THE DAY-OF-THE-WEEK EFFECT ON BUCHAREST STOCK EXCHANGE

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Abstract

This study investigates the presence on Bucharest Stock Exchange of one of the most documented seasonal anomalies of financial assets' returns: the day-of-the-week effect. We use daily returns for five Romanian official exchange indices and for one MSCI Barra country index during May 2007-March 2013, thereby including both the 2007-2009 financial markets meltdown and the 2009-2012 recovery that followed it. We employed a GARCH-M model with dummy variables for both the mean and the variance equation, but the results obtained don't offer clear enough and sufficient statistically significant arguments to confirm the presence of the above mentioned effects on all the six indices investigated.

Keywords: stock returns, volatility, seasonal anomalies, frontier markets, GARCH models
JEL classification: G01, G02, G12, G14, G15

1. Introduction

The calendar effects of the financial assets returns is a frequent topic among retail investors, professional money managers and behavioral science researchers, mainly because they are all fascinated and intrigued by the fact that financial markets, despite being extremely competitive and difficult to predict, still leave slight gaps and inefficiencies that can be speculated in order to obtain exceptional returns.

Seasonal effects, a different name for the calendar effects, are considered to be cyclical anomalies in market returns, based on the calendar. The most well-known and discussed such cyclical anomalies are the January effect and the weekend effect (also known as the Monday effect). Other popular types of anomalies mentioned in the financial literature are the day of the month effect (the hypothesis that the turn of the month is associated with returns higher than the average) and the Friday effect (also higher than the average returns on Fridays), or the Thursday effect on some Asian markets.

Most recent studies consider that such effects depend on the size of the market (or of the portfolios examined), measured by capitalization or volume of shares traded, and on the particular economic situation during the investigated period of time. Also, many authors concluded that these cyclical anomalies are more likely to be found on market indices, or on large and well diversified portfolios, than on individual assets.

Our research focused on a wide range of indices from the Romanian capital market, considered by investors and international institutions to be part of the frontier markets category, during a period that included both significant and consistent up and down trends.

The rest of the paper is organized as follows: section 2 presents the most relevant Romanian and international related studies; section 3 describes the data that we worked with and the data mining methodology that we have used; section 4 presents the results that we have obtained; finally section 5 summarizes the most important conclusions and proposes further studies in this field.

2. Literature review

The literature on day of the week and month of the year effects is very rich and refers to many national and international markets of regions of the world. The conclusion of the previous studies are not always in agreement, the results of the investigations conducted by previous authors being dependent on the characteristics and time periods of the markets that were investigated, such as: level of maturity, size, economic cycle, organizational structure etc.

Fields (1931) was among the first authors to argue for the existence of special patterns in the intra-week stock market returns. Fields didn't conduct statistical test for this hypothesis, but his paper opened the door to a great number of articles by other authors. A little later, Cross (1973) analyzed more than 40 years of daily data for Dow-Jones and other American indices and sustained his conclusions. His work was continued by French (1980) who was the first to employ statistical methods in order to test for the presence of the calendar effects. He used found that the expected return for Mondays is about three times larger than the average expected returns for the other days of the week.

Among others, Gibbons and Hess (1981), Rogalski (1984), Jaffe and Westerfield (1985), Condoyanni (1987) and Ziemba (1991) used simple linear regression models and conducted t-tests and F-tests in order to investigate the presence of day of the Monday effect in Japanese, Australian, Canadian, US and some European stock markets.

Connolly (1989, 1991) was the first to abandon the previous approaches and to use econometric models such as GARCH and Bayesian models in order to deal with the most frequent problems that occur in the simple linear regression models, such as: non-normality of the residuals, conditional heteroscedasticity of the residuals and sometimes the presence of autocorrelation among the daily returns.

Lakonishok and Smidt (1988) used more 90 years of daily data for Dow Jones Industrial Average and found evidence of persistent anomalies in returns around the end of the week, end of the month, end of the year and around holidays.

Lauterbacha and Ungar (1995) used OLS regression and argued that in Israel (where the average inflation rate was relatively high during a few decades previously to the date of the article) the calendar effects are present but in a different from than in most international markets. After the authors adjusted the stock returns with inflation the dissimilarities disappeared, which could suggest that such effects should be measured in real terms.

Boynton, Oppenheimer and Reid (2009) made tests on day of the week effect on the Japanese stock market and found that until 1990s the Tuesdays exhibits abnormal losses while after 1990s the Tuesdays effects are replaced by similar effects on Mondays. They argue that those effects are driven by volume changes.

Rahman (2009) examined the presence of day of the week anomaly in three official indices from Dhaka Stock Exchange during 2005-2008 using both linear regression and GARCH(1,1) with dummy regressors and found statistically significant negative coefficients for Sundays and Mondays and statistically significant positive coefficient for Thursdays.

Tevdovski, Mihajlov and Sazdovski (2012) examined the presence of day of the week effect on stock market indices from osnia and Herzegovina, Bulgaria, Croatia, Macedonia and Serbia during 2006-2011, using linear regression with dummy variables and Wald test. They found statistically significant Monday effect only in Croatian and Bulgarian stock markets.

Angelovska (2013) employed single ANOVA regression model with dummy variables, but also more advanced models such as GARCH(1,1), EGARCH, M-GARCH(1,2) and M-EGARCH and found evidence about the existence of day of the week effect on Thursday in both return and volatility of the Macedonian Stock Exchange.

Romanian authors were also interested to investigate the presence of calendar anomalies on Romanian stock market. Among others, Tudor (2008) studied daily logarithmic returns for the official composite Bucharest Stock Exchange index during 2000-2005 and employed a linear regression model with dummy variables, but found no evidence to support the existence of the aforementioned effects.

Also, Balint and Gica (2012) used a GARCH(1,1) model to search for January effects both on returns and volatility of 30 companies (grouped on 3 portfolios according with their capitalization) traded on Bucharest Stock Exchange during 2003-2010. The authors observed that the January effect occurred before the 2007-2009 financial crisis, but afterwards, due to lower share price and liquidity results became inconclusive.

The presence of the January effect on Bucharest Stock Exchange was also investigated by Stancu and Geambasu (2012) by analyzing the excess returns (after excluding the risk adjusted expected returns) obtained during 2002-2010 by three portfolios, of ten stocks each, grouped by size and trading volume. For both methods of computing portfolios (capitalization or trading volume), the authors found higher excess returns in January, sustaining the hypothesis of calendar anomalies.

3. Data and methodology

Our study was conducted on the most older and popular 5 official Bucharest Stock Exchange indices: BET, BET-C, BET-FI, BET-XT and BET-NG. Also, it included the standard Romanian country index (large + mid cap) from MSCI Barra. We have collected daily prices for all the six indices during the period May 1st 2007 – March 15th 2013, courtesy of the Bucharest Stock Exchange Trading Department and MSCI Barra.

In order to eliminate the obvious non-stationarity from our data we have transformed the price time series into return time series for all the 6 assets. According to Strong (1992), "there are both theoretical and empirical reasons for preferring logarithmic returns. Theoretically, logarithmic returns are analytically more tractable when linking together sub-period returns to form returns over long intervals. Empirically, logarithmic returns are more likely to be normally distributed and so conform to the assumptions of the standard statistical techniques." For these reasons we have decided to use logarithmic returns in our study. The computation formula of the logarithmic returns is as follows:

$$R_{i,t} = Ln\left(\frac{P_{i,t}}{P_{i,t-1}}\right)$$

where Ri,t is the return of asset i in period t; Pi,t is the price of asset i in period t and Pi,t-1 is the price of asset i in period t-1.

As a result of this initial data gathering we obtained a data base with 6 time series of log-returns, each with 1534 daily observations.

This article builds upon the foundations laid by our previous research (Panait and Slavescu, 2012) showing that volatility "persistency is more present in the daily returns as compared with the weekly and monthly series". Also, we know from previous studies that "GARCH-in-mean was well fitted on the weekly and monthly time series but behaved less well on the daily time series" for 3 Romanian stock market indices and the most liquid 7 individual stocks during 1997-2012.

For the reasons stated above, and having in mind the conclusions of other authors mentioned in the literature review section stating that GARCH family models often better succeed in extracting most autocorrelation and heteroscedasticity from residuals than simple linear regression models, we decided to use a GARCH-M model with dummy variables in both the mean and the variance equations:

$$R_{i,t} = \mu + \gamma_0\sigma_t^2 + \gamma_1 D_{mon} + \gamma_2 D_{tue} + \gamma_3 D_{wed} + \gamma_4 D_{thu}$$
$$\sigma_{i,t}^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 + \gamma_5 D_{mon} + \gamma_6 D_{tue} + \gamma_7 D_{wed} + \gamma_8 D_{thu}$$

where Ri,t is the return of asset i in period t; σi,t is the standard deviation of asset i in period t; μ is the average return for asset i during the investigated period; ω, α and β are the usuar coefficients of the variance equation of a GARCH(1,1) model; γ_0 represents the variance coefficient from the mean equation of the model; D_{mon} - D_{thu} represent the dummy variables (for example D_{mon} has a value of 1 only in Mondays and a value of 0 during the rest of the daily observations); and γ_1- γ_8 represent the coefficient of the dummy variable from both the mean and the variance equation of the model

Before estimating the GARCH-in-mean model, we investigated all the data series in order to see if they meet the pre-conditions for the GARCH-in-mean model. We observed that average returns for all the time series are not statistically significantly different from zero and that the values for standard deviation are in all cases significantly larger than mean values. Most of the time series present negative skewness, excess kurtosis and "fat tails". Also, none of the 6 time series studied are normally distributed as proven by values for the Jarque-Bera tests (see Table 1 for details, at the end of this article).

Going further, we computed the squared returns for all the 6 time series and tested for evidence of heteroscedasticity and volatility clustering. We found clustering of volatility in the daily returns of all the 5 official Bucharest Stock Exchange indices, but we were unable to confirm it for the MSCI Barra Romania country index (see Figure 1 for details, at the end of this article).

Also, we investigated the heteroscedasticity of the 6 time series, by calculating the autocorrelation (AC) and partial autocorrelation (PAC) functions, and also by performing the Ljung-Box Q-statistics. In all our calculations we used a 20 period lag.

We observed the presence of serial correlation till the 20-th lag in the daily squared returns for all the 5 official Bucharest Stock Exchange indices, but again we were unable to confirm its presence for the MSCI Barra Romania country index (see Table 2 for details, at the end of this article). Since heteroscedasticity is a pre-condition for applying the GARCH models to a financial time series, this means that we might be unable to fit such a GARCH model on the daily returns of MSCI Barra Romania country index.

4. Results

Table 3 included at the end of this article presents the values obtained for the coefficients of the GARCH-M model used to test the presence of the day-of-the-week effect in Romanian stock market indices. In all our estimates of the model we have used the hypothesis that the errors are normally distributed. Below are the conclusions that can be drawn from this table:

(1) First, we observed that with only in the case of three out of the six indices investigated (MSCI Barra Romania country index, BET-XT and BET_FI) the estimated coefficients of the model respect the requirement that $(\alpha + \beta)<1$, which is a crucial condition for a mean reverting process.

(2) Second, we noticed that in all cases the two main estimated coefficients for the variance equation of the model (the α and β coefficients) are statistically significant at the 99% confidence level. The ω coefficient of the variance equation of the model is statistically significant only in the case of BET-XT and BET-FI indices.

(3) Third conclusion, and an extremely important one, is that, with only one exception, the γ_1 coefficients are statistically significant and have negative values. This practically confirms the Monday effect, respectively the hypothesis that there is a statistically significant lower expected return on Mondays in comparison with the end of the week.

(4) In all cases the γ_5 coefficients are statistically significant and have positive values which argue that on Mondays the average volatility is higher comparing with the end of the week. Still, this fourth conclusion

derived from Table 3. can be maintained only for the three indices where the estimated coefficients from the variance equation of the model respected the requirement that $(\alpha + \beta) <1$, meaning that we can draw this conclusion only for MSCI Barra Romania country index, BET-XT and BET_FI indices, not for all of the six indices investigated.

(5) We also notice a Tuesday effect in returns, for 5 out of the 6 indices investigated. This is not present in the volatility of the indices but, instead, it is replaced here by a Thursday effect in all the three cases where the estimated coefficients from the variance equation of the model respected the requirement that $(\alpha + \beta) <1$.

For the conclusions above to be credible, we diagnosed the goodness of fit of the GARCH-M models, in all the cases, by looking into the properties of the residuals and squared residuals:

(1) First we investigated the autocorrelation (AC) and partial correlation (PAC) of the standardize residuals till the 20-th lag, and also we performed the Ljung-Box Q-statistics at the 20^{th} lag. The results presented in Table 4 (at the end of this article) show that in most cases there was no significant (at the 10% threshold level) autocorrelation. Also we investigated the autocorrelation (AC) and partial correlation (PAC) of the squared standardized residuals till the 20-th lag and also we performed the Ljung-Box Q-statistics at the 20^{th} lag. The results, also presented in Table 4 shows that in 4 out of 6 cases the model failed to extract all significant autocorrelation from the standardized squared resiaduals.

(2) Second we employed the Jarque-Bera tests and found that none of the series of residuals are normal distributed.

(3) Third we calculated the statistics of the ARCH-LM tests and noticed that in most cases all the ARCH effects were successfully removed from the residuals.

5. Conclusions

In this paper we studied the day-of-the-week effect on daily returns for 6 Romanian stock market indices during May 1^{st} 2007 – March 15^{th} 2013 using a GARCH-M model with four dummy variables both in the mean and in the variance equations.

We found statistically significant coefficients for the Monday and Tuesday dummy variables in the mean equation of the model, for all 6 indices, which argues for the presence of abnormal returns during those days of the week. Both the Monday and Tuesday coefficients were negative, showing that lower returns comparing with the turn of the week were more likely during those days.

Also, we found statistically significant coefficients for the Monday and Thursday dummy variables in the variance equation of the model, which can be interpreted as abnormal volatility during those days of the week. Still, only in 3 out of 6 indices the GARCH-M model showed a mean reverting behavior for the conditional variance ($\alpha + \beta < 1$). Also, the model didn't succeed to extract all autocorrelation from squared standardized residuals (although it managed to extract most autocorrelation effects and most ARCH effects from the simple standardized residuals) and neither of the residuals were normal distributed. These reasons led us to conclude that the results showing a Monday and a Thursday effect in volatility for 5 out of the 6 indices investigated are not statistically clear enough and that the research of the day-of-the-week effect on Bucharest Stock Exchange should be continued by fitting other models from the GARCH family, especially asymmetrical models.

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Table 1: Descriptive statistics

	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability
RO_MSCI	-0.0005	0.0227	-2.25	35.92	70549	0
BET	-0.0003	0.0195	-0.54	9.25	2475	0
BET-XT	-0.0005	0.0210	-0.48	8.64	2010	0
BET-NG	-0.0004	0.0204	-0.37	11.86	4857	0
BET-FI	-0.0006	0.0281	-0.21	8.74	2029	0
BET-C	-0.0004	0.0180	-0.68	10.10	3216	0

Source of data: Bucharest Stock Exchange, MSCI Barra; calculations by the authors

Figure 1: Presence of volatility clustering in simple returns

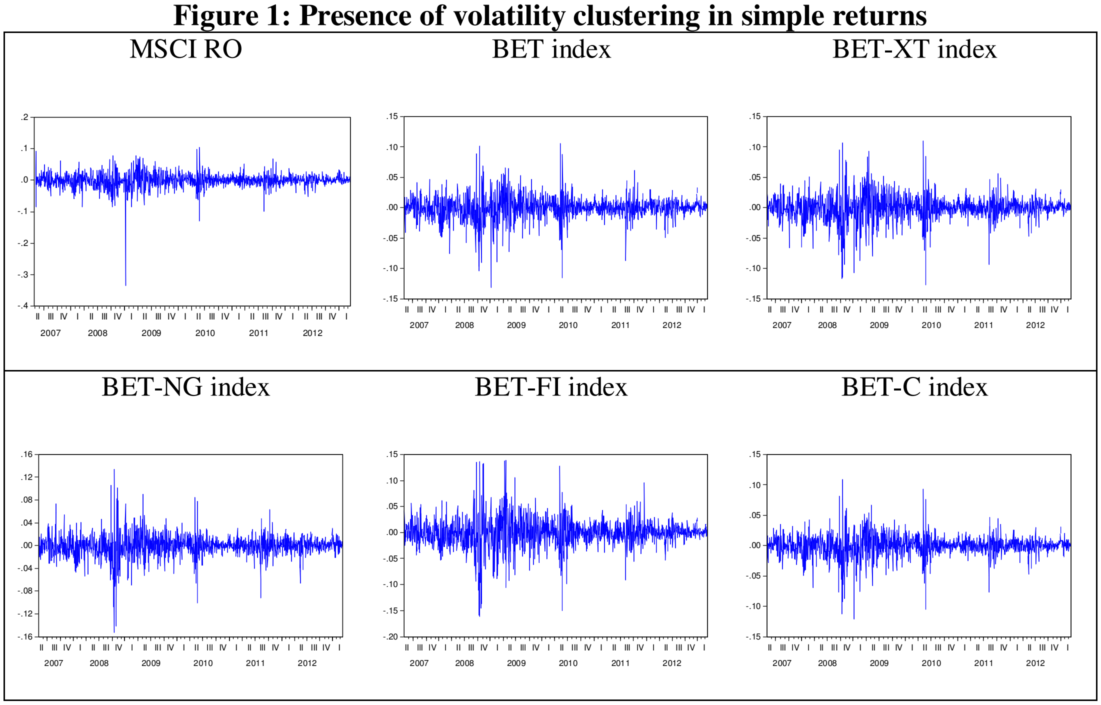

Table 2: Estimation of the autocorrelation (AC), partial autocorrelation (PAC) and Q-statistic with 20 lags for the squared returns

	AC	PAC	Q test	p-value
RO_MSCI	0.018	0.014	12.9	0.882
BET	0.117	-0.004	847.7	0
BET-XT	0.134	-0.019	1193.7	0
BET-NG	0.128	-0.041	1974.0	0
BET-FI	0.150	-0.051	1749.9	0
BET-C	0.137	0.013	1022.2	0

Source of data: Bucharest Stock Exchange, MSCI Barra; calculations by the authors

Table 3: Estimated values for the coefficients of the GARCH-M model used to test the presence of the Monday effect

	Coeff value	Std. error	Z ststistic	p-val		Coeff value	Std. error	Z ststistic	p-val
	Mean equation					Variance equation			
MSCI Barra Romania country index									
γ_0	-1.2816	1.9021	-0.6738	0.5004	ω	0.0000	0.0000	-0.8256	0.4090
μ	0.0022	0.0009	2.3999	0.0164	α	0.1992	0.0195	10.2293	0.0000
γ_1	-0.0037	0.0012	-3.0397	0.0024	β	0.7925	0.0159	49.7879	0.0000
γ_2	-0.0035	0.0011	-3.1257	0.0018	γ_5	0.0001	0.0000	2.0394	0.0414
γ_3	-0.0007	0.0020	-0.3389	0.7347	γ_6	0.0000	0.0000	-0.6843	0.4938
γ_4	0.0000	0.0011	-0.0082	0.9935	γ_7	0.0003	0.0000	11.9326	0.0000
					γ_8	-0.0002	0.0000	-5.3820	0.0000
BET									
γ_0	-0.2253	1.7987	-0.1253	0.9003	ω	0.0000	0.0000	-0.6613	0.5084
μ	0.0022	0.0007	2.9124	0.0036	α	0.2086	0.0145	14.3697	0.0000
γ_1	-0.0040	0.0010	-4.0306	0.0001	β	0.7977	0.0128	62.1732	0.0000
γ_2	-0.0021	0.0009	-2.1897	0.0285	γ_5	0.0000	0.0000	2.0889	0.0367
γ_3	-0.0011	0.0009	-1.1761	0.2395	γ_6	0.0000	0.0000	-0.2364	0.8131
γ_4	-0.0007	0.0009	-0.7864	0.4316	γ_7	0.0000	0.0000	-0.0902	0.9281
					γ_8	0.0000	0.0000	1.8105	0.0702

BET-XT									
γ_0	-0.3815	1.7150	-0.2225	0.8240	ω	0.0000	0.0000	-2.2276	0.0259
μ	0.0018	0.0008	2.3941	0.0167	α	0.1656	0.0129	12.8024	0.0000
γ_1	-0.0036	0.0012	-3.1504	0.0016	β	0.8311	0.0123	67.8235	0.0000
γ_2	-0.0017	0.0010	-1.6605	0.0968	γ_5	0.0001	0.0000	4.6948	0.0000
γ_3	-0.0009	0.0009	-1.0277	0.3041	γ_6	0.0000	0.0000	-0.1930	0.8470
γ_4	-0.0002	0.0010	-0.1574	0.8749	γ_7	0.0000	0.0000	0.0429	0.9658
					γ_8	0.0001	0.0000	3.3454	0.0008
BET-NG									
γ_0	-0.0130	1.7824	-0.0073	0.9942	ω	0.0000	0.0000	-0.3958	0.6923
μ	0.0018	0.0007	2.3954	0.0166	α	0.1937	0.0185	10.4503	0.0000
γ_1	-0.0031	0.0010	-2.9528	0.0031	β	0.8142	0.0147	55.3393	0.0000
γ_2	-0.0020	0.0010	-1.9849	0.0472	γ_5	0.0000	0.0000	2.2570	0.0240
γ_3	-0.0012	0.0009	-1.3030	0.1926	γ_6	0.0000	0.0000	-0.8936	0.3715
γ_4	-0.0008	0.0009	-0.8745	0.3818	γ_7	0.0000	0.0000	0.3823	0.7022
					γ_8	0.0000	0.0000	0.3971	0.6913
BET-FI									
γ_0	-1.0920	1.2602	-0.8666	0.3862	ω	0.0000	0.0000	-1.8793	0.0602
μ	0.0016	0.0010	1.6192	0.1054	α	0.2989	0.0282	10.5822	0.0000
γ_1	-0.0015	0.0014	-1.1047	0.2693	β	0.6925	0.0220	31.5306	0.0000
γ_2	-0.0011	0.0013	-0.8374	0.4024	γ_5	0.0001	0.0000	5.3942	0.0000
γ_3	-0.0008	0.0012	-0.6646	0.5063	γ_6	0.0001	0.0000	2.8940	0.0038
γ_4	-0.0001	0.0014	-0.0423	0.9662	γ_7	0.0000	0.0000	-1.8642	0.0623
					γ_8	0.0001	0.0000	5.0178	0.0000
BET-C									
γ_0	-0.6605	1.9337	-0.3416	0.7327	ω	0.0000	0.0000	-1.9102	0.0561
μ	0.0023	0.0006	3.7779	0.0002	α	0.1865	0.0136	13.7526	0.0000
γ_1	-0.0040	0.0009	-4.5973	0.0000	β	0.8212	0.0122	67.4307	0.0000
γ_2	-0.0030	0.0008	-3.6336	0.0003	γ_5	0.0000	0.0000	2.5389	0.0111
γ_3	-0.0016	0.0008	-2.0132	0.0441	γ_6	0.0000	0.0000	1.3284	0.1841
γ_4	-0.0010	0.0008	-1.2996	0.1937	γ_7	0.0000	0.0000	0.1594	0.8734
					γ_8	0.0000	0.0000	2.8507	0.0044

Source of data: Bucharest Stock Exchange, MSCI Barra; calculations by the authors

Table 4: Estimation of the autocorrelation (AC), partial autocorrelation (PAC) and Q-statistic with 20 lags for the standardized residuals and squared standardized residuals

	Simple standardized residuals				Squared standardized residuals			
	AC	PAC	Q test	p-value	AC	PAC	Q test	p-value
RO_MSCI	-0.028	-0.029	30.614	0.060	0.000	0.001	4.257	1.000
BET	-0.026	-0.025	38.747	0.007	0.016	0.017	23.717	0.255
BET-XT	-0.029	-0.030	48.069	0.000	0.008	0.014	34.060	0.026
BET-NG	-0.029	-0.023	26.977	0.136	0.008	0.015	36.508	0.013
BET-FI	-0.033	-0.036	49.753	0.000	-0.007	0.000	25.430	0.185
BET-C	-0.025	-0.026	52.209	0.000	0.021	0.023	17.418	0.626

Source of data: Bucharest Stock Exchange, MSCI Barra; calculations by the authors