DE GRUYTER OPEN

STUDIES IN LOGIC, GRAMMAR AND RHETORIC 37 (50) 2014

DOI: 10.2478/slgr-2014-0018

The Occurrence of the Day-of-the-Week Effects on Polish and Major World Stock Markets

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Abstract. The aim of this paper is to analyze the occurrence of the so called day of the week effects in market return time series from the period of January 2003 to September 2013 (and additionally January 1999 to December 2002). The study focuses on four indices of the Warsaw Stock Exchange (WIG, WIG20, mWIG40 and sWIG80) and additionally five indices of major world stock exchanges (NIKKEI 225, DAX, CAC40, S&P 500, and IBEX). The main data sample was divided into three subperiods in order to determine whether or not the intensity of day of the week anomalies is constant in time. The study revealed a substantial number of the day of the week anomalies in earliest subperiods and very limited evidence of those effects in later ones, giving rise to the conclusion that the intensity of the day of the week anomalies is diminishing with time. The most common effect identified on the WSE was a positive Friday effect. The Monday effect often described in early literature on the subject matter seems to currently occur very rarely. The study also indicates that the day of the week effects were more persistent among stocks with smaller market capitalization on the WSE.

Keywords: stock market anomalies, day of the week effect, Warsaw Stock Exchange, market efficiency

1. Introduction

Researchers of equity markets for decades have been trying to explain the variations in returns from financial instruments listed on markets all over the world. If a variation cannot be explained by an established market model it is often considered as a pricing anomaly. Price anomalies caught the attention of investors and economists in the early 80s of the past century, some of those are known as calendar anomalies. The aim of this paper is to establish whether or not the day of the week effects can be found in the time series of market returns from the Warsaw Stock Exchange (WSE), and to compare those outcomes with other more established stock markets.

ISBN 978–83–7431–413–8 ISSN 0860-150X

Since the 70s the concept of effective capital markets is a cornerstone of classical finance. The efficient market hypothesis (EMH) in its weak form states that the analysis of historical rates of returns should not provide any useful information in determining the future returns, and hence would not allow to obtain above average gains from only that source of information. Because of that, under the EMH no long lasting seasonally recurring patterns should exist in the stock market prices. However, many studies provide evidence that there exist some temporal regularities in the time series of market returns on stocks, what indicates that market returns may be dependent on: the time of the day, the day of the week or the month of the year.

The calendar anomalies are based on the assumption that historical changes in prices of financial instruments contain information that may provide some viable predictions for their future values. In other words studies of market anomalies suggest that investors may utilize the outcomes of historical anomalies in order to forecast future market prices and thus obtain abnormal profits. Hence the calendar anomalies are not in line with the weak form efficiency of the EMH. The most common calendar anomalies are: "the day of the week effect" and the "January effect" which are the regularities in price changes on certain days of the week and on certain months in the year respectively.

This paper examines the period of January 2003 – September 2013, subdivided into three subperiods in order to establish whether the possible anomalies are present throughout the whole data sample or whether their intensity changes. The paper examines if the possible changes in intensity of the anomalies can be explained with the passage of time (as information on the anomalies becomes more widespread) or by changing market conditions in relation with the recent financial crisis. Additionally a period of January 1999 – December 2003 was also analyzed. The following indices have been included in this study: WIG, WIG20, mWIG40, sWIG80, NIKKEI 225, DAX, CAC40, S&P 500, and IBEX.

2. Deviations from the efficient market hypothesis

A significant number of studies conducted on equity markets, revealed some recurring deviations from market efficiency, which can be described as market anomalies. Market is efficient with respect to information when it is not possible to obtain an abnormal profit with the use of that information. In practice it may happen that the market is not fully efficient. When certain

investment strategies allow to obtain an abnormal rate of return or when the market has a lagged reaction to certain types of information or when it overacts to information then it most likely means that the market is not efficient. Figure 1. shows a hypothetical reaction to positive information with a possible under-reaction and overreaction.

In the case of an efficient market the price of the share expresses the new information without delay when it reaches the market (day 0. in Figure 1.), hence the information does not result in any other price changes at any other time. The dotted line represents an overreaction to the release of new information and a further adjustment to the adequate price level. The dashed line represents a market that has a prolonged reaction to new information.

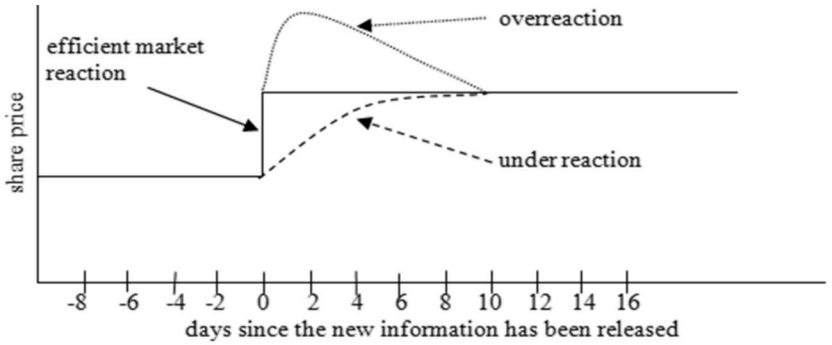

Figure 1. Price adjustment as a reaction to positive information on an efficient/not efficient market

Source: (Jamróz, 2011, p. 27)

The analysis of anomalies is usually based on the observation of long term financial time series for the studied effect and its repetitions. The time series should have a significant length as it lowers the probability of detecting incidental or one-off phenomenon. The continuation of the anomaly is a necessary condition for creating profitable investment strategies (Woś, Żarnowski, 2000, p. 38).

Classification of equity market anomalies is not an easy task. It happens that an observed phenomenon might be classified to two or more different categories. On the other hand sometimes it is also hard to determine whether the observed anomaly is a new unique effect or only a modification of an earlier occurrence. (Szyszka, 2003, p. 59) It is possible to distinguish three basic segments of divergences from the EMH, those are: calendar anomalies, fundamental anomalies and market under and overreactions (see figure 2.).

Calendar anomalies exist when the rate of return on the investment depends on the timeframe in which it is measured. The most common examples of calendar anomalies include: the January effect, the day of the week effect, and the hour of the day effect. New anomalies are constantly being described in literature. Historically it was noted that the DJIA index has never had a decline in price over a year ending in 5. The January effect is amongst the most established anomalies, many studies indicate that the average rates of return are significantly higher in the first month of the year; see eg.: (Keim 1983), (Roll, 1983), or (Lakonishok and Smidt, 1988). It is most apparent in prices of companies with a relatively small market capitalization.

The day of the week effects were first identified on the American market. Monday rates of return were on average lower than the rates of return on other days of the week and Friday rates of return were generally higher (so called weekend effect). In their study Smirlock and Starks (1986) recognized an hour of the week effect, according to which the returns on the first trading hour of Monday were on average negative and positive on the first trading hours of other days of the week. An extensive empirical study on the temporal distribution of rates of return within a month was conducted by Ariel (1987) in which he demonstrated that the majority of increases in stock prices occurred in the first half of the month. The studies conducted by Szyszka (Szyszka, 1999, pp. 55–58) indicate some regularity in temporal distribution of the rates of return on the WSE, such that the average return on Mondays is higher than that on other days of the week.

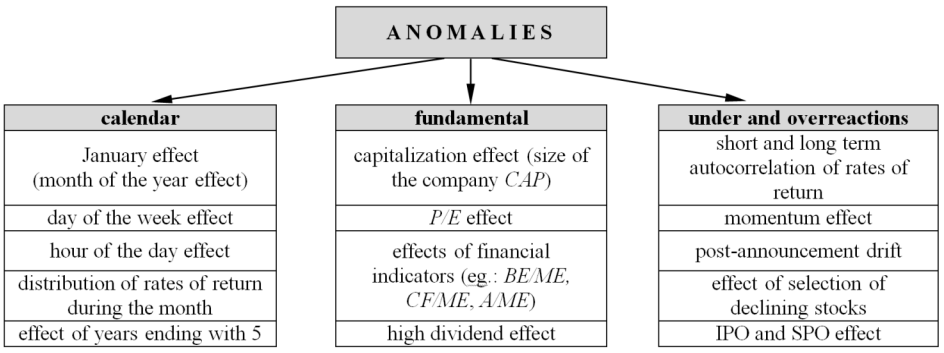

Figure 2. Most popular equity market anomalies
Source: (Jamróz, 2011, p. 29)

Fundamental anomalies are a relation between the rates of return on a specific stock with its certain fundamental characteristic. This group of anomalies includes: the market capitalization effect (size of the company effect), eg. (Banz, 1981, pp. 3–18), (Reinganum, 1983, pp. 89–104), the price to earnings effect (P/E), the effects of market indicators based on the value of Market Equity and the high dividend effect. Calendar and fundamental anomalies may be interpreted as proofs against the medium form efficiency of the markets and under or overreactions as proofs against the weak form market efficiency (Grotowski, 2003, pp. 133–134).

Many studies indicate that the deviations from the market efficiency are not long lasting and gradually diminish with time. Sometimes the obtained results are dependent on the utilized statistical methods or on the selected timeframe. Apart from the fact that some anomalies lose their intensity when they are described in literature and are in turn more known. An example of that is the January effect and the small companies effect on the WSE (Siwek, 2000, pp. 150–163).

3. A survey of selected studies of the day of the week effects

Since seasonality of stock market returns allows for a certain level of predictability of future prices, it is not in line with the EMH. Despite that a lot of evidence of seasonality of market returns can be found in financial literature. The day of the week effects have been described independently in a number of papers (eg. (French, 1980), (Gibbson, & Hess, 1981) and (Keim, & Stambaugh 1985)) which show that on the American market average rates of return on Mondays were significantly lower and on Fridays significantly higher than average rates of return on other days of the week.

The observation of the weekend effect gave rise to the question of when exactly are the negative returns (observed on Mondays) realized. This could either happen between the end of the trading session on Friday and the beginning of trading on Monday or only during the Monday trading session. A study by Rogalski (1984) provides evidence that the decline in price happens during the weekend when the market is closed. Smirlock and Starks (1986) confirmed the findings of Rogalski for the period of 1974–1983, however their study also showed that the exact opposite was true for earlier years (the entirety of negative returns was realized during the Monday trading session).

Lakonishok and Maberly (1990), analyzed the existence of weekend effects in relation to institutional and individual investors. Their study shows

that individual investors are more active on Mondays in relation to institutional investors. The reason for that was the fact that individual investors would undertake investment decisions during the weekends and exercise them on Mondays. Moreover the individual investors are more likely to conduct sales of stocks as their first transactions of the week, as they want to obtain funds for consecutive purchases. On the other hand many institutional investors would start planning their transactions on Monday meetings and conduct the majority of those on later days.

There is a substantial amount of studies on the day of the week effects on other markets outside of the United States. Kiymaz and Berument (2003) conducted a study for stock market indices of five countries: the USA, Canada, Japan, United Kingdom, and Germany. Their findings indicate that day of the week effects were present on all of those markets for the period of 1988–2003, however the distribution of those effects during the days of the weeks varied from country to country.

Tonchev and Kim (2004) conducted a study of various calendar anomalies on three eastern European markets (Czech Republic, Slovakia and Slovenia) for the time period of 1999–2003. The results show that the biggest amount of day of the week anomalies could have been found on the smallest Slovenian Ljubljana Stock Exchange.

A study of the Singapore Exchange (Wong, Agarwal, & Wong, 2006) revealed a negative Monday effect, however the effect was much less apparent after the 1997 Asian financial crisis. Kenourgios and Samitas (2008) measured the Monday effect on the Athens Stock Exchange for two subperiods (1995–2000 and 2000–2005) and discovered that the effect was much stronger in the former period and observable yet statistically insignificant in the latter, hence they concluded that the day of the week effect is becoming weaker and, at the time of the study, already had no significant impact on the prices of stocks. Basher and Sadorsky conducted an extensive study of the day of the week effects for 21 emerging markets (for the period of December 1992 – October 2003). The paper showed that the day of the week effect was not present on many of the analyzed stock exchanges. The markets that did exhibit strong statistically significant day of the week anomalies were: Philippines, Pakistan, Taiwan, Malaysia, Thailand, and Turkey.

When it comes to the Polish stock market a study by Szyszka (2003) is an often quoted research of the calendar anomalies. The study shows that in the period of 1994–1999, contrary to the US markets, Monday rates of return on WSE were on average higher than on other days of the week. The author concludes however that the observed anomalies are rather modest in size, hence in practice it would be very hard to obtain abnormal

returns based on them. Landmesser (2006) identified positive Monday and Friday effects on the WSE (period of 2002 – 2005). Similarly to Szyszka, Landmesser dismisses those anomalies as too small for an application in a successful trading strategy. A study by Grotowski (2008), for the period of July 1999 – June 2007 did not reveal a statistically significant Monday effect, although it did find evidence for the effects of Thursday and Friday. Those effects were most apparent in the stock market indices and not in individual stocks, hence the conclusion (similar to previously quoted authors), that those anomalies although statistically significant provide little help in actual investing.

The question whether or not financial crisis has an effect on market anomalies is an open one. Some evidence can be found in a study by Gajdošová, Heryán, and Tufan (2011) conducted on 5 Central European markets: Poland, Czech Republic, Slovakia, Hungary, and Turkey. The study revealed that, to a certain extent, day of the week effects were more prevalent during the period of the recent financial crisis than in the preceding period on the Czech and Hungarian markets. No such evidence was found for the markets of Poland, Slovakia and Turkey. A different study on Central European markets (Czech Republic, Hungary and Poland) by Stavárek and Heryán (2012), concludes that the occurrences of the day of the week effects in Central European markets are erratic and not consistent over time and that the situation remained unchanged during the period of financial crisis. Limited evidence (only indicative and certainly not conclusive) that the day of the week effects might be intensified during the financial crisis on Ukrainian and Romanian markets are presented in a study by Hourvouliades and Kourkoumelis (2010). The same study shows however that there is no such evidence for the stock markets of Cyprus and Bulgaria, and for markets of Greece and Turkey where the day of the week effects diminish over time, despite the financial crisis.

4. Data and methodology

The data analyzed in this study consists of a time series of daily logarithmic returns on the four main market indices of the WSE (WIG, WIG20, mWIG40, and sWIG80) and 5 indices from major stock exchanges (NIKKEI 225, DAX, CAC 40, IBEX, and S&P 500). The returns were calculated based on the daily closing price quotes from stooq.pl service. The period of the time series ranges from January 2003 to September 2013. That period has been divided into 3 subperiods that correspond with the changes in the sit-

uation on the global financial market. The division of the studied period was carried out based on the situation on the New York Stock Exchange (as it can be considered the market where the crisis originated and a proxy for the global financial outlook). The S&P 500 index peaked on 9$^{\text{th}}$ of October 2007 and was in gradual decline since then until the minimum was reached on 9$^{\text{th}}$ of March 2009. Hence the period of beginning of November 2007 – end of February 2009 was designated as the period of stock market decline. The first subperiod captures a bull market prior to the world financial crisis (January 2003 – end of October 2007), the second period corresponds to the declining market during the financial crisis (beginning of November 2007 – end of February 2009), and the third period is a period of a growing market recovering from the crisis (beginning of March 2009 – beginning of September 2013).

Table 1. provides the basic descriptive statistics of the data. It is worth noting that all normality tests indicate that the returns are not normally distributed and that the kurtoses of all the indices but WIG20 indicate a fat-tailed distribution. It is also worth noting that many of the indices (most notably all of the WSE indices and the S&P 500 index) are heavily autocorrelated.

After the initial results were obtained an additional period of observations was added to the data sample. That period includes the returns on all of the above indices from January 1999 until December 2002.

The method used in order to detect the day of the week effects is a standard approach in determining those effects (see e.g. (Tonchev, Kim, 2004, p. 1036) and (Kamaly, Tooma, 2009, p. 883)). A following model was utilized in this study:

$$R_t = \alpha_0 + \sum_{i=1}^{S} \beta_i R_{t-1} + \sum_{j=1}^{4} \delta_j D_{jt} + \varepsilon_t$$

where: R_t is the daily logarithmic return on day t, and D_{jt} is a dummy variable indicating the day of the week for $j = 1$ to 4, D_{jt} indicates Monday, Tuesday, Thursday and Friday respectively. α_0, β_i, and δ_j are the parameters of the model.

Wednesday was dropped from the model in order to avoid the so called dummy variable trap. If all five trading days were included in the observation matrix then every other column of the matrix would be a linear combination of the five columns, hence the matrix would not be invertible and it would be impossible to estimate the model. The model includes a number of lagged returns in order to account for the autocorrelation in the return series. In each case the number of lagged returns (from 1 to 3) was

Table 1

Descriptive statistics of the returns time series from the period: January 2003 – September 2013

Panel A: Descriptive statistics									
	WIG	NIKKEI 225	DAX	CAC 40	S&P 500	IBEX	WIG20	mWIG40	sWIG80
No. of ret.	2679	2619	2719	2734	2685	2711	2679	2679	2679
Mean	0,000457	0,00017	0,000353	0,000076	0,000218	0,000102	0,000264	0,00044	0,000836
Median	0,000846	0,000533	0,000987	0,000457	0,000788	0,000749	0,000597	0,000977	0,001551
St. Dev.	0,013	0,015	0,014	0,014	0,012	0,015	0,015	0,011	0,011
Skewness	−0,42	−0,58	0,018	0,063	−0,307	0,114	−0,251	−0,946	−1,077
Kurtosis	3,29	8,01	5,70	6,31	10,49	6,78	2,81	5,66	5,65
Panel B: Autocorrelation Ljung-Box Q statistics									
Lags [p-value]	WIG	NIKKEI 225	DAX	CAC 40	S&P 500	IBEX	WIG20	mWIG40	sWIG80
1	24,30 [0,000]	3,69 [0,055]	0,14 [0,707]	4,79 [0,029]	34,78 [0,000]	0,52 [0,468]	5,15 [0,023]	108,35 [0,000]	170,98 [0,000]
2	25,78 [0,000]	3,78 [0,151]	1,39 [0,499]	9,06 [0,011]	43,45 [0,000]	5,86 [0,053]	10,93 [0,004]	116,36 [0,000]	190,51 [0,000]
3	27,77 [0,000]	4,31 [0,229]	5,21 [0,157]	21,03 [0,000]	47,82 [0,000]	13,17 [0,004]	11,40 [0,010]	137,94 [0,000]	233,55 [0,000]
4	27,88 [0,000]	5,57 [0,233]	6,55 [0,162]	24,07 [0,000]	48,07 [0,000]	13,21 [0,010]	11,53 [0,021]	142,94 [0,000]	242,41 [0,000]
Panel C: Normality tests									
Shapiro-Wilka [p-value]	0,96 [1,77e–026]	0,927 [9,33e–034]	0,93 [6,43e–033]	0,92 [4,49e–034]	0,88 [4,39e–041]	0,93 [2,00e–033]	0,96 [7,18e–024]	0,93 [1,67e–033]	0,92 [3,20e–034]
Lillieforsa [p-value]	0,062 [$\sim = 0$]	0,068 [$\sim = 0$]	0,078 [$\sim = 0$]	0,075 [$\sim = 0$]	0,0993 [$\sim = 0$]	0,076 [$\sim = 0$]	0,056 [$\sim = 0$]	0,083 [$\sim = 0$]	0,085 [$\sim = 0$]
Jarque-Bera [p-value]	1291,06 [4,46e–281]	7152,3 [0]	3685,39 [0]	4536,98 [0]	12360,4 [0]	5199,65 [0]	911,75 [1,03e–198]	3974,6 [0]	4089,65 [0]

No. of ret. – Number of returns, St. Dev. – Standard Deviation; p-values given in brackets. Source: Own elaboration.

chosen based on the Ljung Box Q statistic reported in Table 1. The day of the week effects are measured by the δ_j parameters. If the parameter of the model is statistically significant it means that the day of the week effect may occur, the sign of the parameter indicates whether the effect is positive or negative. Additionally Appendix 1 contains a table with descriptive statistics for the returns on the individual days of the week. Biggest mean return could have been observed on the WIG20 index on Monday and on foreign markets on DAX on Tuesday. The biggest negative mean return occurred on sWIG80 on Tuesday and the next biggest negative mean return occurred on CAC 40 on Monday.

5. Empirical results

The results of this study are summarized in tables 2–5. The parameters δ_1 through δ_4, indicate the Monday, Tuesday, Thursday and Friday effects respectively. The sign of the estimated parameters indicate the direction of the effect and the respective p values indicate the statistical significance of the effects. Instances where there is evidence of a statistically significant day of the week effect are highlighted with bold font. It is clear that when the whole sample of observations from the studied period is considered (Table 2), there is little indication that the day-of the week effects are taking place, especially for big markets and companies with big market capitalization. The only effects that demonstrate statistical significance are related to the small companies' index sWIG80 of the Warsaw Stock Exchange, those are a negative Tuesday effect and a positive Friday effect. Both effects were significant at 95% confidence level. This may indicate that (at least on Polish stock market) the day of the week effects are more prevalent and durable on smaller markets and smaller classes of assets and that investors trading with more established stocks are faster to incorporate new information about market anomalies in their trading strategies.

Data from the first analyzed subperiod (January 2003 to October 2007) that corresponds to the pre-crisis market growth (Table 3) demonstrates more instances of statistically significant day of the week effects. Those are: positive Friday effects on all four indices of the Warsaw Stock Exchange, a negative Tuesday effect on the main WIG index and a positive Monday effect on the WIG20 index. It is interesting to observe that in this timeframe all indices of the Warsaw Stock Exchange consistently exhibit a positive Friday effect (although the effect was significant only at a 90% confidence level for mWIG40 index) and that again no day of the week effects could

Table 2
Results for the period: January 2003 – September 2013 (whole sample)

Index	α_0	β_1	β_2	β_3	δ_1	δ_2	δ_3	δ_4
WIG	0,00022 [0,69390]	0,09957*** [<0,00001]	−0,0355* [0,06783]	0,03351* [0,08339]	0,00072 [0,36505]	−0,00015 [0,85181]	−0,00024 [0,76394]	0,00064 [0,41933]
WIG20	−0,00015 [0,82446]	0,04677** [0,01573]	−0,04818** [0,01286]	0,01832 [0,34375]	0,00148 [0,11738]	0,00009 [0,92438]	−0,00017 [0,8585]	0,00065 [0,49075]
mWIG 40	0,00028 [0,56616]	0,19746*** [<0,00001]	−0,00055 [0,97769]	0,07936*** [0,00004]	0,00001 [0,98567]	−0,00027 [0,69205]	−0,00034 [0,62051]	0,00081 [0,23317]
sWIG 80	0,00074 [0,11158]	0,2453*** [<0,00001]	−0,00125 [0,94963]	0,10854*** [<0,00001]	−0,00077 [0,24558]	**−0,0014**** [0,03322]	−0,00017 [0,79925]	**0,00135**** [0,04314]
NIKKEI 225	0,0005 [0,45927]	−0,03787* [0,05278]	—	—	−0,00042 [0,66627]	−0,00072 [0,45333]	−0,00004 [0,96299]	−0,00045 [0,63873]
DAX	0,00026 [0,6768]	—	—	—	0,00024 [0,79139]	0,0004 [0,65481]	0,00009 [0,91928]	−0,00013 [0,88204]
CAC40	0,00029 [0,63831]	−0,04627** [0,01539]	−0,04376** [0,02192]	−0,0706*** [0,00022]	−0,00059 [0,50772]	−0,00001 [0,99019]	−0,00041 [0,63893]	0 [0,99601]
S&P 500	−0,00001 [0,98573]	−0,119*** [<0,00001]	−0,0659*** [0,00069]	0,02589 [0,18002]	−0,00007 [0,92677]	0,00101 [0,18985]	0,00034 [0,65574]	0,00002 [0,98243]
IBEX	0,0002 [0,76026]	—	−0,04258** [0,0264]	−0,0508*** [0,00806]	−0,00129 [0,15881]	0,00031 [0,73224]	0 [0,99584]	0,00054 [0,55414]

p-values are given in brackets; *, **, *** – indicate that the model parameter is statistically significant at 90%, 95% and 99% level of significance respectively (this applies to Tables 2–6).

Source: Own elaboration based on stooq.pl

have been observed on other analyzed markets. Since WSE is the smallest of the six markets this seems to support the hypothesis that the day of the week effects persist longer on smaller markets.

The next subperiod corresponds to the declining market of the global financial crisis (October 2007 – March 2009, Table 4). This period exhibits almost no statistically significant day of the week effects, apart from the Tuesday effect on the S&P 500 index. However this result is only significant at a 90% confidence level and may be only coincidental. A relative lack of day of the week anomalies can either be a result of abnormal market conditions with higher than average levels of autocorrelation and constantly declining prices or simply an outcome of the learning process as described by Shwert (Shwert, 2002 p. 45). As investors become more aware of the day of the week abnormalities they adjust their trading strategies accordingly what in turn results in diminishing of those effects. The results from the

Table 3

Results for the period: January 2003 – October 2007

Index	α_0	β_1	β_2	β_3	δ_1	δ_2	δ_3	δ_4
WIG	0,00074 [0,11158]	0,2453*** [<0,00001]	−0,00125 [0,94963]	0,10854*** [<0,00001]	−0,00077 [0,24558]	**−0,0014**** [0,03322]	−0,00017 [0,79925]	**0,00135**** [0,04314]
WIG20	−0,00039 [0,64541]	0,03106 [0,2802]	0,01505 [0,60066]	0,00508 [0,85971]	**0,00289**** [0,01825]	0,00015 [0,90022]	0,00109 [0,37193]	**0,00255**** [0,0361]
mWIG 40	0,00031 [0,62678]	0,1269*** [<0,00001]	0,03435 [0,23212]	0,12331*** [0,00002]	0,00134 [0,13603]	−0,00065 [0,46192]	0,0008 [0,37368]	**0,00169*** [0,05899]
sWIG 80	0,00082 [0,26485]	0,19652*** [<0,00001]	0,02818 [0,3311]	0,13929*** [<0,00001]	0,00129 [0,21512]	−0,0016 [0,11922]	0,00036 [0,73032]	**0,00268***** [0,00953]
NIKKEI 225	0,00013 [0,8745]	0,00031 [0,99218]	—	—	0,00094 [0,42825]	0,00016 [0,88701]	0,00043 [0,70859]	0,00137 [0,23894]
DAX	0,00014 [0,85895]	—	—	—	0,00106 [0,33707]	0 [0,99979]	0,00143 [0,19042]	0,00098 [0,37102]
CAC40	0,00044 [0,50849]	−0,03553 [0,20949]	−0,00615 [0,82791]	−0,05173* [0,06769]	−0,00031 [0,74832]	−0,00059 [0,53177]	0,00042 [0,65836]	0,00095 [0,3209]
S&P 500	0,00089 [0,07858]	−0,09617*** [0,00079]	−0,03179 [0,26849]	0,03143 [0,2718]	−0,00018 [0,80857]	−0,00042 [0,55602]	−0,0006 [0,40204]	−0,00083 [0,24991]
IBEX	0,00109 [0,07009]	—	0,02157 [0,44894]	−0,01522 [0,59211]	−0,00108 [0,2078]	−0,00079 [0,354]	−0,00005 [0,95602]	0,00022 [0,79705]

Source: Own elaboration based on stooq.pl

next period (March 2009 – September 2013, Table 5) seem to support the hypothesis that the scope of anomalies is diminishing with time. This period on average corresponds to markets recovering from the crisis, hence it can be described as a period of moderate growth. Despite of that the amount of day of the week anomalies that can be observed is no greater than in the previous period of market decline. There has been only one instance of a statistically significant day of the week effect, that is a positive Monday effect on the sWIG80 index. This effect is more significant than the S&P 500 Monday effect from the previous subperiod and can be considered as further evidence for the hypothesis that market anomalies persist longer for smaller asset classes and on smaller markets.

In order to further verify the hypothesis that day of the week effects diminish as time goes by, an additional period preceding the main data sample of this study was analyzed. The results of this additional analysis are summarized in table 6. The day of the week effects are captured by parameters δ_1 through δ_4 in the same way as in the previous subperiods. The additional period extends from January 1999 to December 2002. This

Table 4

Results for the period: November 2007 – February 2009

Index	α_0	β_1	β_2	β_3	δ_1	δ_2	δ_3	δ_4
WIG	−0,00291	0,10783*	−0,10152*	0,12538**	−0,00022	0,00183	0,00023	−0,0014
	[0,2231]	[0,05242]	[0,06887]	[0,02459]	[0,94699]	[0,58755]	[0,94556]	[0,67781]
WIG20	−0,00351	0,0474*	−0,09816	0,09468*	0,0007	0,00341	0,00076	−0,00247
	[0,22096]	[0,39421]	[0,07866]	[0,09053]	[0,86355]	[0,39934]	[0,85142]	[0,54342]
mWIG 40	−0,00207	0,20275***	−0,04588	0,15614***	−0,0014	−0,00058	−0,00144	0,00003
	[0,31774]	[0,00028]	[0,41516]	[0,00497]	[0,63037]	[0,843]	[0,62135]	[0,99136]
sWIG 80	−0,00148	0,24053***	−0,08243	0,17303***	−0,00332	−0,0014	−0,00012	0,00109
	[0,39565]	[0,00002]	[0,1443]	[0,00181]	[0,17488]	[0,56771]	[0,96173]	[0,65759]
NIKKEI 225	−0,00062	−0,06408	—	—	−0,00021	0,00002	−0,00125	−0,00448
	[0,78918]	[0,15757]	—	—	[0,95141]	[0,994]	[0,69975]	[0,16685]
DAX	−0,00429	—	—	—	0,0033	0,00621	−0,00041	0,00136
	[0,11956]	—	—	—	[0,39706]	[0,11026]	[0,91641]	[0,72533]
CAC40	−0,00334	−0,13085**	−0,10217*	−0,10073*	0,00022	0,00339	−0,0024	0,00035
	[0,23907]	[0,01742]	[0,06419]	[0,06688]	[0,95726]	[0,39982]	[0,55098]	[0,93092]
S&P 500	−0,00565**	−0,16945***	−0,18215***	0,07078	0,00051	**0,00754***	0,00226	0,00366
	[0,04947]	[0,00246]	[0,00109]	[0,20208]	[0,90161]	[0,06618]	[0,58392]	[0,36816]
IBEX	−0,00284	—	−0,06322	−0,06617	−0,00138	0,0028	−0,00113	0,00145
	[0,31858]	—	[0,25605]	[0,2342]	[0,73133]	[0,48462]	[0,77877]	[0,71635]

Source: Own elaboration based on stooq.pl

Table 5

Results for the period: March 2009 – September 2013

Index	α_0	β_1	β_2	β_3	δ_1	δ_2	δ_3	δ_4
WIG	0,00131	0,10912***	−0,06226**	−0,04833	−0,00029	−0,00088	−0,0014	−0,00036
	[0,1059]	[0,00026]	[0,03731]	[0,10485]	[0,7975]	[0,44135]	[0,22389]	[0,7549]
WIG20	0,00117	0,04598	−0,08457***	−0,03928	0,00016	−0,00115	−0,00168	−0,00056
	[0,21987]	[0,12331]	[0,00443]	[0,18698]	[0,90394]	[0,3947]	[0,21673]	[0,67879]
mWIG 40	0,00094	0,22378***	−0,02748	−0,05154*	−0,00077	0,00029	−0,00115	0,00039
	[0,16723]	[<0,00001]	[0,36815]	[0,08411]	[0,42339]	[0,76594]	[0,23242]	[0,68756]
sWIG 80	0,00122**	0,28973***	−0,01881	−0,0231	**−0,00193****	−0,00106	−0,00074	0,00011
	[0,038]	[<0,00001]	[0,54472]	[0,43883]	[0,02056]	[0,20045]	[0,37288]	[0,89514]
NIKKEI 225	0,00135	−0,04352	—	—	−0,00192	−0,00194	0,00004	−0,00032
	[0,16928]	[0,14851]	—	—	[0,17569]	[0,16079]	[0,97467]	[0,81826]
DAX	0,00168*	—	—	—	−0,0015	−0,00083	−0,00118	−0,0017
	[0,07029]	—	—	—	[0,25835]	[0,52747]	[0,3695]	[0,1996]

Index	α_0	β_1	β_2	β_3	δ_1	δ_2	δ_3	δ_4
CAC40	0,00111 [0,25713]	−0,00762 [0,7957]	−0,03662 [0,21316]	−0,07159** [0,0151]	−0,00124 [0,37132]	−0,00051 [0,7123]	−0,00078 [0,5739]	−0,00122 [0,38223]
S&P 500	0,00049 [0,53494]	−0,07312** [0,01383]	0,03186 [0,28325]	−0,07026** [0,01787]	−0,00008 [0,94158]	0,0008 [0,47204]	0,00086 [0,43997]	−0,00015 [0,89646]
IBEX	0 [0,99891]	— —	−0,05997** [0,04169]	−0,06079** [0,03901]	−0,00146 [0,35181]	0,00072 [0,64363]	0,00048 [0,75922]	0,00067 [0,66884]

Source: Own elaboration based on stooq.pl

Table 6
Results for the period: January 1999 – December 2002 (additional period)

Index	α_0	β_1	β_2	δ_1	δ_2	δ_3	δ_4
WIG	−0,00206* [0,05765]	0,03242 [0,30797]	−0,03329 [0,29502]	0,001 [0,51803]	0,0019 [0,21451]	**0,00391**** [0,01112]	**0,00379**** [0,01379]
WIG20	−0,00146 [0,25421]	0,01305 [0,67903]	0,03421 [0,27839]	−0,00054 [0,76643]	0,00064 [0,7252]	**0,00417**** [0,02206]	0,00237 [0,19333]
mWIG 40	−0,00056 [0,49723]	0,03433 [0,27283]	0,06624** [0,0346]	−0,00086 [0,46425]	−0,00087 [0,45475]	**0,00247**** [0,03386]	**0,00253**** [0,03046]
sWIG 80	−0,00122 [0,14448]	0,06791** [0,03293]	−0,04423 [0,16533]	0,00046 [0,69687]	0,0001 [0,9354]	0,00188 [0,11235]	**0,0028**** [0,01842]
NIKKEI 225	−0,00139 [0,2099]	−0,03817 [0,23329]	−0,02041 [0,52389]	0,00064 [0,68844]	0,00109 [0,48541]	0,00166 [0,28949]	0,0011 [0,48115]
DAX	−0,00282** [0,03065]	−0,02047 [0,51608]	−0,01028 [0,74543]	0,00218 [0,24003]	0,00183 [0,32239]	**0,00355*** [0,05407]	**0,00332*** [0,07289]
CAC40	−0,00282** [0,01662]	0,00577 [0,85465]	−0,04102 [0,19309]	**0,0031*** [0,06453]	0,00178 [0,28313]	**0,00483***** [0,00358]	0,00263 [0,11533]
S&P 500	0,00004 [0,97075]	−0,00228 [0,94259]	−0,03525 [0,26496]	−0,00009 [0,94887]	−0,00197 [0,15467]	0,00083 [0,54763]	−0,00083 [0,54986]
IBEX	−0,0024** [0,03778]	−0,01257 [0,69169]	−0,0498 [0,11685]	0,0015 [0,35826]	0,0017 [0,2957]	**0,00354**** [0,03035]	0,00233 [0,15397]

Source: Own elaboration based on stooq.pl

period clearly exhibits the greatest number of statistically significant day of the week effects. Furthermore those effects can be observed on markets that did not exhibit any day of the week effects in the previously analyzed timeframe. Hence those additional results provide strong evidence for the notion that market anomalies will disappear as time goes by and investors are becoming more aware of them. The effects that can be observed are: Friday effects on WIG, mWIG40, sWIG80, and DAX indices; Thursday

effects on WIG, WIG20, mWIG40, DAX, CAC40, and IBEX indices; and a Monday effect on CAC40 index. It is also worth noting that all of those effects are positive.

6. Conclusions

This study reveals some interesting patterns in the behavior of stock market anomalies. First of all the obtained results suggest that market anomalies will became less prevalent with time especially as the information about those anomalies becomes more widespread. This supports the results obtained by Shwert (Shwert, 2002 p. 45). Given those results it seems that investment decision making based on the historically observed market anomalies may be inadvisable and can only produce abnormal returns when the information on those anomalies is not yet widespread. Currently the day of the week effects seem to be non-existent on big established equity markets, as in the most recent analyzed subperiod the only statistically significant effect could have been observed on the sWIG80 index. Although there was no long term consistency in the case of the signs of the day of the week effects, Friday effects observed in this study were in all cases positive and most prevalent on the Polish Warsaw Stock Exchange. It may be the case that the Friday effects tend to be the last remaining day of the week effects on most markets as the anomalies diminish. In many early studies the Monday effect seemed to be the most common one, results obtained in this paper suggest that currently the Monday effect is quite rare and that the most common one is the Friday effect.

Another conclusion from the study is the indication that the day of the week effects and broadly speaking market anomalies in general may persist for the longest time on smaller markets with lower market caps. In the studied period, the day of the week effects were most common on the small companies' sWIG80 index, and were much less common on bigger markets than the Warsaw Stock Exchange. Those results seem to be in line with other studies conducted on small markets e.g. (Tonchey, Kim 2004).

Based on the studied subperiods it seems that the prevalence of the day of the week effects is not related to the actual market situation. The sample contained subperiods of market growth that were both abundant and scarce in day of the week anomalies, although this conclusion may require a more in depth study of this phenomenon.

Although this study reveals some regularities it seems that when it comes to day of the week effects, there are no clear and consistent patterns

apart from the diminishment of those effects in time, hence in practice it would be very hard to undertake sound investment decisions based on those anomalies. Furthermore it is safe to say that for the analyzed markets, day of the week anomalies are currently very weak if not non-existent.

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Appendix 1. Descriptive statistics for individual days of the week

	WIG					NIKKEI 225					DAX				
	All days	**Monday**	**Tuesday**	**Thursday**	**Friday**	**All days**	**Monday**	**Tuesday**	**Thursday**	**Friday**	**All days**	**Monday**	**Tuesday**	**Thursday**	**Friday**
No. of days	2679	530	541	531	531	2619	484	532	535	534	2719	535	549	549	537
Mean	0,00046	0,00103	0,00016	0,00003	0,00085	0,00016	0,00004	−0,00022	0,00043	0,00004	0,00039	0,00050	0,00066	0,00035	0,00019
Std. Dev.	0,013	0,014	0,012	0,013	0,011	0,015	0,016	0,015	0,016	0,015	0,014	0,016	0,013	0,014	0,013
Skewness	−0,423	−0,285	−0,384	−0,486	−0,911	−0,582	−0,436	0,448	−1,097	−1,277	0,053	0,243	0,727	−0,070	−0,298
Kurtosis	3,305	2,537	2,356	3,014	5,913	8,029	1,625	15,330	9,552	6,870	5,770	7,624	7,876	4,197	2,948
	CAC 40					**S&P 500**					**IBEX**				
	All days	**Monday**	**Tuesday**	**Thursday**	**Friday**	**All days**	**Monday**	**Tuesday**	**Thursday**	**Friday**	**All days**	**Monday**	**Tuesday**	**Thursday**	**Friday**
No. of days	2734	540	549	551	541	2685	502	549	542	538	2711	533	547	548	535
Mean	0,00008	−0,00032	0,00028	−0,00005	0,00023	0,00023	−0,00011	0,00100	0,00034	0,00001	0,00013	−0,00111	0,00046	0,00031	0,00082
Std. Dev.	0,014	0,017	0,013	0,014	0,014	0,012	0,014	0,013	0,013	0,010	0,015	0,016	0,013	0,014	0,015
Skewness	0,069	0,434	−0,143	−0,162	0,108	−0,303	−0,167	0,828	−0,752	0,044	0,118	1,109	−0,309	−0,097	−0,377
Kurtosis	6,296	9,025	2,211	3,419	6,367	10,474	14,665	9,440	6,433	3,495	6,767	11,974	2,229	3,417	6,591
	WIG20					**mWIG40**					**sWIG80**				
	All days	**Monday**	**Tuesday**	**Thursday**	**Friday**	**All days**	**Monday**	**Tuesday**	**Thursday**	**Friday**	**All days**	**Monday**	**Tuesday**	**Thursday**	**Friday**
No. of days	2679	530	541	531	531	2679	530	541	531	531	2679	530	541	531	531
Mean	0,00026	0,00137	−0,00002	−0,00030	0,00050	0,00044	0,00051	0,00015	0,00006	0,00110	0,00084	0,00058	−0,00038	0,00089	0,00222
Std. Dev.	0,015	0,016	0,015	0,016	0,014	0,011	0,012	0,010	0,012	0,010	0,011	0,012	0,011	0,011	0,010
Skewness	−0,251	−0,031	−0,293	−0,297	−0,707	−0,947	−0,966	−0,752	−1,001	−1,428	−1,078	−1,258	−1,258	−1,196	−1,133
Kurtosis	2,823	2,918	1,875	2,223	4,087	5,675	3,348	3,594	6,235	12,226	5,673	5,478	4,259	6,703	8,523

Source: Own elaboration based on stooq.pl