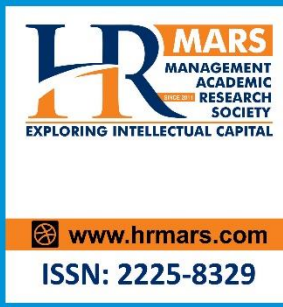




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An Econometric Analysis of Market Anomaly - Day of the Week Effect on a Small Emerging Market

Julijana Angelovska

Faculty of Economics and Administrative Science, International Balkan University,
Tasko Karaga bb, Skopje, Macedonia
Email: julijana.angelovska@yahoo.com

Abstract

The research about the existence of seasonal behavior in return and volatility of Macedonian Stock Exchange is done. Under different model specifications the hypothesis if mean returns are significantly different in the five trading days is tested. The evidence of existence of predictable pattern or market inefficiency can be used for profitable market strategy or forecasting of the predictable movements in asset prices can provide investors with opportunities to generate abnormal returns. The results differ under different model specifications. While simple single ANOVA model and dummy variable regression using OLS methodology, could not find enough evidence to reject the null hypothesis, or mean returns are not significantly different in the five trading days, the more advanced models like GARCH (1,1), EGARCH and modified M-GARCH (1,1) and M-EGARCH, found evidence about existence of a day of the week effect on Thursday.

Keywords: Efficient Market, Market Anomaly, Day of the Week Effect, Garch, Egarch

Introduction

"Discovery commences with the awareness of anomaly, i.e., with the recognition that the nature has somehow violated the paradigm-induced expectations that govern normal science."

Thomas Kuhn (Thaler, 1987)

Together with rational expectations models, another major approach to explain stock market aggregate return behavior has been developed. It is so-called behavioral approach. Market anomalies in stock markets should be related to investors' trading strategies, which are based on their psychologies along with other factors. According to Efficient Market Hypothesis prices contain all relevant information (Fama, 1965). An active area of investigation in finance literature is to explore the existence of a pattern in stock returns. A predictable pattern is evidence against market efficiency. Seasonal effects in security markets have attracted much interest among both academics and practitioners, as existence of seasonal effects in equity markets can be evidence against Efficient Market Hypotheses, as the predictable movements in asset prices provide investors with

opportunities to generate abnormal returns. Even if the pattern does not seem to affect the stock returns directly, it can provide useful guideline to investors concerning their investment decision. It tries to widen the range of analytic tools with which to approach the processes of decision making.

Broadly speaking, calendar effects occurs when the returns of financial assets display specific characteristics over specific days, weeks, months or even years.

A data set from a small European capital market, namely the Macedonian stock market is considered in this research. Emerging markets provide an interesting "out of sample" test of the existence of calendar anomalies, since many well-known calendar anomalies do not exist in the emerging stock markets (Claessens et al., 1995).

The objective of this research is to find out whether the day of week effect exists in Macedonian capital market or not. Researches on day of the week effect have been carried out under different model specifications and the following hypothesis is tested:

Ho: Mean returns are not significantly different in the five trading days.

H1: Mean returns are significantly different in the five trading days.

To test the hypothesis several econometric models are used: single factor ANOVA, dummy variable regression (OLS methodology), GARCH (1,1), M-GARCH(1,1), EGARCH, M-EGARCH.

Literature Review

There is undoubtedly an extensive literature on stock market anomalies referred to seasonal effects. Researchers' first observation about the day of the week effect was the belief that securities market returns on Mondays are less than the other days of the week, and are often negative on average. Studies on such stock market anomalies started since the late 1920' where Kelly (1930) revealed the existence of a Monday effect on the US markets where the returns turned out to be negative. From there on, researchers have documented findings in support of the low Monday returns in the US markets. This effect has been observed in both American and foreign exchanges. Even though studies have documented Monday effect since the 1920s, no theory has adequately explained the reasons it exists.

While the Monday effect in the US stock market is extensively documented during the 1980.s, [(French 1980), (Gibbons and Hess, 1981), (Rogalski, 1984), and (Keim and Stambaugh 1984)], later some papers present evidence that the Monday effect in the US and UK stock markets has gradually disappeared. Fortune (1998) shows that after 1987 there is no evidence of a negative weekend return. Mehdian and Perry (2001) show that in the 1987-1998 period Monday returns are not significantly different from returns during the rest of the week for the SP500, DJCOMP and NYSE (large-cap) indexes. Coutts and Hayes (1999); Steeley (2001) also show empirically that the Monday effect exists but is not as strong as has been previously documented for the UK stock indices. Wang, Li, and Erickson (1997) show that the Monday effect (negative returns) occurs primarily in the last two weeks of the month for a number of stock indices consistently over the period 1962-1993, while returns for the first part of the month are not statistically significantly different from zero.

Similar kinds of effects have been found in other capital markets. Jaffe and Westerfield (1985a,b) test for the weekend effect and find out significant negative mean returns on Mondays in the US, Canada and the UK stock markets, and significant negative Tuesday returns in the Japanese and Australian stock markets, whereas Broca (1992) found the Wednesday effect in the Indian capital market. Similarly, DuBois and Louvet (1996) find negative returns on Mondays and Tuesdays and positive returns on Wednesdays for eleven indices in nine countries from 1969 to 1992, whereas Tong

(2000) reported this stock market anomaly in twenty three stock markets which include European, Asian and North American markets. In addition, Aggarwal and Rivoli (1989) reported a negative Monday and Tuesday effects on four Asian emerging markets. Likewise, Choudhry (2000) tested the day of the week effect on emerging Asian markets using a GARCH model approach with the results suggesting the presence of significance day of the week effect even though of different magnitude across the markets. Moreover, Nath and Dalvi (2004) examined the week day effect in the Indian equity market and found evidence of Monday and Friday effects before the rolling settlement in 2002. Furthermore, Al-Loughani and Chappell (2001) documented on the existence of the day of the week effect in the Kuwait Stock Exchange. On the other hand some researchers found no evidence of day of the week effect, Malaikah (1990); Aybar (1992) did not find any evidence of the day of the week pattern in the capital markets of Saudi Arabia, Kuwait, and Turkey, Santemases (1986), Pena (1995); Gardezabal and Regulez (2002) have documented on insignificant week day effects on the Spanish stock markets. Platev, Lyroudi and Kanaryan (2003) investigated the existence of the day-of-the-week effect in eight Central European stock markets: Romania, Hungary, Latvia, Czech, Russia, Slovakia, Slovenia and Poland for the period September 22, 1997 to March 29, 2002. They found mixed results in their study. They found that the Czech and Romanian markets have significant negative returns on Monday and the Slovenian market has significant positive returns on Wednesday and has insignificant negative returns on Fridays. They also concluded that the Polish and Slovak markets have no day-of-the week effect anomaly. Aly et. al (2004) result suggest no evidence of day of the week effect in the Egyptian stock market. Their findings indicate that while Monday stock returns are significantly positive, they are not significantly different from returns during the rest of the week. Since they found that the returns on Monday are significantly more volatile than the returns from Tuesday to Thursday, they conclude that the significantly positive returns on Monday are associated with returns that are more risky. Rahman, (2009) using GARCH (1,1) model found statistically significant negative coefficients for Sunday and Monday and statistically significant positive coefficient for Thursday dummies in Dhaka Stock Exchange in Bangladesh. Agathee (2008) investigated the existence of day of the week effect in the emerging market of Mauritius using observations from Stock Exchange of Mauritius for a period of 2006. The study found that the Friday returns are higher relative to other trading days. The study also concluded that the mean returns across the five week days are jointly not significantly different from zero.

Leontitsis and Siriopoulos (2007) present a forecasting method based on chaos theory taking into account the specific calendar characteristics, and they give empirical results for NASDAQ Composite Index and TSE 300 Composite Index. Their study shows that there is a great deal of improvement on out-of-sample forecasting results, for calendar-corrected time series. On the other hand, if the time series does not show any calendar affection at all, the forecasting is not improved a lot. This fact was clearly shown on the results regarding the TSE 300 Cmp results. In a second paper Leontitsis and Siriopoulos (2006) present a way to incorporate some of the most significant calendar effects on forecasting by neural networks. The main advantage of their method is that it gives no correction to time series that do not show calendar effects. Finally, they indicate that calendar effects may be hidden in indices, which represent low-risk stocks.

Data and Methodology

The data set used to investigate the day of the week effects in Macedonian Stock Market consists of daily closing values for the major Macedonian Stock Exchange index, the MBI10 Index, in

the period from January 4, 2005 to December 31, 2009. MBI10 is a weighted index using closing prices and published by the Macedonian Stock Exchange. Prior to January 2006, stock trading in Macedonian capital market took place from Monday to Thursday. Unconditional logarithmic returns that amount to 1,190 observations are calculated as follows:

$$R_t = \log\left(\frac{P_t}{P_{t-1}}\right) \times 100 \quad (1)$$

Where P_t and R_t refer to MBI10 price of index and return of MBI10 index on day t , respectively. In order to test the stated hypothesis single factor ANOVA is used. The standard F-statistic is calculated as following:

$$F = \frac{\frac{BSS}{df_b}}{\frac{WSS}{df_w}} \quad (2)$$

Where, BSS is between sums of squares, WSS is within sum of squares and df_b is degrees of freedom between groups and df_w is degrees of freedom within groups.

BSS and WSS are calculated as follows:

$$BSS = n_1(\bar{x}_1 - \bar{x})^2 + n_2(\bar{x}_2 - \bar{x})^2 + \dots + n_n(\bar{x}_n - \bar{x})^2 \quad (3)$$

Where, $n_1, n_2 \dots n_n$ is the sample size of every working day from Sunday to Friday, $\bar{x}_1, \bar{x}_2 \dots \bar{x}_n$, is the mean return of every working day from Monday to Friday, and \bar{x} is the population mean.

$$WSS = (n_1 - 1)SD_1^2 + (n_2 - 1)SD_2^2 + \dots + (n_n - 1)SD_n^2 \quad (4)$$

Where, $n_1, n_2 \dots n_n$ is the sample size of every working day from Sunday to Friday, $SD_1^2, SD_2^2 \dots SD_n^2$, is the standard deviation of returns of each working day from Monday to Friday.

To detect the presence of day of the week the following dummy variable regression is used:

$$R_t = \beta_0 + \beta_1 D_{1t} + \beta_2 D_{2t} + \beta_3 D_{3t} + \beta_4 D_{4t} + \beta_5 D_{5t} + \varepsilon_t \quad (5)$$

Where R_t is the daily return as defined earlier; D_1 through D_5 are dummy variables such that:

- D_1 = if t is a Monday, then $D_1=1$ and $D_1=0$ for all other days;
- D_2 = if t is a Tuesday, then $D_2=1$ and $D_2=0$ for all other days;
- D_3 = if t is Wednesday, then $D_3=1$ and $D_3=0$ for all other days;
- D_4 = if t is a Thursday, then $D_4=1$ and $D_4=0$ for all other days;
- D_5 = if t is a Friday, then $D_5=1$ and $D_5=0$ for all other days;

β_1 - β_5 are coefficients to be estimated using ordinary least squares (OLS). The stochastic disturbance term is indicated by ε_t . The hypothesis to be tested is:

$$\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 \quad (6)$$

Most of the studies reported in the finance literature investigate the day of the week effect in mean returns by employing the conventional OLS methodology on appropriately defined dummy variables. However, this methodology has two limitations. First, the error terms may not be white noise due to autocorrelation and second, heteroskedasticity problems resulting to misleading inferences.

To address the first drawback, we include lagged values of the return variable in a model with the following stochastic equation:

$$R_t = \beta_1 D_{1t} + \beta_2 D_{2t} + \beta_3 D_{3t} + \beta_4 D_{4t} + \beta_5 D_{5t} + \sum_{i=1}^n \beta_i R_{t-i} \quad (7)$$

The final prediction error criterion (FPEC) specifies the lag order n such that it eliminates autocorrelation in the residual.

For the second limitation progress can be made by using models of family GARCH, as variations in volatility are second very important part. It is important to know whether a certain day of the week high (low) returns are associated with respectively high (low) volatility in a given day.

Hsieh (1988) modified Engle (1982) и Bollerslev (1986) GARCH (1,1) model:

$$R_t = \mu + \phi R_{t-1} + \varepsilon_t \quad (8)$$

$$\sigma_t^2 = \omega + \alpha \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 \quad (9)$$

$$\frac{r_t}{\sigma_t} \approx N(0,1)$$

By including day of the week effects, adding dummy variables for days of the week in the variance equation (9), the new variance equation is:

$$\sigma_t^2 = \omega + \omega_1 D_{1t} + \omega_2 D_{2t} + \omega_3 D_{3t} + \omega_4 D_{4t} + \omega_5 D_{5t} + \alpha \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 \quad (10)$$

Actually allows return conditional variance to vary for each day of the week by modeling the conditional variance from the mean equation as modified GARCH. Thus the second specification (10) incorporates the effect of the day of the week for both equations.

GARCH models accepted by Davidson and Peker (1996); Clare, Ibrahim and Thomas (1998); Foo and Kok (2000); Kok (2001); Kok and Wong (2004) assume symmetrical behavior of market reactions to positive and negative news. But in reality, most commonly seen is that the negative returns are followed by higher volatility than positive. Anomalies of the day of the week further will be investigated with EGARCH model, which can hit a possible asymmetry in the behavior of the capital market.

EGARCH process (Nelson, 1991, Brooks, 2002):

$$\ln(\sigma_t^2) = \omega + \beta * \ln(\sigma_{t-1}^2) + \alpha * \frac{u_{t-1}}{\sqrt{(\sigma_{t-1}^2)}} + \delta * \left[\frac{u_{t-1}}{\sqrt{(\sigma_{t-1}^2) - \sqrt{(2/\pi)}}} \right] \quad (11)$$

Empirical Results

Macedonian capital market is represented by the Macedonian Stock Exchange. The modern history of the capital market is associated with structural changes in the 1990s, crossing the country's transition to free market economy. The process of privatization has already resulted in the formation of more joint stock companies which have imposed the necessity of creating the marketing infrastructure for transfer of newly created securities. Although many regional markets passing through the same transition period were established earlier, the constitution of the Macedonian Stock Exchange launched in September 1995. However, the official start of trading on the Macedonian Stock Exchange is considered March 28, 1996, when the first stock bell rang with a very modest amount of trading (Angelovska 2011). Macedonian Stock Exchange as small and developing market, during the period 2005–2009, witnessed its first bull and bear market in its short history. Descriptive statistics in Table 1 shows high volatility provided by positive first order autocorrelation.

Table 1. Summary of Maximum/Minimum Returns/Standard Deviations of the MBI10 for the period January 4, 2005-December 31, 2009

Mean	0.084593	Skewness	-0.214094
Maximum	8.089667	Kurtosis	7.336696
Minimum	-10.28315	Jarque-Bera	941.6013
Std. Dev.	1.867947	Probability	0.000000
Observations	1190	First order AC	0.522

Source: MSE

Returns for each day of the week separately are calculated for each year as well as for the whole period. Table 2 provides summary statistics for daily index returns through different time periods. The coefficient of variation CV is a measure of return obtained per unit of risk, which is useful for comparison of risk-return exchange through the days and years too. The mean return for the entire period is negative on Monday, which could indicate the presence of the Monday effect similar to most of the empirical evidence on the capital market in America. The highest mean return for the same period is on Wednesday. Volatility for the entire period does not differ across days of the week, except Friday when the volatility is smallest, but it is the result of fewer observations for 2005, when Friday was a non-trading day. Coefficients of variation are not significantly different and very low, which is an indication of low returns or high risk, or both.

Table 2. Summary Statistics of Daily Returns by trading days of the MSE in the period of 2005-2009

	2005	2006	2007	2008	2009	2005-09
Monday						
Observations	49,00	49,00	49,00	49,00	47,00	243,00
Average	0,20	0,09	0,29	-0,41	-0,15	-0,02
Standard Deviation	2,37	1,09	1,61	2,27	1,99	1,93
Coefficient of Variation	0,08	0,08	0,18	-0,18	-0,08	-0,01
P-value	0,00	0,03	0,00	0,00	0,15	0,00
Tuesday						
Observations	48,00	50,00	48,00	51,00	49,00	247,00
Average	0,52	0,28	0,23	-0,58	0,08	0,02
Standard Deviation	2,13	1,45	1,67	2,01	2,12	1,91
Coefficient of Variation	0,24	0,19	0,14	-0,29	0,04	0,01
P-value	0,00	0,00	0,00	0,00	0,25	0,00
Wednesday						
Observations	52,00	49,00	52,00	49,00	51,00	253,00
Average	0,47	0,08	0,27	-0,57	0,36	0,13
Standard Deviation	1,93	1,05	1,69	2,03	2,01	1,82
Coefficient of Variation	0,24	0,08	0,16	-0,28	0,18	0,07
P-value	0,00	0,06	0,55	0,00	0,12	0,00
Thursday						
Observations	49,00	52,00	49,00	49,00	50,00	249,00
Average	0,46	0,33	0,25	-0,79	0,09	0,09
Standard Deviation	1,92	0,93	2,07	2,38	2,10	1,97
Coefficient of Variation	0,24	0,35	0,12	-0,33	0,04	0,05
P-value	0,00	0,61	0,00	0,00	0,00	0,00
Friday*						
Observations		51,00	49,00	50,00	46,00	196,00
Average		0,16	0,45	-0,29	0,17	0,12
Standard Deviation		0,80	1,53	1,82	2,20	1,67
Coefficient of Variation		0,20	0,29	-0,16	0,08	0,07
P-value		0,68	0,41	0,00	0,00	0,00

*Essentially, the MSE has been trading on a daily basis for the full year as from 2006.

Annual analyses through the trading days of the week show inconsistency in terms of the direction and magnitude of returns. Such inconsistent sample may suggest that returns are random and as such can reduce support for any argument in favor of a day of the week effect. For that reason in order to test the hypothesis, single factor ANOVA is used and the standard F-statistic is calculated. Tests for equality of mean returns are made and results across years are provided in Table 3. The null of equality of mean returns cannot be rejected that is in accordance with the results of mean returns across day of the week reported in Table 2. But even though test of equality in means cannot be

rejected, they differ in variance ratios. This finding is significant to investigate risk-return trade-off in financial markets.

Table. 3 Test of equality of mean returns in the days of the week

	2005	2006	2007	2008	2009	2005-09
F-статистика	0,24	0,53	0,13	0,39	0,58	0,23
P-вредност	0,87	0,71	0,97	0,81	0,68	0,92

To detect the presence of day of the week, further on, the most exploited methodology - dummy variable regression, equation (5) is used. If the daily returns are drawn from an identical distribution, they will be expected to be equal. The null hypothesis will indicate a specific pattern in the stock return thus the presence of day of the week anomaly. The same regression is repeated for each individual year and for the whole period. Table 5 provides β_1 - β_5 dummy variables coefficients. Statistically significant coefficient provides evidence of the effect of day of the week. In 2006 there is evidence of day of the week effect or statistically significant positive Tuesday and Thursday are detected, while in 2008 statistically significant negative again Tuesday and Thursday are found. For the whole period again no day of the week effect is detected.

Table 5. Regression coefficients estimated using ordinary least squares (OLS) from equation (5) on daily returns

	β_1	β_2	β_3	β_4	β_5	R_{t-1}	F-stat.
2005	-0,08 (-0,33)	0,35 (1,53)	0,21 (0,92)	0,13 (0,55)		0,64 (11,62)***	7,32
2006	0,01 (0,07)	0,24 (1,84)*	-0,06 (-0,45)	0,29 (2,32)**	-0,02 (-0,17)	0,54 (10,01)***	3,56
2007	0,05 (0,25)	0,04 (0,21)	0,16 (0,79)	0,10 (0,48)	0,32 (1,55)	0,55 (10,11)***	41,58
2008	-0,29 (-1,06)	-0,50 (-1,82)*	-0,38 (-1,34)	-0,53 (-1,86)**	0,003 (0,01)	0,37 (6,34)	14,79
2009	-0,24 (-0,84)	0,21 (0,76)	0,32 (1,19)	0,07 (0,26)	0,008 (0,03)	0,34 (5,58)***	1,74
2005-09	-0,08 (-0,76)	0,09 (0,92)	0,08 (0,82)	0,03 (0,31)	0,09 (0,77)	0,48 (18,88)***	77,79

***, **, and * denotes significance level at 1%, 5% and 10% levels

For the second problem or heteroskedasticity problem, GARCH family models are included: GARCH (1,1), M-GARCH (1,1), EGARCH, M-EGARCH and the results are presented in Table 6.

Thursday is statistically significantly different from the other days of the week which means that day of the week anomaly is detected on Thursday. The results are stable in all models or with modification in variance equation or without, meaning it is not a result of variations in the volatility. Coefficients of the dummy variables in the modified GARCH equation variance are statistically insignificant, but with the modified EGARCH model though it is confirmed statistically significant

coefficient on Thursday there are as well significance in the variations of volatility on Wednesday, and Thursday.

Table 6. Regression Coefficients: GARCH, EGARCH, M-GARCH and M-EGARCH

	GARCH (1,1)	M-GARCH (1,1)	EGARCH (1,1)	M-EGARCH (1,1)
β_1	-0.07(-1,26)	-0.08(-1,3)	-0,02(-0,43)	0,04(0,69)
β_2	0.07(1,19)	0.07(-1,1)	0,04(0,78)	-0,06(-0,84)
β_3	0.10(1,51)	0.10(1,69)*	0,08(1,19)	0,04(0,45)
β_4	0.20(2,96)***	0.21(3,49)***	0,17(3,10)***	0,14(1,62)*
β_5	-0.02(-0,28)	0.00(0,07)	-0,09(-1,42)	-0,12(-1,43)
R_{t-1}	0.47(2,26)	0.47(2,2)***	0,49(22,23)	0,49(20,25)***
Variance Equation				
ω	0.07(7,48)***	-0.30(-0,73)	-0,29(-13,97)***	-0,29(-3,51)***
α	0.27(11,11)***	0.28(10,74)***	-0,02(-1,34)	-0,01(-0,90)
β	0.74(5,05)***	0.73(47,05)***	0,94(142,71)***	0,94(129,35)***
δ			0,45(14,59)***	0,47(13,55)***
ω_1		0.61(1,45)		0,17(1,2)
ω_2		0.39(0,95)		-0,22(-1,69)*
ω_3		0.25(0,60)		0,09(0,83)*
ω_4		0.29(0,71)		-0,09(-0,91)
ω_5		0.34(0,85)		0,04(0,69)

***, **, and * denotes significance level at 1%,5% and 10% levels

Conclusions

Empirical examples identified as day of the week effect shows that returns are not evenly distributed across days of the week. Most commonly observed are the negative returns on Monday called Monday effect. The research using more econometric models to find evidence that mean returns are significantly different in the five trading days was done. The presented data showed that the mean return for the entire period (2005-2009) is negative on Monday, which could indicate the presence of the Monday effect similar to most of the empirical evidence on the capital market in America. But the simple single ANOVA model and dummy variable regression using OLS methodology, could not find stable evidence of presence of day of the week effect, or to reject the null hypothesis. The more advanced models like GARCH (1,1), EGARCH and modified M-GARCH (1,1) and M-EGARCH, found evidence about existence of a day of the week effect in Thursday. The main reason of the interest of financial theorists and practitioners to detect some market anomaly is to use this information or market inefficiency for profitable market strategy or to use for forecasting. The predictable movements in asset prices can provide investors with opportunities to generate abnormal returns. In addition many psychologists believe that investor's psychology can play an important role in causing the anomaly.

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