Stock market efficiency in South Eastern Europe: testing return predictability and presence of calendar effects

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February 2017

Working Paper

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Abstract

This paper examines the calendar effects in ten South Eastern European (SEE) stock markets daily returns during the period 2007 - 2014. We focus on three calendar effects: the day of the week effect, the half month effect and the turn of the month effect. Specifically, we analyze existence of each calendar effect separately in the mean and in the volatility of the index returns. We apply standard regression models with dummy variables for the effects in the mean returns, while we apply GARCH(1,1) models with dummy variables for the effects in the volatility of returns. The results present evidence that the day of the week effects in both mean and volatility are present in nine out of ten SEE stock markets. Contrary, the half month effect in mean returns is present only in one SEE stock market, while half month effect in volatility is present in five out of ten SEE stock markets. The turn of the month effect in mean returns is present in six out of ten SEE stock markets. The turn of the month effect in volatility is present in all SEE stock markets.

Keywords: Calendar anomalies, Daily returns, Generalized autoregressive models, South Eastern Europe.

JEL classification: C32, G14.

1. Introduction

Informationally efficient stock markets create price system that allocate financial capital to most productive uses, and at the same time, such markets reflect the underlying market structure in which intense competition for information competes away any above normal (economic) profits. In its weak form, informational efficiency hypothesis in a sense of Fama (1970, 1991) and Roberts (1967) states that subsequent changes in stock price are unpredictable based on information content of historic prices, since all information contained in price history is fully and instantaneously reflected in stock's current price. The unpredictability of stock prices may be thought to imply that the stock price dynamics is generated by some form of a random walk process. Smith (2012) and Dyakova and

Smith (2013) examined this hypothesis using variance ratio tests within the emerging European stock markets. They found a wide variability of the degree of return predictability.

In the present paper, we challenged the informational efficiency of the stock markets by the so-called calendar effects or calendar anomalies. We focus on three calendar effects: day of the week effect, half of the month effect and turn of the month effect. The day of the week effect presents anomaly that the stock returns on Mondays are systematically lower than returns on other days in the week. The half of the-month effect presents anomaly that the stock returns during the first half of the month are on average higher than the returns for the rest of the month. The turn of the month effect presents anomaly that stock retusrns tend to increase during the last few days and the first few days of each month.

There is a large body of literature that provide empirical evidence for calendar effects in developed stock markets. The most important papers are: Fama (1965), French (1980), Gibbons and Hess (1981), Rogalski (1984), Dyl and Maberly (1988), Agarwal and Tandon (1994), Rubinstein (2001), Schwert (2001), Steely (2001) and Sullivan et al. (2001). There are different explanations for the day of the week effect. Abraham and Ikenberry (1994) argue that the investors have the tendency to sell on Monday after the revision of their portfolios during the weekend. Chen and Singal (2003) shows that the investors closed the short positions (buy) on Fridays and open them again on Mondays (sell). Taylor (2008) comments that not satisfactory explanation has yet been given for the weekend effect. Similarly, academic community has not yet been able to reach consensus about the reasons for half of the month and turn of the month effects. Odgen (1990) points that they arise from the clusterization of salary payments and other liabilities, while Penman (1987) suggests to clusterization of the earnings announcement releases.

Calendar effects are becoming increasingly popular in developing stock markets research (see for example Brooks and Persand, 2001, Fountas and Segredakis 2002, Alagidede and Panagiotidis 2009, Guidi et al. 2011, Rojas and Kristjanpoller 2014). However, the calendar effects in South Eastern Europe (SEE) stock markets have been analyzed rather rarely. Georgantopoulos et al. (2011) investigates calendar anomalies in four SEE stock markets and provides evidence for the existence of three calendar effects (day of the week, turn of the month, time of the month) for Greece and Turkey in the period 2000-2008. Georgantopoulos and Tsamis (2011) shows that two calendar effects (day of the week and January effects) are present in the Macedonian stock market during the period 2002-2008. Georgantopoulos and Tsamis (2012) investigate also the calendar anomalies for Bulgaria and Greece during the period 2002–2008. They found that most of the tested calendar effects exist for Greece and the effects for Bulgaria are limited and exist only in variance. Karadzic and Backovic Vulic (2011) report absence of three calendar anomalies: the January effect, the turn-of the-month effect and the holiday effect for the Montenegrin capital market during the period 2004 - 2010. Tevdovski et al. (2012) found day of the week effect in the Bulgarian and Croatian stock market during the period 2006-2011. Oprea and Țilică (2014), find some evidence of the day-of-the-week effect in several SEE and Central and east (CEE) emerging stock markets (Bosnia, Bulgaria, Croatia, Latvia, Serbia and Slovenia).

In these regards, the present paper examine the existence of the three calendar effects (day of the week effect, half of the month effect and turn of the month effect) in all ten SEE stock markets. Moreover, we analyze existence of each calendar effect separately in the mean and in the volatility of the leading stock market index returns. The period of observation is from 2007 to 2014, which covers the influence of the Global financial crisis. We provide an evidence for the existence of calendar effects in the SEE stock markets during the observed period.

The rest of the paper is organized as follows. Section 2 presents employed methodology: the variance ratio test and the models for calendar effects estimation. Section 3 provides description of the data used in the analysis. The findings of the empirical analysis are presented in the Section 4. Section 5 concludes.

2. Empirical methodology

In this section, we present the empirical methodology: first the variance-ratio test that is used for exploration of random walk hypothesis, and second, models for estimation of three calendar effects that could be detected on daily data (the day of the week effect, the half month effect, and the turn of the month effect).

Variance-ratio test

A consequence of informational efficiency is that stock returns should behave as random walk process. Random walk hypothesis is true if the variance of a multi-period return is the sum of single-period variances. There are several tests that empirically explore this property, while the most important is the variance-ratio test of Lo and MacKinlay (1988). The idea of the test is that if data follow random walk, the variance of q-period returns should be q times the variance of 1-period returns. So, the variance ratio should approach to one:

$$VR(N) = \frac{\sigma^2(q)}{q\sigma^2(1)} = 1. \tag{1}$$

When the random walk hypothesis is false, $\mathrm{VR}(q)$ equals $q\sigma^2(1)$ plus covariance terms between all pairs of distinct returns (Taylor, 2005). The variance ratio z-statistic:

$$z_N = \frac{\widehat{VR}(q)-1}{\sqrt{\hat{\sigma}^2(q)}} \tag{2}$$

is asymptotically $\mathrm{N}(0,1)$ for appropriate choice of estimator $\hat{\sigma}^2(q)$. Lo and MacKinlay provide an estimator in the case of homoscedastic random walk hypothesis (i.i.d. null) and in the case of heteroscedastic random walk hypothesis (martingale null).

It is common to evaluate the z-statistics for several values of q, since the variance ratio restriction holds for every period $q > 1$. Chow and Denning (1993) propose test statistic that examines the maximum absolute value of set of multiple variance ratio statistics in order to control the size of the joint test. Improvement of the small sample properties of individual and joint variance ratio tests can be made by a wild bootstrap approach of Kim (2006).

Estimation of the day of the week effect

We use a standard methodology to test for daily seasonality in stock market returns (See for example, French 1980, Rogalski 1984, Agrawal and Tandon 1994, and Mills and Couts 1995). It is the following regression model with dummy variables:

$$R_t = \alpha_1 + \sum_{i=2}^{5} \alpha_i D_{it} + u_t \tag{3}$$

$$h_t^2 = \alpha + \beta u_{t-1}^2 + \gamma h_{t-1}^2 + \sum_{i=2}^{5} \delta_i D_{it} \quad (4)$$

where, in the mean equation, R_t is the daily logarithmic return (in %) on a selected stock index; D_{it} is binary dummy variable for various trading days in the week, Tuesday, …, Friday, respectively (i.e. $D_{2t} = 1$ if day t is Tuesday, zero otherwise, etc.) Monday represents the control category. The coefficient α_1 indicates the mean daily return for Monday (control category), while α_2 to α_5 represents the difference between the mean daily return for Monday and the mean daily return for each of the other days in the week. The error term is noted as u_t and it is assumed to be identically and independently distributed (IID). Gujarati (2004) argue that this type of models are more general than the t test which can be used to compare the means of two groups or categories only. If there are no differences among index returns across days of the week, the coefficients α_2 to α_5 are zero. Therefore, the null hypothesis of the relevant Wald test is $H_0: \alpha_i = 0$ for $i = 2, \ldots, 5$. If the null hypothesis is rejected, then stock returns should exhibit some form of the day of the week seasonality (Georgantopoulos and Tsamis, 2011).

The variance equation is an GARCH(1,1) model, where, h_t^2 is the conditional variance of u_i. It is used for estimation of the day of the week effect in volatility. If there is no day of the week effect in volatility, the parameters δ_2 to δ_5 are zero, so the null hypothesis is $H_0: \delta_i = 0$ for $i = 2, \ldots, 5$.

Estimation of the half month effect

We use model originally proposed by Lakonishok and Smidt (1988) for estimation of the half month effect. The mean and variance equations are:

$$R_t = \alpha_0 + \alpha_1 H_{1t} + u_t \quad (5)$$

$$h_t^2 = \alpha + \beta u_{t-1}^2 + \gamma h_{t-1}^2 + \delta H_{1t} \quad (6)$$

where, H_{1t} is binary dummy variable, which takes value 1 if the trading day t is from the first to the fiftheen calendar days of the month, and 0 otherwise. The coefficient α_0 indicates the mean daily return for the trading days in the second half of the month (control category), while α_1 represents the difference between the mean daily return for the first half of the month and control category. The coefficient δ indicates the half month effect in volatility. If there is no half month effect in volatility, the parameter δ is zero.

Estimation of the turn of the month effect

We use a model originally proposed by Ariel (1987), Lakonishok and Smidt (1988), and Agrawal (1994) for estimation of the turn of the month effect . The mean and variance equations are:

$$R_t = \alpha_0 + \alpha_1 T(-3)_t + \alpha_2 T(-2)_t + \alpha_3 T(-1)_t + \alpha_4 T(+1)_t + \alpha_5 T(+2)_t + \alpha_6 T(+3)_t + u_t \quad (7)$$

$$h_t^2 = \alpha + \beta u_{t-1}^2 + \gamma h_{t-1}^2 + \delta_1 T(-3)_t + \delta_2 T(-2)_t + \delta_3 T(-1)_t + \delta_4 T(+1)_t + \delta_5 T(+2)_t + \delta_6 T(+3)_t \quad (8)$$

where dummy variables are used as indication of the turn of the month. Specifically, $T(-3)$, $T(-2)$ and $T(-1)$ are dummy variables that represent the third last, the second last and the last trading day in the month, respectively, while $T(+1)$, $T(+2)$, $T(+3)$ are dummy variables that represent the first, the second and the third trading day in the month, respectively. The coefficients α_1 to α_6 indicates the differences between the mean return of the specific day from the turn of the month and the mean return of the rest of the days in the month. The null hypothesis of the relevant Wald test is $H_0: \alpha_i = 0$ for $i = 1, \ldots, 6$. If the null hypothesis is rejected, then stock returns should exhibit some form of the turn of the month effect in mean. The coefficients δ_1 to δ_6 indicates the differences in the volatility between the specific day from the turn of the month and the rest of the days in the month. The null hypothesis of the relevant Wald test is $H_0: \delta_i = 0$ for $i = 1, \dots, 6$. If the null hypothesis is rejected, then stock returns should exhibit some form of the turn of the month effect in volatility.

3. Data

We apply the relevant stock markets indices of all ten SEE countries: BELEX15 (Serbia), SASX10 (Bosnia and Herzegovina), SOFIX (Bulgaria), CROBEX (Croatia), ATHEX Composite (Greece), MBI10 (Macedonia), MONEX20 (Montenegro), BET (Romania), SLOETOP (Slovenia), BIST100 (Turkey). The source of the data is DataStream database. We use daily log returns (in percent) calculated from the price indexes for the stock markets measured in the national currency. Voronkova (2004) argue that usage of the national currencies restricts their changes to movements in the security prices and avoids distorting the analysis with devaluations of the exchange rates. The data covers the period from January 11, 2007 to June 25, 2014. It gives a total of 1945 observations. The main characteristic of the observation period is the Global financial crisis that started to influence the SEE stock markets from the middle of 2007.

Table 1: Descriptive statistics of the stock market indices daily returns

	Mean	**Std. Deviation**	**Skewness**	**Kurtosis**
BELEX15	-0.0572	1.4790	0.19	15.56
SASX10	-0.1058	1.4471	-11.93	344.43
SOFIX	-0.0473	1.3608	-1.01	12.70
CROBEX	-0.0309	1.3665	0.02	18.73
ATHEX	-0.0669	2.0728	0.06	5.70
MBI10	-0.0443	1.3791	-0.44	11.92
MONEX20	-0.0317	1.6518	0.80	11.96
BET	-0.0104	1.7485	-0.61	11.07
SLOETOP	-0.0360	1.2416	-0.45	9.82
BIST100	0.0395	1.7836	-0.23	7.05

Source: Authors calculation based on Datastream database data.

Table 1 reports the descriptive statistics of the stock market indices daily returns. Nine of ten SEE stock indices experienced mean negative daily return in the observed period. The exception is BIST100 index (Turkey). The market risk measured with standard deviation is lowest in SLOETOP (Slovenia) and highest in ATHEX (Greece). All indices have positive kurtosis indicating a fatter-tailed distribution than normal.

4. Empirical findings

The results of the joint variance-ratio tests for the observed period are presented in the table 2. The first column of the table reports the maximum variance-ratio test statistics ($z - \text{statistic}$) under the homoscedastic random walk, while the second column reports the maximum variance-ratio test statistics ($z - \text{statistic}$) using heteroskedasticity robust standard error estimates. Under the random walk hypothesis (null hypothesis), the value of the variance-ratio test is 1 and the test statistic have a standard normal distribution (asymptotically). In the case of all SEE indices, except SASX10, the test statistics reject the random walk hypothesis both for homoskedastic and heteroscedastic possibility. For SASX10, the rejection of the null hypothesis of the homoscedastic, but not heteroskedastic random walk, indicate that the rejection of the null hypothesis of the random walk may be due to heteroskedasitity and therefore the index meet at least some requirements of a random walk. These results means that SEE stock markets, except Bosnian, are not efficient over the observed period.

Table 2: Joint Variance ratio tests

	Homoskedastic random walk hypothesis	**Heteroskedasticity random walk hypothesis**
BELEX15	Max |z| (at period 2) 15.9411*** (0.0000)	Max |z| (at period 4) 6.0882*** (0.0000)
SASX10	Max |z| (at period 2) 18.4417*** (0.0000)	Max |z| (at period 8) 2.0268 (0.1601)
SOFIX	Max |z| (at period 2) 21.3718*** (0.0000)	Max |z| (at period 2) 7.5261*** (0.0000)
CROBEX	Max |z| (at period 2) 18.1843*** (0.0000)	Max |z| (at period 2) 6.9553*** (0.0000)
ATHEX	Max |z| (at period 2) 19.7122*** (0.0000)	Max |z| (at period 2) 12.5283*** (0.0000)
MBI10	Max |z| (at period 4) 14.6455*** (0.0000)	Max |z| (at period 4) 6.3674*** (0.0000)
MONEX20	Max |z| (at period 4) 16.6811*** (0.0000)	Max |z| (at period 4) 7.0134*** (0.0000)
BET	Max |z| (at period 2) 20.8048*** (0.0000)	Max |z| (at period 2) 9.0154*** (0.0000)
SLOETOP	Max |z| (at period 2) 17.0374*** (0.0000)	Max |z| (at period 2) 7.261777*** (0.0000)
BIST100	Max |z| (at period 2) 22.0539*** (0.0000)	Max |z| (at period 2) 13.1121*** (0.0000)

Note: */**/*** indicate that the parameter is significantly different from zero at 10%/5%/1% level; p values are reported in brackets.

Table 3 reports the estimates of the day of the week effect in stock returns. The Wald test is not rejecting the null hypothesis that the coefficients α_2 to α_5 are zero only in the case of BIST100. On the other hand, the null hypothesis of no day of the week effect in the mean returns is rejected in all other cases: on 10% significance level for SASX10 and SOFIX, and on 1% significance level in all other cases. In the case of CROBEX, the mean daily return of every trading day in the week is higher than the mean daily return in Monday. In the case of BET and SLOETOP, the mean daily return in Wednesday, Thursday and Friday are higher than the mean daily return in Monday. In the case of BELEX15 and MBI10, the mean daily return in Thursday and Friday are higher than the mean daily return in Monday. In the case of SASX10 and ATHEX, the mean daily return in Wednesday and Friday are higher than the mean daily return in Monday. In case of SOFIX, the mean daily return in Wednesday and Thursday are higher than the mean daily return in Monday. In the case of MONEX20, the mean daily return for Friday is higher than the mean daily return in Monday.

Table 3: The day of the week effect in the mean

	α_1	α_2	α_3	α_4	α_5	**Wald test F-statistic**
BELEX15	-0.0622	-0.0107	0.0578	0.1164**	0.1617***	3.4831***
	(0.1153)	(0.8434)	(0.2530)	(0.0276)	(0.0040)	(0.0077)
SASX10	-0.1522***	-0.0515	0.1215**	0.0800	0.1291**	2.0328*
	(0.0002)	(0.6498)	(0.0315)	(0.1859)	(0.0262)	(0.0873)
SOFIX	-0.0496	-0.0090	0.1212**	0.1135*	0.0751	2.3331*
	(0.2144)	(0.8691)	(0.0284)	(0.0549)	(0.1807)	(0.0537)
CROBEX	-0.1818***	0.1461**	0.2282***	0.2431***	0.2454***	5.9780***
	(0.0001)	(0.0122)	(0.0001)	(0.0000)	(0.0000)	(0.0001)
ATHEX	-0.1705*	0.0553	0.4002***	0.1956	0.3566***	4.4121***
	(0.0513)	(0.6672)	(0.0009)	(0.1137)	(0.0025)	(0.0015)
MBI10	-0.1002***	-0.0711	0.0439	0.1652***	0.1219**	6.8093***
	(0.0073)	(0.1659)	(0.4155)	(0.0009)	(0.0184)	(0.0000)
MONEX20	-0.0599	-0.0609	-0.0107	0.0486	0.1710**	3.5192***
	(0.2359)	(0.3774)	(0.8725)	(0.4716)	(0.0168)	(0.0072)
BET	-0.0916*	0.0948	0.1606**	0.2482***	0.2215***	3.6901***
	(0.0748)	(0.1692)	(0.0194)	(0.0005)	(0.0021)	(0.0053)
SLOETOP	-0.0997**	-0.0081	0.1306**	0.1332**	0.2160***	4.4238***
	(0.0330)	(0.8972)	(0.0470)	(0.0407)	(0.0005)	(0.0015)
BIST100	0.1699**	-0.0785	-0.0148	0.0173	-0.0987	0.5005
	(0.0383)	(0.4703)	(0.8936)	(0.8745)	(0.3484)	(0.7354)

Note: */**/*** indicate that the parameter is significantly different from zero at 10%/5%/1% level; p values are reported in brackets.

Table 4 reports the estimates of the day of the week effect in volatility. The Wald test is not rejecting the null hypothesis that the coefficients δ_2 to δ_5 are zero only in the case of SLOETOP. On the other hand, the null hypothesis of no day of the week effect in returns volatility is rejected in all other cases: on 5% significance level for

MBI10 (Macedonia) and BET (Romania), and on 1% significance level in all other cases. In the case of CROBEX, every trading day in the week appears to have lower variances than Monday. In the case of MONEX20 and BET, Tuesday, Wednesday and Friday appears to have lower variances than Monday. In the case of BIST100, Tuesday, Thursday and Friday appears to have lower variances than Monday. In the case of ATHEX, Wednesday and Thursday appears to have lower variances than Monday. In the case of SOFIX, only Friday appears to have lower variance than Monday. In the case of SASX10, Wednesday appears to have lower variances than Monday, while Tuesday and Thursday appears to have higher variances. In the case of BELEX only Friday appears to have higher variance than Monday. In the case of MBI10 only Tuesday appears to have higher variance than Monday.

Table 4: The day of the week effect in volatility

	α	β	γ	δ_2	δ_3	δ_4	δ_5	**Wald test F-statistic**
BELEX15	0.0291	0.3189***	0.6973***	-0.0053	-0.0021	-0.0544	0.1909***	7.9886***
	(0.4739)	(0.0000)	(0.0000)	(0.9405)	(0.9698)	(0.2867)	(0.0012)	(0.0000)
SASX10	-0.0055	0.1269***	0.7996***	5.7122***	-4.3811***	0.1317***	-0.0124	228.612***
	(0.8520)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0087)	(0.8147)	(0.0000)
SOFIX	0.1367***	0.2484***	0.7284***	-0.0733	-0.0346	-0.0450	-0.1998***	3.4979***
	(0.0034)	(0.0000)	(0.0000)	(0.3663)	(0.5899)	(0.4668)	(0.0029)	(0.0075)
CROBEX	0.1888***	0.1043***	0.8967***	-0.3006***	-0.2351***	-0.1967***	-0.1644***	12.0108***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0010)	(0.0000)
ATHEX	0.5297***	0.0903***	0.9011***	-0.1800	-1.1528***	-0.5054*	-0.5192	4.3651***
	(0.0050)	(0.0000)	(0.0000)	(0.6013)	(0.0001)	(0.0802)	(0.1336)	(0.0016)
MBI10	0.0367	0.2422***	0.7576***	0.1079*	-0.0701	0.0019	-0.0198	3.0056**
	(0.3023)	(0.0000)	(0.0000)	(0.0760)	(0.1532)	(0.9674)	(0.7300)	(0.0174)
MONEX20	0.2765***	0.2132***	0.7755***	-0.3586***	-0.1720**	-0.1116	-0.3481***	4.2530***
	(0.0000)	(0.0000)	(0.0000)	(0.0004)	(0.0302)	(0.1620)	(0.0002)	(0.0020)
BET	0.1925***	0.2032***	0.7952***	-0.2068*	-0.2260**	0.0245	-0.2793***	2.6399**
	(0.0018)	(0.0000)	(0.0000)	(0.0640)	(0.0123)	(0.7915)	(0.0080)	(0.0323)
SLOETOP	0.1425***	0.2114***	0.7201***	-0.0877	-0.0471	-0.0306	-0.0251	0.3670
	(0.0110)	(0.0000)	(0.0000)	(0.3591)	(0.5615)	(0.6941)	(0.8061)	(0.8322)
BIST100	0.6236***	0.1206***	0.8496***	-1.0017***	-0.1389	-0.4010*	-1.0438***	6.3718***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.5125)	(0.0827)	(0.0000)	(0.0000)

Note: */**/*** indicate that the parameter is significantly different from zero at 10%/5%/1% level; p values are reported in brackets.

Table 5 reports the estimates of the half month effect in stock returns. The coefficient α_1 is not significant in the cases of all SEE stock market indices, except in the case of SLOETOP. In the case of SLOETOP, the coefficient is significant at 5% level and it imply that the mean daily return for the trading days in the first half of the month is lower than the mean daily return for the trading days in the second half of the month.

Table 6 reports the estimates of the half month effect in volatility. The coefficient δ is not significant in the cases of BELEX, SOFIX, ATHEX, MONEX20 and BET. In the cases of SASX, CROBEX, MBI10 and SLOETOP, the significant coefficient imply that the volatility of the returns for the for the trading days in the first half of the month is higher than the volatility of the returns for the trading days in the second half of the month. In contrary, in the case of BIST100, the trading days in the first half of the month have lower volatility than the trading days in the second half of the month.

Table 7 reports the estimates of the turn of the month effect in stock returns. The Wald test is not rejecting the null hypothesis that the coefficients α_1 to α_6 are zero in the cases of SASX, CROBEX, MBI10 and MONEX20. The null hypothesis of no turn of the month effect in the mean returns is rejected on 1% significance level for BELEX, ATHEX and BET and on 10% significance level for SOFIX, SLOETOP and BIST100. In the case of BELEX the days $T(-2)$, $T(-1)$ and $T(+3)$ appears to have higher mean daily returns than the mean of the rest of the month trading days, while the days $T(+1)$ and $T(+2)$ appears to have lower mean daily returns than the mean of the rest of the month trading days. Similarly, in the case of SLOETOP the day $T(-1)$ have higher and the day $T(-1)$ have lower daily returns than the mean daily returns in the rest of the month trading days. In the case of ATHEX significant is only day $T(-1)$ with lower mean daily returns than the rest of the month days. Contrary, in the case of BET, the days $T(-2)$, $T(-1)$ and $T(+1)$ appears to have higher mean daily returns than the rest of the month days. It is same in the case of SOFIX where only $T(-2)$ and $T(-1)$ are significant, while in the case of BIST100 only $T(+1)$ is significant.

Table 8 reports the estimates of the turn of the month effect in volatility. The Wald test is rejecting the null hypothesis that the coefficients δ_1 to δ_6 are zero for all SEE stock indices. The null hypothesis of no turn of the month effect in volatility is rejected on 5% significance level for SOFIX and MBI10 and on 1% significance level for all other cases. SASX appears to have lower variances in the all turn of the month days in comparison to the variance of the rest of the month trading days. The rest of the stock indices have some combination of the turn of the month days with higher and lower variances in comparison with the variance of the rest of the month days.

5. Conclusion

This paper investigates the random walk hypothesis as well as the three calendar effects (day of the week effect, half month effect and the turn of the month effect) in all ten SEE stock markets for the most recent period (from January 11, 2007 to June 25, 2014) which immanent characteristic is the Global financial crisis. Using the variance-ratio test, we found that random walk hypothesis is rejected for all SEE stock markets, except the Bosnian stock market.

Table 9 summarizes the results of the calendar effects. The day of the week effects are present in the mean returns of SEE stock markets. The exemption is the Turkish stock market. Similarly, the day of the week effect in volatility is present in all SEE stock markets, except in Slovenian one. Half month effect in mean returns is present only in the Slovenian stock market, while half month effect in volatility is present in five out of ten SEE stock markets. The turn of the month effect in mean returns is present in six out of ten SEE stock markets. The exemptions are Bosnian, Croatian, Macedonian and Montenegro stock markets. The turn of the month effect in volatility is present in all SEE stock markets.

Table 9: Summary of the selected calendar effects in mean and volatility

	Day of the week		Half month effect		The turn of the month effect	
	Mean	**Volatility**	**Mean**	**Volatility**	**Mean**	**Volatility**
BELEX15	Strong	Strong	None	None	Strong	Strong
SASX10	Weak	Strong	None	Strong	None	Strong
SOFIX	Weak	Strong	None	None	Weak	Moderate
CROBEX	Strong	Strong	None	Moderate	None	Strong
ATHEX	Strong	Strong	None	None	Strong	Strong
MBI10	Strong	Moderate	None	Strong	None	Moderate
MONEX20	Strong	Strong	None	None	None	Strong
BET	Strong	Moderate	None	None	Strong	Strong
SLOETOP	Strong	None	Moderate	Moderate	Weak	Strong
BIST100	None	Strong	None	Strong	Weak	Strong

Note: Weak/Moderate/Strong present the significance */**/*** of the respective Wald test.

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Appendix

Table 5: The half month effect in the mean

	α_0	α_1
BELEX15	-0.0102	0.0251
	(0.6666)	(0.4615)
SASX10	-0.0946***	-0.0816
	(0.0016)	(0.4285)
SOFIX	0.0356	-0.0446
	(0.2080)	(0.2484)
CROBEX	-0.0038	-0.0130
	(0.8642)	(0.6745)
ATHEX	0.0351	-0.0001
	(0.4780)	(0.9988)
MBI10	-0.0401	-0.0015
	(0.1034)	(0.9651)
MONEX20	0.0056	-0.0668
	(0.8592)	(0.1196)
BET	0.0430	0.0156
	(0.2228)	(0.7431)
SLOETOP	0.0383	-0.0876**
	(0.1984)	(0.0456)
BIST100	0.1104**	0.0296
	(0.0181)	(0.6367)

Note: */**/*** indicate that the parameter is significantly different from zero at 10%/5%/1% level; p values are reported in brackets.

Table 6: The half month effect in volatility

	α	β	γ	δ
BELEX15	0.0512***	0.3233***	0.6956***	0.0070
	(0.0000)	(0.0000)	(0.0000)	(0.4853)
SASX10	0.3707***	0.2064***	0.3986***	1.2803***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
SOFIX	0.0671***	0.2481***	0.7311***	-0.0054
	(0.0000)	(0.0000)	(0.0000)	(0.6630)
CROBEX	0.0018	0.1054***	0.8977***	0.0132**
	(0.5743)	(0.0000)	(0.0000)	(0.0268)
ATHEX	0.0243	0.0842***	0.9092***	0.0510
	(0.2442)	(0.0000)	(0.0000)	(0.2164)
MBI10	0.0174***	0.2328***	0.7690***	0.0402***
	(0.0024)	(0.0000)	(0.0000)	(0.0001)
MONEX20	0.0737***	0.2099***	0.7766***	0.0132
	(0.0000)	(0.0000)	(0.0000)	(0.3268)
BET	0.0555***	0.1951***	0.8049***	-0.0104
	(0.0000)	(0.0000)	(0.0000)	(0.5498)
SLOETOP	0.0913***	0.2131***	0.7138***	0.0388**
	(0.0000)	(0.0000)	(0.0000)	(0.0189)
BIST100	0.1557***	0.1106***	0.8610***	-0.1168***
	(0.0000)	(0.0000)	(0.0000)	(0.0006)

Note: */**/*** indicate that the parameter is significantly different from zero at 10%/5%/1% level; p values are reported in brackets.

Table 7: The turn of the month effect in the mean

	α_0	α_1	α_2	α_3	α_4	α_5	α_6	Wald test F-statistic
BELEX15	-0.0130	-0.0373	0.2128**	0.2887***	-0.1618***	-0.1616**	0.1528**	9.0433***
	(0.5346)	(0.6246)	(0.0279)	(0.0002)	(0.0001)	(0.0227)	(0.0458)	(0.0000)
SASX10	-0.1492**	0.0954	0.1064	0.0815	0.0237	-0.0343	0.0832	0.3099
	(0.0200)	(0.4399)	(0.4060)	(0.5505)	(0.8177)	(0.8074)	(0.4508)	(0.9321)
SOFIX	0.0063***	0.0566	0.2006**	0.1912**	-0.0967	-0.0360	-0.0895	1.9989*
	(0.7898)	(0.6309)	(0.0342)	(0.0338)	(0.2489)	(0.7130)	(0.3076)	(0.0627)
CROBEX	-0.0307	-0.0156	0.0653	0.2009**	-0.0482	-0.0038	0.0871	1.0547
	(0.1250)	(0.7873)	(0.3551)	(0.0297)	(0.5898)	(0.9638)	(0.2683)	(0.3878)
ATHEX	-0.0325	0.2146	-0.0070	0.7313***	0.0954	0.2412	0.0985	4.0632***
	(0.4684)	(0.3517)	(0.9737)	(0.0000)	(0.5457)	(0.1603)	(0.6480)	(0.0005)
MBI10	-0.0701***	0.0842	0.1231**	0.1036	0.0835	0.0660	-0.0480	1.1729
	(0.0018)	(0.2254)	(0.0388)	(0.1560)	(0.3476)	(0.4302)	(0.6016)	(0.3179)
MONEX20	-0.0382	0.1668	0.1281	0.0323	0.0145	-0.0755	-0.0352	0.8574
	(0.1787)	(0.1044)	(0.2064)	(0.7732)	(0.8651)	(0.4445)	(0.7077)	(0.5256)
BET	0.0123	-0.0660	0.3334***	0.1942*	0.2501**	0.0090	0.1166	3.1220***
	(0.6663)	(0.5873)	(0.0010)	(0.0798)	(0.0456)	(0.9353)	(0.3149)	(0.0048)
SLOETOP	-0.0055	-0.0126	0.2152**	0.1425	-0.0530	-0.2027*	0.0067	1.9713*
	(0.8321)	(0.9102)	(0.0294)	(0.1170)	(0.4809)	(0.0760)	(0.9494)	(0.0665)
BIST100	0.0795**	-0.1061	0.1338	0.2345	0.1143	0.5278***	0.0471	2.0908*
	(0.0354)	(0.5598)	(0.4279)	(0.1378)	(0.6422)	(0.0019)	(0.7609)	(0.0514)

Note: */**/*** indicate that the parameter is significantly different from zero at 10%/5%/1% level; p values are reported in brackets.

Table 8: The turn of the month effect in volatility

	α	β	γ	δ_1	δ_2	δ_3	δ_4	δ_5	δ_6	Wald test F-statistic
BELEX15	0.0529***	0.3492***	0.6719***	-0.0754	0.1870	-0.0377	-0.2234***	0.0208	0.2864***	10.1171***
	(0.0000)	(0.0000)	(0.0000)	(0.3061)	(0.1069)	(0.7475)	(0.0012)	(0.6928)	(0.0001)	(0.0000)
SASX10	1.2919***	0.1402***	0.4314***	-1.5141***	-0.9293***	-0.6795***	-1.2867***	-0.6287***	-1.0040***	98.4969***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
SOFIX	0.0648***	0.2464***	0.7267***	0.0363	0.0620	-0.0379	-0.1420*	0.3676***	-0.1932*	2.2186**
	(0.0000)	(0.0000)	(0.0000)	(0.5257)	(0.4879)	(0.6912)	(0.0609)	(0.0030)	(0.0699)	(0.0388)
CROBEX	0.0062*	0.1094***	0.8985***	-0.1176***	0.0241	0.2394***	-0.1783**	0.0223	0.0007	4.8494***
	(0.0869)	(0.0000)	(0.0000)	(0.0002)	(0.5821)	(0.0045)	(0.0459)	(0.8297)	(0.9933)	(0.0001)
ATHEX	0.0463*	0.0904***	0.9020***	1.3795***	-1.0966**	-0.7447***	0.0921	0.3132	0.2681	4.8237***
	(0.0655)	(0.0000)	(0.0000)	(0.0016)	(0.0133)	(0.0080)	(0.7289)	(0.4580)	(0.4914)	(0.0001)
MBI10	0.0344***	0.2358***	0.7660***	-0.1244***	-0.0897*	0.1314**	-0.0721	0.0528	0.1676***	8.0879**
	(0.0000)	(0.0000)	(0.0000)	(0.0081)	(0.0687)	(0.0406)	(0.2342)	(0.3008)	(0.0035)	(0.0000)
MONEX20	0.0881***	0.2202***	0.7684***	-0.2808***	0.1596	0.0351	-0.3251***	0.0262	0.2575***	8.6501***
	(0.0000)	(0.0000)	(0.0000)	(0.0013)	(0.1857)	(0.8060)	(0.0013)	(0.7617)	(0.0014)	(0.0000)
BET	0.0334***	0.2055***	0.7937***	0.2905*	-0.4079**	0.2284	0.1988	-0.1122	0.2675*	3.4986***
	(0.0002)	(0.0000)	(0.0000)	(0.0788)	(0.0228)	(0.1997)	(0.2173)	(0.5135)	(0.0573)	(0.0019)
SLOETOP	0.1063***	0.2193***	0.7077***	0.0804	-0.0857	0.0012	-0.3201***	0.5930***	-0.1613	6.8866***
	(0.0000)	(0.0000)	(0.0000)	(0.3989)	(0.4332)	(0.9921)	(0.0008)	(0.0001)	(0.2246)	(0.0000)
BIST100	0.0808***	0.1047***	0.8692***	0.1006	0.2815	-0.2903	1.5683***	-0.9361*	-0.5170	4.7248***
	(0.0000)	(0.0000)	(0.0000)	(0.7595)	(0.4815)	(0.5068)	(0.0004)	(0.0561)	(0.1808)	(0.0001)

Note: */**/*** indicate that the parameter is significantly different from zero at 10%/5%/1% level; p values are reported in brackets.