis, suggesting that these countries did not suffer from the crisis that much in terms of weak-form of market efficiency.

Furthermore, the measure of volatility persistence given by $\alpha+\beta$ ranges from 0.85 to 1.01 before the crisis period while ranges from 0.80 to 1.02 during the crisis period. High values of the measure of persistency close to 1 indicate high persistency of volatility clusters on the markets. However among the countries, Czech Republic, Hungary, Latvia, Lithuania, Malta, Slovakia, Slovenia and Turkey have relatively lower persistency levels, $\alpha+\beta<1$, and performs better in terms of our second efficiency criteria in both prior and post crisis periods. The weak-form of efficiency for the stock markets of Cyprus, Estonia, Romania, and Bulgaria seemed to be affected badly with a value of $\alpha+\beta$ greater than 1.

Table 3: Estimated Differences in GARCH (1,1) Models

	DIFFERENCES BETWEEN THE CRISES							
	Δ in ϕ	**% Δ in ϕ**	**Δ in α+β**	**% Δ in α+β**	**Δ in ARCH**	**%Δ in ARCH**	**Δ in GARCH**	**% Δ in GARCH**
Czech Republic	-0,0109 -0,0529	-56,39	0,0094	0,9649	0,05	61,697	-0,0407	-4,56
Cyprus	0,0113 -0,0515	-96,44	0,0002	0,0180	-0,02	-17,451	0,0217	2,45
Estonia	-0,0188 0,0000	0,00	0,0013	0,1310	0,009	7,2683	-0,0079	-0,89
Latvia	-0,0195 -0,1426	0,00	0,1121	13,0985	-0,09	-32,881	0,2085	37,07
Lithuania	0,0048 0,0000	0,00	0,1080	13,6255	-0,005	-2,4105	0,1131	19,36
Hungary	-0,0084 0,0552	37,93	0,0123	1,2764	0,009	10,979	0,0028	0,31
Malta	-0,0039 0,0000	0,00	-0,0471	-5,5277	-0,013	-5,9259	-0,0337	-5,38
Slovenia	-0,0366 0,0000	0,00	-0,0339	-3,4088	-0,14	-30,444	0,1065	19,95
Slovakia	0,0008 -0,1162	-22,55	0,0144	1,4762	-0,03	-51,578	0,0486	5,32
Bulgaria	0,0134 0,0000	0,0000	0,0097	0,9613	0,07	41,4238	-0,0614	-7,30
Romania	-0,0741 0,0644	16100	0,0375	3,7847	0,017	6,5272	0,0202	2,78
Turkey	-0,0027 -0,0865	-44,38	0,0017	0,1806	0,022	27,409	-0,0212	-2,44

In Table 3 and 4 which are derived from Table 2, we present the differentiations of the mean and variance coefficients of the GARCH (1,1) model and the p-values of efficiency parameters of AR(1) as well as $\alpha+\beta$, between the crises periods. The estimated differences in both ARCH and GARCH term give insight how volatility and persistence in volatility have changed after the crisis for the countries. In terms of persistence in volatility (% change in GARCH term, B), Latvia, Slovenia and Lithuania have the biggest change with 37.07 %, 19.95 % and 19.36, respectively. The percentage change in persistency of volatility for the other countries look relatively smaller, ranged from 5.32% to -7.30 % between the two periods.

Table 4: Estimated AR(1) and $\alpha+\beta$ for Efficiency Decisions

COUNTRIES	Probability of ϕ=[ar(1)]			$\alpha+\beta$			Decision for the Effect of Crisis
	PRE	POST	% Δ	PRE	POST	% Δ	
Bulgaria	NE (0.0000)	NE (0.0000)	0,00	NE (1.01)	NE (1.02)	0,96	Still inefficient
Czech Republic	E (0.0938)	NE (0.0409)	-56,4	E (0.97)	E (0.98)	0,96	Departed from efficiency
Cyprus	E (0.0534)	NE (0.0019)	-96,4	NE (1.00)	NE (1.00)	0,02	Departed from efficiency
Estonia	NE (0.0000)	NE (0.0000)	0,00	NE (1.00)	NE (1.00)	0,13	Still inefficient
Hungary	E (0.1455)	E (0.2007)	37,9	E (0.96)	E (0.97)	1,28	Still efficient
Latvia	E (0.1473)	NE (0.0047)	0,00	E (0.85)	E (0.96)	13,10	Departing from efficiency
Lithuania	NE (0.0000)	NE (0.0000)	0,00	E (0.79)	E (0.90)	13,63	Still inefficient
Malta	NE (0.0000)	NE (0.0000)	0,00	E (0.85)	E (0.80)	-5,53	Still inefficient
Romania	NE (0.0004)	E (0.0648)	16100	E (0.99)	NE (1.02)	3,78	Inefficient but getting closer to efficiency
Slovenia	NE (0.0000)	NE (0.0000)	0,00	NE (0.99)	NE (0.96)	-3,41	Still inefficient
Slovakia	E (0.5151)	E (0.3989)	-22,5	NE (0.97)	NE (0.99)	1,48	Still efficient but slightly departing from efficiency
Turkey	E (0.1949)	E (0.1084)	-44,3	E (0.95)	E (0.95)	0,18	Still efficient but slightly departing from efficiency

For the results of the diagnostics tests, autocorrelation of standardized residuals (Ljung-Box Q Statistics), autocorrelation of squared standardized residuals (Ljung-Box Q^2 Statistics), and ARCH LM test of order (1) for the GARCH (1,1) is summarized in Table 6. The results suggest the statistics are significant and imply that GARCH models for each country are successful for modeling the both serial correlation and structure in conditional mean and variances. Furthermore ARCH-LM test gives evidence that there is no more ARCH effect in the residuals of the model.

5. Conclusion

This paper investigated the impact of recent global financial crisis on the weak-form of efficiency of markets of newly joined European Union countries and Turkey, using GARCH(1,1) model. Thus, the main objective was to explore for the presence of the weak-form of market efficiency, as Fama (1970) introduced, among the new members of EU and Turkey as a candidate of EU and comparing them and to answer the question of whether the 2008 crisis makes them depart from stock market efficiency. In this sense, the study also aims to answer the question of whether the recent global financial crisis in 2008 has affected efficiency of markets of newly joined 11 EU countries and Turkey differently.

As a result of findings of the analysis for the weak-form of market efficiency, two criteria of market efficiency are summarized in Table 4. We take the efficiency parameter of AR(1) in the mean equation of GARCH(1,1) into the account as the first, and the degree of persistency in volatility, sum of $\alpha + \beta$,as the second and confirming criteria of the results obtained from the first criteria. The results indicate that Bulgaria, Estonia, Lithuania, Malta and Slovenia have very significant AR(1) terms, indicating weak-form of market inefficiency both pre-crisis and post-crises periods. Furthermore, the second criteria results also support inefficiency decision for the countries of Bulgaria, Estonia and Slovenia, though does not confirm the results of the countries of Lithuania and Malta. However it obvious that Lithuania experienced increasing degree of volatility persistency after the crisis, while the degree of persistency in volatility after the crisis has decreased for Slovenia and Malta. We can categorize Romania differently, in a manner that Romania exited from the crisis with a slightly insignificant efficiency term, AR(1), but still suffered from the persistency of volatility which is greater than 1. On the other hand, Czech Republic, Cyprus and Latvia clearly departed from weak-form of efficiency after the crisis according to the first and the second criteria with an increasing degree of persistency. Among the selected countries, Hungary, Slovakia and Turkey performed better, with an insignificant AR(1) term and slightly increasing degree of persistency in volatility as an impact of the crisis. Among three of them, Hungary appeared the best efficient market with increasing insignificancy of the AR(1) term while Slovakia and Turkey follow her with an efficient but slight departing from efficiency. In this group, however, Turkey stepped forward slightly, in terms of lower and non-increasing degree of persistency in volatility as the second criteria.

Given the results mentioned, the study may have some limitations or shortcomings, which may be eliminated in a further research. As most of the literature describes the generally used specification of GARCH (1,1) models, it might necessary to expand both the order of the model and ARMA higher as well as to employ one of the asymmetric GARCH models for each country, if necessary. On the other hand, any type of multivariate GARCH models for each country might be more significant since the conditional variance of each country might be affected country specific institutional variables such as degree of capital liberalization, financial deepness that affects the composition of foreign portfolios, type of tax imposed on financial revenues (like Tobin tax), and intensity of corporate customers traded in the markets.

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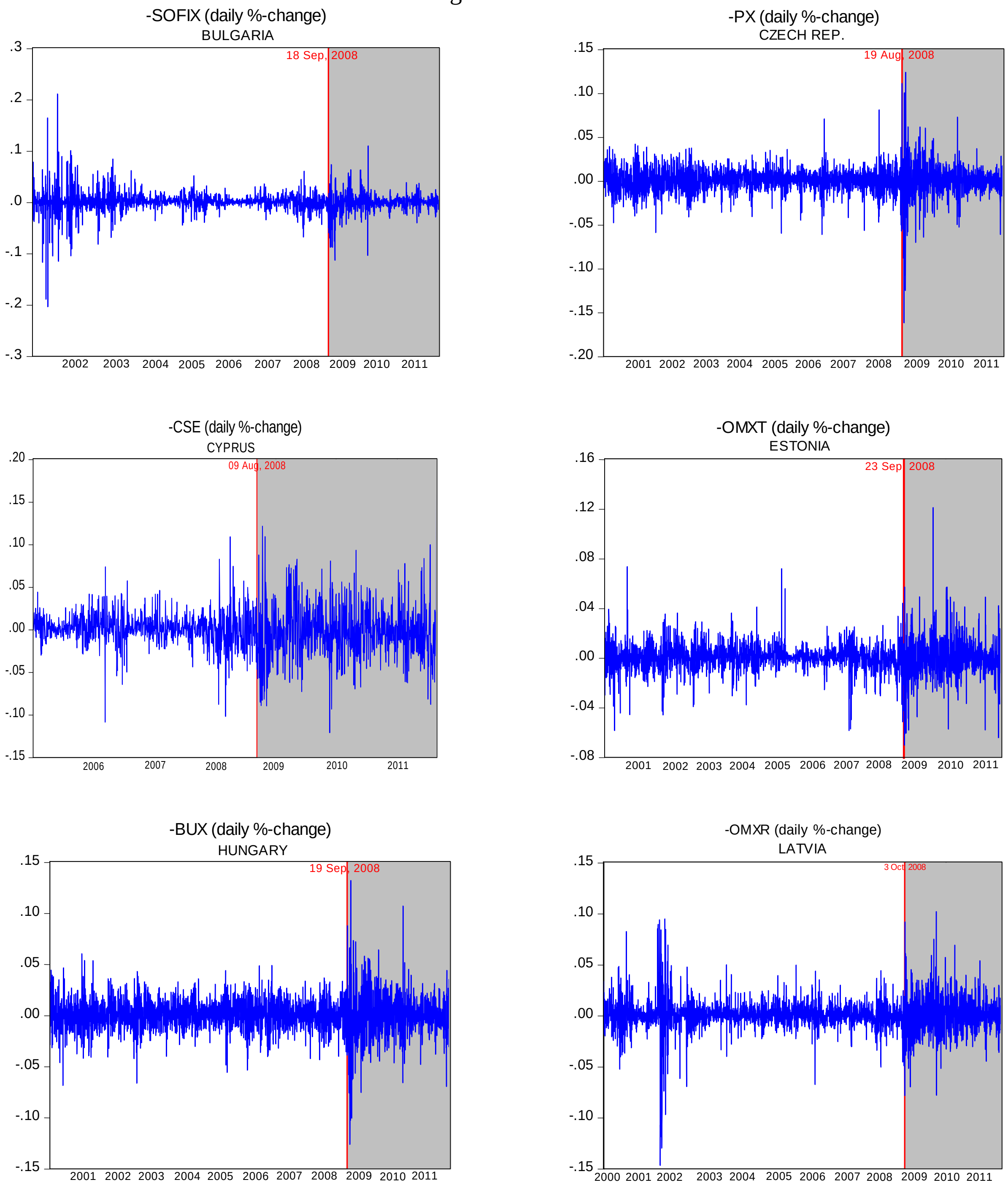
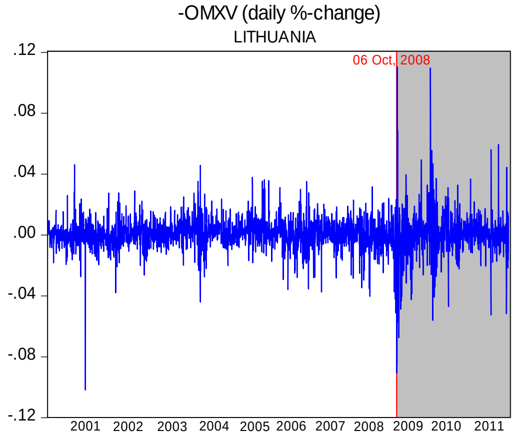
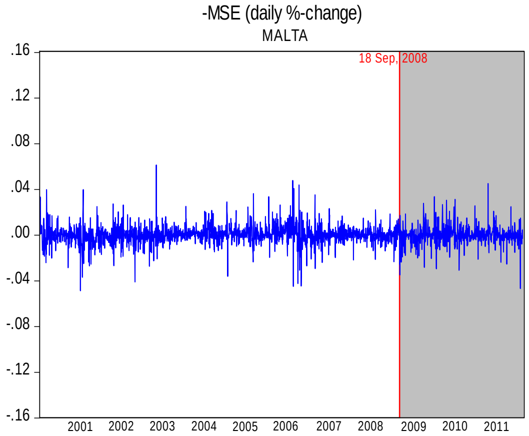
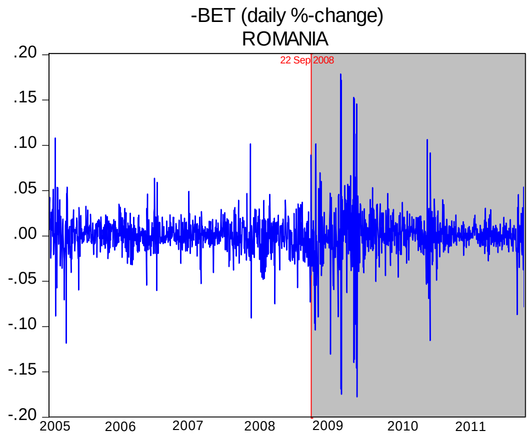
APPENDIX

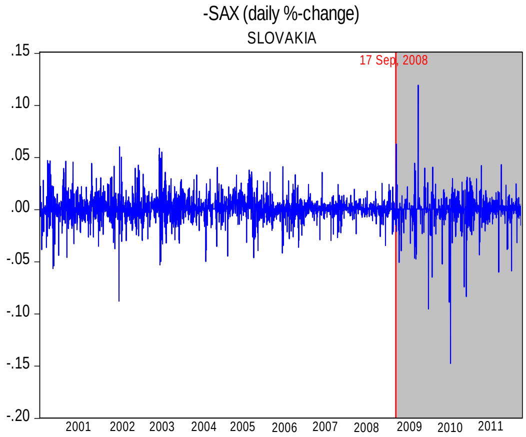
Figure 1: Returns

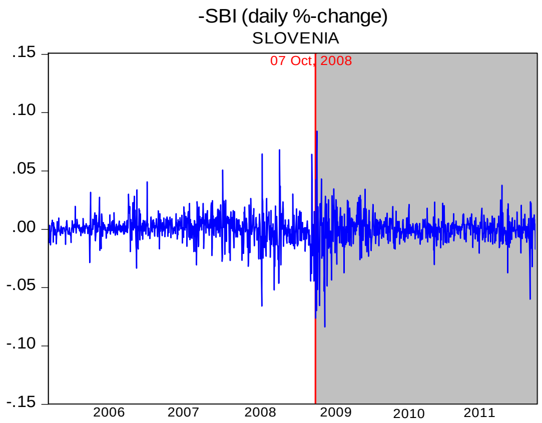



-OMXV (daily %-change)
LITHUANIA
06 Oct, 2008
.12
.08
.04
.00
-.04
-.08
-.12
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011


-MSE (daily %-change)
MALTA
18 Sep, 2008
.16
.12
.08
.04
.00
-.04
-.08
-.12
-.16
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011


-BET (daily %-change)
ROMANIA
22 Sep 2008
.20
.15
.10
.05
.00
-.05
-.10
-.15
-.20
2005 2006 2007 2008 2009 2010 2011


-SAX (daily %-change)
SLOVAKIA
17 Sep, 2008
.15
.10
.05
.00
-.05
-.10
-.15
-.20
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011


-SBI (daily %-change)
SLOVENIA
07 Oct, 2008
.15
.10
.05
.00
-.05
-.10
-.15
2006 2007 2008 2009 2010 2011

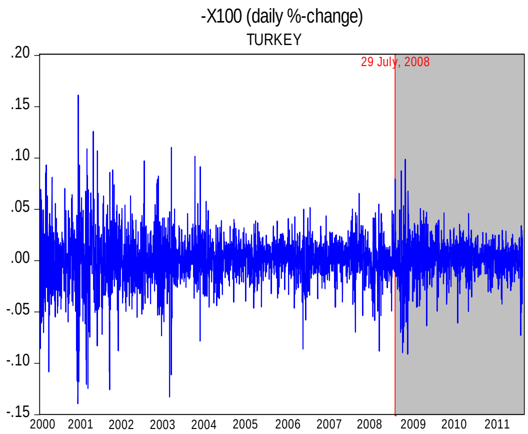

-X100 (daily %-change)
TURKEY
29 July, 2008
.20
.15
.10
.05
.00
-.05
-.10
-.15
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011

Table 5: ARCH Effect

Czech Republic	Pre-Crisis	F-statistic	11,1431	Prob. F(2,2184)	0.0000
		Obs*R-squared	22,0915	Prob. Chi-Square(2)	0.0000
	Post-Crisis	F-statistic	13,9331	Prob. F(2,2930)	0.0000
		Obs*R-squared	27,6319	Prob. Chi-Square(2)	0.0000
Cyprus	Pre-Crisis	F-statistic	6,2025	Prob. F(2,927)	0.0021
		Obs*R-squared	12,2808	Prob. Chi-Square(2)	0.0022
	Post-Crisis	F-statistic	5,2187	Prob. F(2,1637)	0.0055
		Obs*R-squared	10,3903	Prob. Chi-Square(2)	0.0055
Estonia	Pre-Crisis	F-statistic	2,6474	Prob. F(6,2231)	0.0146
		Obs*R-squared	15,8213	Prob. Chi-Square(6)	0.0147
	Post-Crisis	F-statistic	5,8804	Prob. F(2,2979)	0.0028
		Obs*R-squared	11,7263	Prob. Chi-Square(2)	0.0028
Latvia	Pre-Crisis	F-statistic	5,8960	Prob. F(2,1745)	0.0028
		Obs*R-squared	11,7330	Prob. Chi-Square(2)	0.0028
	Post-Crisis	F-statistic	10,8221	Prob. F(2,2469)	0.0000
		Obs*R-squared	21,4821	Prob. Chi-Square(2)	0.0000
Lithuania	Pre-Crisis	F-statistic	1,1903	Prob. F(3,2220)	0.3119
		Obs*R-squared	3,5716	Prob. Chi-Square(3)	0.3116
	Post-Crisis	F-statistic	2,2823	Prob. F(3,2940)	0.0772
		Obs*R-squared	6,8404	Prob. Chi-Square(3)	0.0772
Hungary	Pre-Crisis	F-statistic	10,7538	Prob. F(2,2175)	0.0000
		Obs*R-squared	21,3264	Prob. Chi-Square(2)	0.0000
	Post-Crisis	F-statistic	23,5948	Prob. F(2,2929)	0.0000
		Obs*R-squared	46,4889	Prob. Chi-Square(2)	0.0000
Malta	Pre-Crisis	F-statistic	5,4313	Prob. F(3,2134)	0.0010
		Obs*R-squared	16,2006	Prob. Chi-Square(3)	0.0010
	Post-Crisis	F-statistic	3,6691	Prob. F(3,2872)	0.0118
		Obs*R-squared	10,9805	Prob. Chi-Square(3)	0.0118
Slovenia	Pre-Crisis	F-statistic	15,5031	Prob. F(2,882)	0.0000
		Obs*R-squared	30,0551	Prob. Chi-Square(2)	0.0000
	Post-Crisis	F-statistic	15,9699	Prob. F(2,1617)	0.0000
		Obs*R-squared	31,3793	Prob. Chi-Square(2)	0.0000
Slovakia	Pre-Crisis	F-statistic	20,3437	Prob. F(3,2107)	0.0000
		Obs*R-squared	59,4256	Prob. Chi-Square(3)	0.0000
	Post-Crisis	F-statistic	8,3420	Prob. F(8,2844)	0.0000
		Obs*R-squared	65,4119	Prob. Chi-Square(8)	0.0000
Bulgaria	Pre-Crisis	F-statistic	15,9044	Prob. F(3,1659)	0.0000
		Obs*R-squared	46,4912	Prob. Chi-Square(3)	0.0000
	Post-Crisis	F-statistic	86,8542	Prob. F(3,2392)	0.0000
		Obs*R-squared	235,3603	Prob. Chi-Square(3)	0.0000
Romania	Pre-Crisis	F-statistic	7,5049	Prob. F(3,921)	0.0001
		Obs*R-squared	22,0728	Prob. Chi-Square(3)	0.0001
	Post-Crisis	F-statistic	1,9173	Prob. F(15,1656)	0.0180
		Obs*R-squared	28,5421	Prob. Chi-Square(15)	0.0184
Turkey	Pre-Crisis	F-statistic	5,4486	Prob. F(2,1145)	0.0044
		Obs*R-squared	10,8227	Prob. Chi-Square(2)	0.0045
	Post-Crisis	F-statistic	32,6091	Prob. F(2,1921)	0.0000
		Obs*R-squared	63,1752	Prob. Chi-Square(2)	0.0000

Table 6: Diagnostic Test for Estimated GARCH (1,1) Model

	Diagnostic Tests - Pre-Crisis			**Diagnostic Tests - Post-Crisis**		
	Ljung-Box Q Statistics	**Ljung-Box Q Statistics**	**ARCH LM test**	**Ljung-Box Q Statistics**	**Ljung-Box Q Statistics**	**ARCH LM test**
Czech Republic	0.8983 (0.343)	3,2230 (0.073)	0.995816 (0.3183)	1,7785 (0.182)	1,4233 (0.233)	1,417298 (0.2338)
Cyprus	0.4855 (0.486)	0.5969 (0.440)	0,071731 (0.7888)	0.7821 (0.377)	0.2711 (0.603)	0.896697 (0.3437)
Estonia	16,3000 0.006)	1,5613 (0.906)	0.000189 (0.9890)	8,1941 (0.004)	0.2460 (0.620)	0.191174 (0.6619)
Latvia	8,4988 (0.004)	2,4808 (0.115)	1,509855 (0.2192)	6,9098 (0.009)	2,6465 (0.104)	1,85619 (0.1731)
Lithuania	14,0450 (0.001)	0.1741 (0.917)	0.045706 (0.8307)	17,9220 (0.000)	0.1464 (0.929)	0.000978 (0.9751)
Hungary	0.7205 (0.396)	0.2054 (0.650)	0.095409 (0.7574)	2,1761 (0.140)	0.5523 (0.457)	0.480261 (0.4883)
Malta	6,3204 (0.042)	1,6460 (0.439)	0.066246 (0.7969)	9,3080 (0.010)	1,6771 (0.432)	0.005119 (0.9430)
Slovenia	20,7370 (0.000)	1,4676 (0.226)	1,08925 (0.2966)	12.799 (0.000)	0.1971 (0.657)	0.050128 (0.8228)
Slovakia	3,3396 (0.188)	4,2695 (0.118)	0.013386 (0.9079)	4,6139 (0.100)	1,9559 (0.376)	0.261017 (0.6094)
Bulgaria	10.133 (0.006)	1,3727 (0.503)	0.621441 (0.4305)	18.492 (0.000)	2,0885 (0.352)	0.181319 (0.6702)
Romania	0.2158 (0.898)	1,4843 (0.476)	0.557009 (0.4555)	2,4909 (0.288)	3,2493 (0.197)	3,18004 (0.0745)
Turkey	0.3142 (0.575)	0.7867 (0.375)	0.243330 (0.6218)	0.7284 (0.393)	0.2114 (0.646)	0.149859 (0.6987)

Note: *p*-values are in the parentheses. Autocorrelation of Standardized Residuals (Ljung-Box Q Statistics), Autocorrelation of Squared Standardized Residuals (Ljung-Box Q^2 Statistics), and ARCH LM test of order (1) for the GARCH (1,1).