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Calendar anomalies in the Ukrainian stock market

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Calendar Anomalies in the Ukrainian Stock Market

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Abstract

This paper is a comprehensive investigation of calendar anomalies in the Ukrainian stock market. It employs various statistical techniques (average analysis, Student's t-test, ANOVA, the Kruskal-Wallis test, and regression analysis with dummy variables) and a trading simulation approach to test for the presence of the following anomalies: Day of the Week Effect; Turn of the Month Effect; Turn of the Year Effect; Month of the Year Effect; January Effect; Holiday Effect; Halloween Effect. The results suggest that in general calendar anomalies are not present in the Ukrainian stock market, but there are a few exceptions, i.e. the Turn of the Year and Halloween Effect for the PFTS index, and the Month of the Year Effect for UX futures. However, the trading simulation analysis shows that only trading strategies based on the Turn of the Year Effect for the PFTS index and the Month of the Year Effect for the UX futures can generate exploitable profit opportunities that can be interpreted as evidence against market efficiency.

Keywords: Calendar Anomalies; Day of the Week Effect; Turn of the Month Effect; Month of the Year Effect; January Effect; Holiday Effect; Halloween Effect.

JEL classification: G12, C63

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1. Introduction

Stock markets often exhibit a variety of so-called calendar anomalies, including the Day of the Week Effect, the Turn of the Month Effect, the Month of the Year Effect, the January Effect, the Holiday Effect, the Halloween Effect etc. These have been extensively analysed in numerous empirical studies providing mixed evidence. However, to date no comprehensive study has been carried out for Ukraine. The present paper aims to fill this gap by using various statistical techniques (average analysis, parametric tests such as Student's t-test and ANOVA analysis, non-parametric techniques such as the Kruskal - Wallis test, regression analysis with dummy variables) to test for the presence of calendar anomalies in the Ukrainian stock market. To establish whether such effects are not just statistical anomalies but can be exploited by adopting appropriate trading strategies, we employ a trading simulation approach. To reduce the possibility of data-mining three different indices (UX Index, PFTS Index, Futures for the UX Index) are used.

The layout of the paper is as follows. Section 2 briefly reviews the most common calendar anomalies and the available evidence. Section 3 describes the data and outlines the empirical methodology. Section 4 presents the empirical results. Section 5 offers some concluding remarks.

2. Calendar Anomalies

The most frequently observed calendar anomalies and the evidence for them are discussed below.

The Day-of-the-Week effect (the Weekend effect, the Monday effect) implies that the distribution of stock returns is different for different days of the week. For example Cross (1973) analysed the Standard & Poor's Composite Stock Index data from January 1953 to December 1970 and claimed to have found some patterns in the behaviour of US asset prices, namely an increase on Fridays and a decrease on Mondays.

The Turn of the Month Effect was reported, among others, by Ariel (1987), who found that returns on the last and the first four trading days are higher than on other days of the month. Different event windows have been used in the literature. The most common nowadays is (-1;+3).; for example, Lakonishok and Smidt (1988) analysed US stocks over a period of 90 years and found that cumulative returns in the four days between the last trading day of the month and the following three trading days exceeded returns over the entire month.

The Turn of the Year Effect amounts to stock returns in the last week of December and the first two weeks of January being higher than returns at other times of the year. For instance, Clark and Ziemba (1987) found that on the last trading days in December and on the first eight trading days in January stock returns are higher (see also the seminal study by Rozeff and Kinney, 1976).

The Month of the Year Effect and the January Effect are found when returns vary depending on the month of the year, with January exhibiting higher returns, as reported, for instance, by Wachtel (1942) for the Dow Jones Industrial Average over the time period 1927-1942. Rozeff and Kinney (1976) also provided similar evidence. The so-called Mark Twain Effect is observed when stock returns are lower in October than in other months.

The Holiday Effect implies that pre-holiday average returns are higher than post-holiday returns. For example, Ariel (1990) showed that they are on average eight times higher than the (usually negative) post-holiday returns; Lakonishok and Smidt (1988), analysing ninety years of data on the Dow Jones Industrial Average index, calculated that the pre-holiday rate of return is 23 times larger than the normal daily rate of return.

The Halloween Effect is characterised by the period from November to April inclusive having significantly stronger average growth than the other months. It is based on the investment strategy “Sell in May and go away”, following which stocks are sold at the

start of May and bought again in the autumn. Jacobsen and Bouman (2002) showed that such a strategy can generate abnormal returns.

It is noteworthy that calendar anomalies might be fading. For example Fortune (1998, 1999), Schwert (2003), and Olson et al. (2010) argue that the weekend effect has become less important over the years. More details on previous studies are provided in Appendix A.

The few papers on calendar anomalies in the Ukrainian stock market include Hourvoulides and Kourkouvelis (2009), Depenchuk et al. (2010) and Caporale et al. (2016a,b), but these only focus on some specific anomalies (e.g., the Weekend Effect). The present one is the first comprehensive study of calendar anomalies in Ukraine.

3. Data and Methodology

We use daily and monthly data on the UX, PFTS and UX futures indices. The sample covers the period from November 2001 to the end of December 2015 for the PFTS Index, from January 2008 to the end of December 2015 for the UX Index, and from April 2010 to the end of December 2015 for the UX futures index. The data sources are the Ukrainian Exchange (<http://www.ux.ua/en/>) and PFTS Stock Exchange (<http://www.pfts.ua/>).

To examine whether there is a calendar effect we use the following techniques:

- average analysis
- parametric tests (Student's t-tests, ANOVA)
- non-parametric tests (Kruskal-Wallis test)
- regression analysis with dummy variables

Returns are computed as follows:

$$R_i = \left(\frac{\text{Close}_i}{\text{Close}_{i-1}} - 1 \right) \times 100\% , \quad (2)$$

where R_i – returns on the i -th day in %;

$Open_i$ – open price on the i -th day;

$Close_i$ – close price on the i -th day.

Average analysis provides preliminary evidence on whether there are differences between returns in “normal” and “abnormal” periods. Both parametric and non-parametric tests are carried out given the evidence of fat tails and kurtosis in stock returns. The Null Hypothesis (H_0) in each case is that the data belong to the same population, a rejection of the null suggesting the presence of an anomaly.

We use two variants of the Student’s t , ANOVA and Kruskal-Wallis tests:

- overall testing – when all data are analysed together;
- separate testing – when we compare data from the period that might be characterised by an anomaly with those from other periods.

We also run multiple regressions including a dummy variable to identify given calendar anomalies:

$$Y_t = a_0 + a_1 D_{1t} + a_2 D_{2t} + \dots + b_n D_{nt} + \varepsilon_t \quad (3)$$

where Y_t – return on the period t ;

a_n – mean return for a specific data group (for example Mondays, Tuesdays etc. in the case of the day of the week anomaly);

D_{nt} – a dummy variable for a specific data group, equal to 1 when the data belong to a specific group (for example, data for a specific day of the week such as Monday in the case of the day of the week anomaly), and equal to 0 when they do not

ε_t – Random error term for period t .

The size, sign and statistical significance of the dummy coefficients provide information about possible anomalies.

When calendar anomalies are detected using the previous methods we examine whether these give rise to exploitable profit opportunities by means of a trading simulation approach. Specifically, we use an algorithm based on the detected anomaly to replicate the

behaviour of a trader who opens positions on the Ukrainian stock market and holds them for a certain period of time (according to the developed algorithm).

We use the following procedure to simulate the trading process. First we compute the percentage result of the deal:

$$\% \text{ result} = \frac{100\% \times P_{open}}{P_{close}} \quad (5)$$

where P_{open} – opening price

P_{close} – closing price

Then this difference is converted into Ukrainian hryvnas (UAH).

$$UAHresult = \% \text{ result} \times 1000 \quad (6)$$

where $UAHresult$ – is result of the deal in UAH.

1000 is the sum of the trading deposit.

The sum of results from each deal in UAH is the total financial result of trading. A strategy resulting in a number of profitable trades $> 50\%$ and positive total profits is defined as indicating an exploitable market anomaly.

To make sure that the results we obtain are statistically different from the random trading ones we carry out t-tests. We chose this approach instead of carrying out z-tests because the sample size is less than 100. A t-test compares the means from two samples to see whether they come from the same population. In our case the first is the average profit/loss factor of one trade applying the trading strategy, and the second is equal to zero because random trading (without transaction costs) should generate zero profit.

The null hypothesis (H_0) is that the mean is the same in both samples, and the alternative (H_1) that it is not. The computed values of the t-test are compared with the critical one at the 5% significance level. Failure to reject H_0 implies that there are no advantages from exploiting the trading strategy being considered, whilst a rejection suggests that the adopted strategy can generate abnormal profits.

4. Empirical Results

The complete set of results can be found in Appendix B. Starting with the Day of the Week Effect, one can see (Figures B.1, B.2 and B.3) that there are no clear signs of this anomaly in the dynamics of the PFTS, UX and UX futures indices, as suggested by all statistical tests as well as the regression analysis. The results for the Turn of the Month Effect are reported in Appendix C. Visual inspection (Figures C.1, C.2 and C.3) suggests possible anomalies in the dynamics of the PFTS and UX but not of the UX futures index. However, this is only implied by the regression analysis, not by the other statistical tests. Although the PFTS index at the turn of the month is four times higher than on other days, this difference is not statistically significant.

The empirical results for the Turn of the Year Effect are presented in Appendix D. Figures D.1, D.2 and D.3 provide visual evidence supporting the presence of this effect in the Ukrainian stock market, but this is confirmed only by the statistical tests for the PFTS index. As for the Month of the Year Effect (see Appendix E), visual inspection (Figures E.1, E.2 and E.3) does not suggest any anomalies, whilst the statistical tests provide some evidence for them in the case of the UX futures index: returns appear to be higher in February and lower in July-August in comparison to other months of the year. There is no evidence either of the Month of the Year Effect, or of the Holiday Effect (Appendix F): although visual inspection (Figures F.1, F.2 and F.3) suggests that pre-holidays returns are higher than normal and post-holiday ones (for both the PFTS and UX indices), these findings are not confirmed by either the statistical tests or the regression analysis.

Finally, concerning the Halloween Effect (see Appendix G), average analysis provides evidence in favour of the rule “sell in May and go away” since returns during the period November-April are much higher than in May-October (almost 7 times), but the statistical tests and the regression analysis show that this difference is significant only in the case of the PFST index.

Table 1, 2 and 3 below summarise the results.

Table 1: Overall results for PFTS index

Anomaly/Methodology	Average analysis	Student's t-test	ANOVA	Kruskal - Wallis test	Regression analysis with dummies
Day of the Week Effect	-	-	-	-	-
Turn of the Month Effect	+	-	-	-	+
Turn of the Year Effect	+	+	+	+	+
Month of the Year Effect	-	-	-	+	-
Holiday Effect	+	-	-	-	-
Halloween Effect	+	+	+	--	+

Table 2: Overall results for UX index

Anomaly/Methodology	Average analysis	Student's t-test	ANOVA	Kruskal - Wallis test	Regression analysis with dummies
Day of the Week Effect	-	-	-	-	-
Turn of the Month Effect	+	-	-	-	-
Turn of the Year Effect	+	-	-	-	-
Month of the Year Effect	-	+	-	-	-
Holiday Effect	+	-	-	-	-
Halloween Effect	+	-	-	-	-

Table 3: Overall results for UX futures

Anomaly/Methodology	Average analysis	Student's t-test	ANOVA	Kruskal - Wallis test	Regression analysis with dummies
Day of the Week Effect	-	-	-	-	-
Turn of the Month Effect	-	-	-	-	-
Turn of the Year Effect	+	-	-	-	-
Month of the Year Effect	-	+	+	+	+
Holiday Effect	-	-	-	-	-
Halloween Effect	+	-	-	-	-

As can be seen, the only detected anomalies are the Turn of the Year and the Halloween Effect for the PFTS index, and the Month of the Year Effect for the UX futures index.

Next we use a trading simulation approach to answer the question whether these are simply statistical anomalies or instead represent exploitable profit opportunities. We begin with the Month of the Year Effect for the UX futures index. First we try to design

appropriate trading rules, i.e. in which months long and short positions respectively should be opened.

Table 4: Anomalies by month for the UX futures

Month	Average analysis	t-test	ANOVA	Kruskal - Wallis test	Regression analysis	Overall
January	-	-	-	-	-	0
February	+	+	+	+	-	4
March	+	+	-	-	-	2
April	-	-	-	-	-	0
May	+	-	-	-	-	1
June	-	-	-	-	-	0
July	+	+	+	-	-	3
August	+	+	-	+	-	3
September	-	-	-	-	-	0
October	-	-	-	-	-	0
November	-	-	-	-	-	0
December	+	-	-	-	-	1

As can be seen, in the case of UX futures anomalies are present mainly in February, July and August, therefore the trading strategy will be the following: open long positions in February and July (since returns on UX futures tend to be higher during these months) and short positions in August. All of them should be closed at the end of the period when they were opened. The trading simulation produces the following results:

Table 5: Trading simulation results for the Month of the Year Effect (UX futures)

Instrument	Number of trades	Number of successful trades	% of successful trades	Financial result, UAH	Overall financial result, %	Average annual financial result, %
UX Futures	17	14	82%	2108	210%	22%

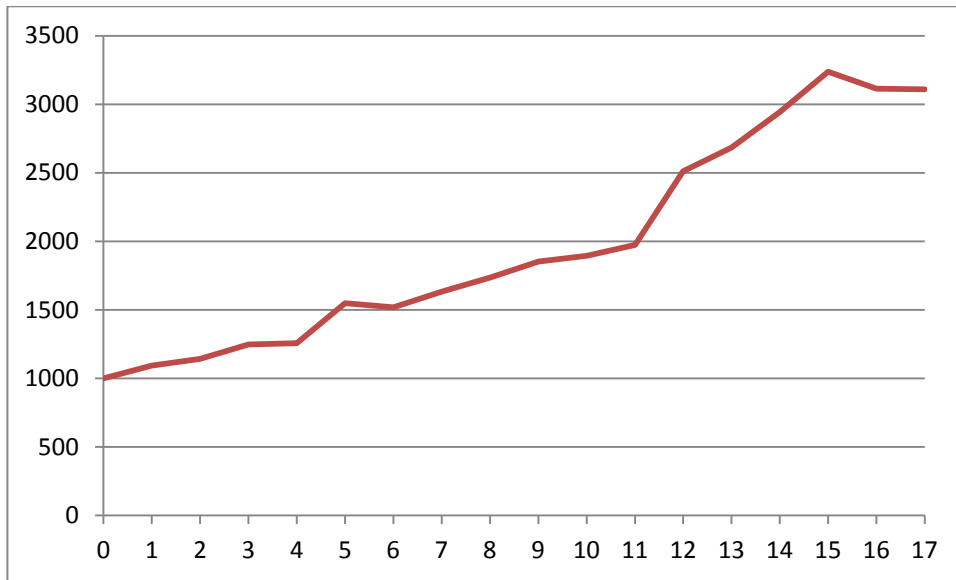


Figure 1 – Trading deposit dynamics for the trading strategy based on the Month of the Year Effect (UX futures)

The t-test results are reported in Table 6.

Table 6: T-test for the trading simulation results for the Month of the Year Effect (UX futures)

Parameter	Value
Number of the trades	17
Total profit (UAH)	2108
Average profit per trade (UAH)	124
Standard deviation (UAH)	149
t-test	3.42
t critical (0,95)	2,11
Null hypothesis	rejected

As we can be seen, H_0 is rejected, which implies that the trading simulation results for the Month of the Year Effect (in the case of UX futures) are statistically different from the random ones and therefore this trading strategy is effective and there is an exploitable profit opportunity.

Concerning the Turn of the Year effect for the PFTS index (stock returns in the last week of December and the first two weeks of January are higher than at other times of the year) the trading strategy will be the following: open a long position in the last week of

December and close it after the first two weeks of January. The trading simulation yields the following results (see Table 7)

Table 7: Trading simulation results for the Turn of the Year Effect (PFTS index)

Instrument	Number of trades	Number of successful trades	% of successful trades	Financial result, UAH	Overall financial result, %	Average annual financial result, %
UX Futures	14	12	86%	1093	100%	5.7%

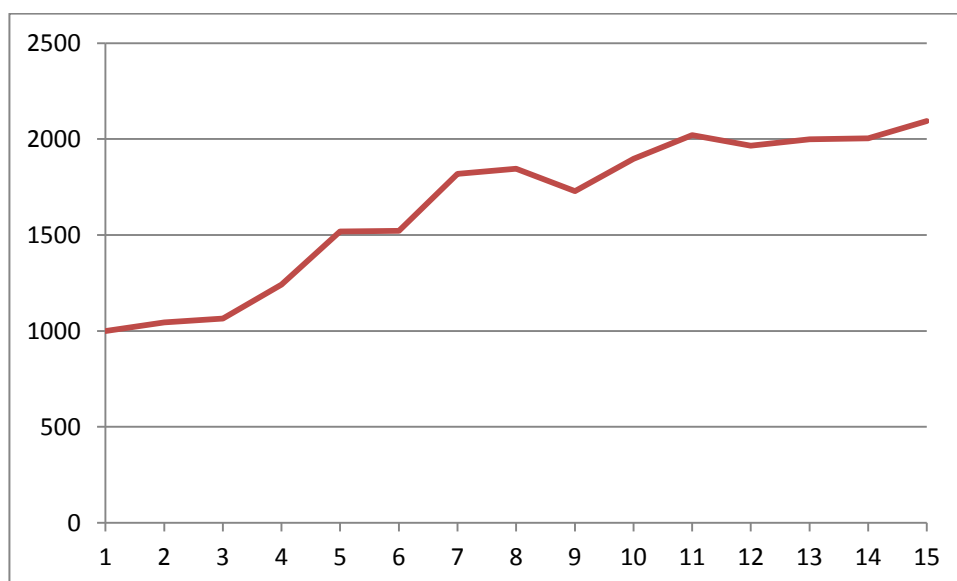


Figure 2 – Trading deposit dynamics for the trading strategy based on the Turn of the Year Effect (PFTS index)

The t-test results are reported in Table 8.

Table 8: T-test for the trading simulation results for the Turn of the Year Effect (PFTS index)

Parameter	Value
Number of the trades	14
Total profit (UAH)	1093
Average profit per trade (UAH)	78
Standard deviation (UAH)	114
t-test	2.55
t critical (0,95)	2,14
Null hypothesis	rejected

In this case H0 is rejected, which again implies that the trading simulation results are statistically different from the random ones and therefore this trading strategy is also effective and can be exploited to make abnormal profits.

Finally, we focus on the Halloween Effect for the PFTS index. This investment strategy can be specified as “Sell in May and go away”, i.e. stocks are sold at the beginning of May and bought again in the autumn. But since the regression analysis results indicated that in the case of the Ukrainian stock market only buys in the autumn generate abnormal returns, the trading strategy will be open long positions on the PFTS index in November and close them in May. The trading simulation results are the following (see Table 9):

Table 9: Trading simulation results for the Halloween Effect (PFTS index)

Instrument	Number of trades	Number of successful trades	% of successful trades	Financial result, UAH	Overall financial result, %	Average annual financial result, %
UX Futures	14	5	64%	30358	3035%	34%

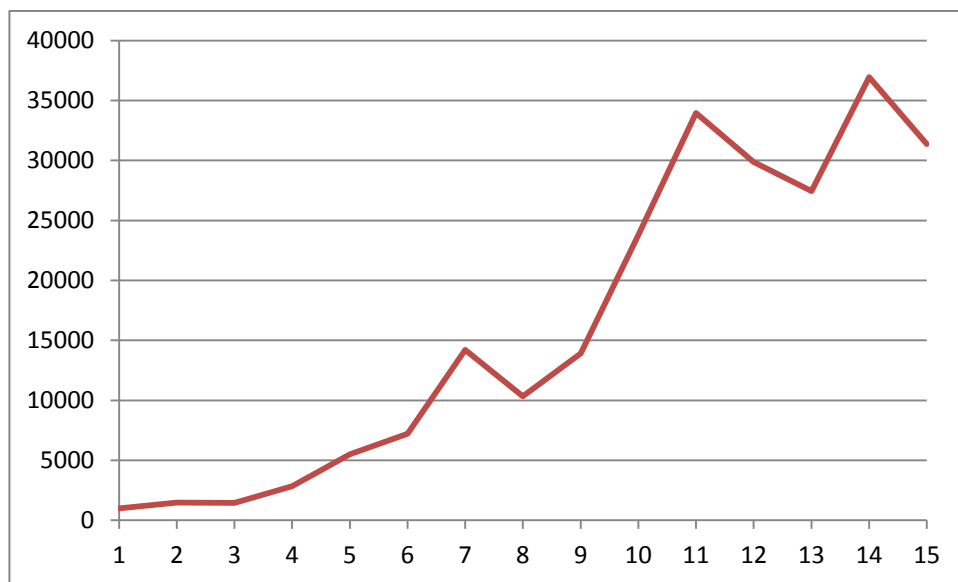


Figure 3 – Trading deposit dynamics for the trading strategy based on the Halloween Effect (PFTS index)

The t-test results are reported in Table 8.

Table 10: T-test for the trading simulation results for the Halloween Effect (PFTS index)

Parameter	Value
Number of the trades	14
Total profit (UAH)	30358
Average profit per trade (UAH)	2168
Standard deviation (UAH)	5127
t-test	1.58
t critical (0,95)	2,14
Null hypothesis	accepted

H0 now cannot be rejected, i.e. in this case there is no statistically significant difference between the trading simulation results and the random ones and therefore no exploitable profit opportunities.

5. Conclusions

In this paper we have examined calendar anomalies (Day of the Week Effect; Turn of the Month Effect; Turn of the Year Effect; Month of the Year Effect; January Effect; Holiday Effect; Halloween Effect) in the Ukrainian stock market using different methods (average analysis, parametric tests including Student's t-test and ANOVA, non-parametric tests such as the Kruskal-Wallis test and regression analysis with dummy variables). Three different indices (PFTS, UX and UX futures) have been considered to avoid data mining.

The results suggest that in general calendar anomalies are not present in the Ukrainian stock market, but there are a few exceptions, i.e. the Turn of the Year and Halloween Effect for the PFTS index, and the Month of the Year Effect for UX futures. However, the trading simulation analysis shows that only trading strategies based on the Turn of the Year Effect for the PFTS index and the Month of the Year Effect for the UX futures can generate exploitable profit opportunities that can be interpreted as evidence against market efficiency.

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Appendix A

Literature review

Author	Tested effects	Object of analysis (time period, market)	Methodology	Results
Lim and Chia (2010)	day of the week effect the twist of the Monday effect	ASEAN -5 stock markets for the period June 10, 2002 through August 21, 2009	Kruskal -Wallis statistic test	Finds support for the day-of-the -week effect in Malaysia and Thailand stock markets. Friday has the highest returns in a week. Find evidence on the twist-of-the Monday effect, where returns on Mondays are influenced by the previous week's returns.
Giovanis (2008)	day of the week effect the month of the year effect	Athens Stock Exchange Market	GARCH estimation	The Monday effect was rejected for the Athens Stock Market. The January effect was found.
Georgantopoulos et al. (2011)	day of the week effect, the January effect, the half month effect, the turn of the month effect the time of the month effect	emerging stock markets (Romania, Bulgaria, Croatia and Turkey) and Greece, during the period 2000-2008	OLS methodology on appropriately defined dummy variables; GARCH estimation	Provide evidence for the existence of three calendar effects (day of the week, turn of the month, time of the month) in both mean and volatility equations for Greece and Turkey
Abhijeet (2011)	turn of the month effect time of the month effect	Bombay Stock Exchange (BSE) for the period April 1998 to March 2008	regression equation with dummy variables	For both the effects, the turn of the month effect as well as the time of the month effect, significant values were found.
Huson and Haque (2009)	day of the week, turn of the month January effect	Malaysian stock index over the period from 1994 to 2004	GARCH (1 1)-M model	Findings indicate the presence of a week-end effect. No clear pattern of January or turn of the month effect was observed.
Tangjitprom (2011)	month-of-year effect, turn-of-month effect, weekend effect	Thai stock market. SET index during 1988 to 2009	multiple regression techniques using dummy variables	Calendar anomalies exist in Thai stock market. The return is abnormally high during December and January. Return is abnormally high on Fridays but abnormally low on Mondays.
Compton et al (2013)	monthly seasonality, weekday seasonality,	two Russian stock indices and two Russian bond	multiple regression techniques using dummy	There is strong evidence of a persistent monthly pattern (but no January effect) and strong evidence of weekday

	and a turn-of-the-month seasonality	indices during 2000-2010	variables	seasonality (but no Monday effect) in the Russian bond market. There is also strong support for a TOM effect in the Russian and US stock and bond markets.
Stoica and Diaconășu (2011)	day of the week, month of the year effect	Central Europe stock markets between 2000 and 2010	multiple regression techniques using dummy variables	the Friday effect in Czech Republic, Croatia and Hungary, positive and significant yields on Thursday in the majority of the cases, the existence of the month of the year effect and the existence of January effect in Czech Republic, Croatia, Macedonia, Romania, Slovenia and Hungary.
Bildik (2004)	the day-of-the-week, turn-of-the-year and January, turn-of-the-month, intra-month, and holiday effects	ISE-100 (Turkish stock market) index from January 2, 1988, to January 15, 1999	regressions with dummy variables	results indicate that calendar anomalies are still significantly existed in the ISE both in stock returns and trading volume consistent to international evidence.
Alshimmiri (2011)	January and weekend effects, Halloween Effect	Kuwait Stock Exchange Index period 1984 -2000	regressions with dummy variables	a weekend effect exists. January effect is not detected. returns during summer months (May-September) tend to be significantly higher than returns during other months of the year (October-April)
Silva (2010)	The Turn-of-the-month and the Holiday effect Weekday or the January "anomalies"	PSI-Geral and PSI20-TR, period 1998-2008	standard OLS regressions with dummies and tests for the equality of means (F-tests and Kruskal-Wallis test). T-test and the Mann-Whitney test	No Weekday or the January "anomalies". The significant "anomalies" were the Pre-holiday effect (where average returns are twelve times higher the other days' returns) and a Turn-of-the-month effect.
Wong et al (2006)	January effect, the day-of-the-week effect, the turn-of-the-month effect and holiday effect	Singapore stock market over the recent period from 1993-2005	GARCH(1,1) model; t-test for two independent samples	The findings reveal that these anomalies have largely disappeared from the Singapore stock market in recent years.

Barone (1990)	weekend and holidays, the end of the months, and the end of the year	Milan Stock Exchange's 'MIB storico' stock index period 1975–1989	regressions with dummies, average analysis	Find evidence of anomalous changes, though not all are stable over time.
Borowski (2015)	monthly, daily, the day-of-the-week, the first and the second half of monthly effects	market of rubber futures, quoted in the Tokyo Commodity Exchange period from 01.12.1981 to 31.03.2015	ANOVA	Calculations indicate the existence of monthly effect. The seasonal effects were also observed for daily averaged rates of returns for different days of the month (15th), as well as for the daily average rates of return on various days of the week (Thursday). The seasonal effects were no registered for the daily average rates of return in the first and in the second half of a month.
Carchano and Pardo Tornero (2011)	day-of-the-week, month-of-the-year, weekday, week-of-the-month, semi-month, turn-of-the-month, end-of-year, holiday-effects, semi-month-of-the-year, and week-of-the-month-of-the-year	S&P 500, DAX and Nikkei stock index futures contracts from 1991 to 2008	percentile-t-bootstrap and Monte Carlo methods	the turn-of-the-month effect in S&P 500 futures contracts is the only calendar effect that is statistically and economically significant and persistent over time.
Hansen et al (2005)	day-of-the-week, turn-of-the-year and January, turn-of-the-month, intra-month, holiday effects	stock indices from Denmark, France, Germany, Hong Kong, Italy, Japan, Norway, Sweden, United Kingdom, United States period until 2002	χ^2 test	Calendar effects are significant for returns in most of these equity markets, but end-of-the-year effects are predominant.
Caporale (2014)	day-of-the-week	35 US companies included in the Dow Jones index, 8 Blue-chip Russian companies, period 2005-2014	A Trading Robot and Fractional Integration Analysis	Anomaly cannot be exploited to make abnormal profits, and therefore it is not inconsistent with the Efficient Market Hypothesis

Appendix B

Empirical results for the Day of the Week Effect

Average analysis

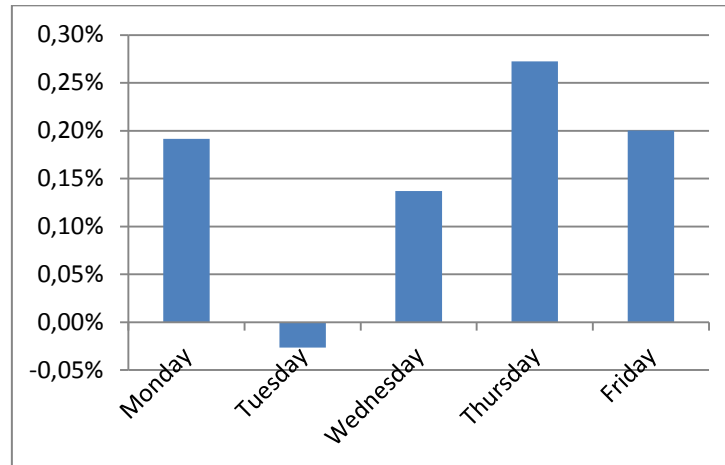


Figure B.1 – Average analysis case of PFTS index

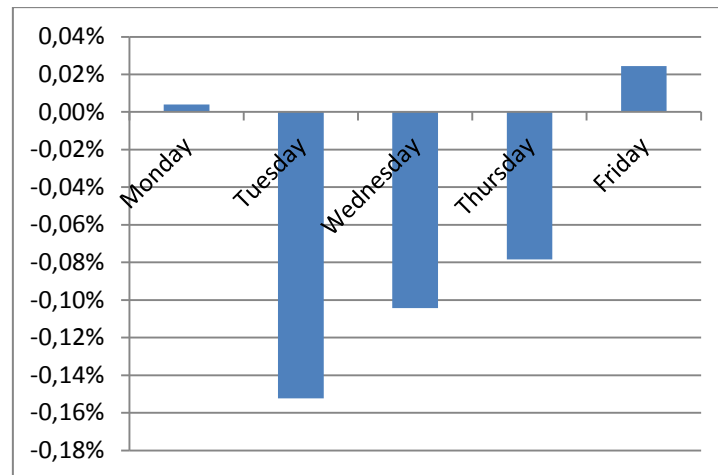


Figure B.2 – Average analysis case of UX index

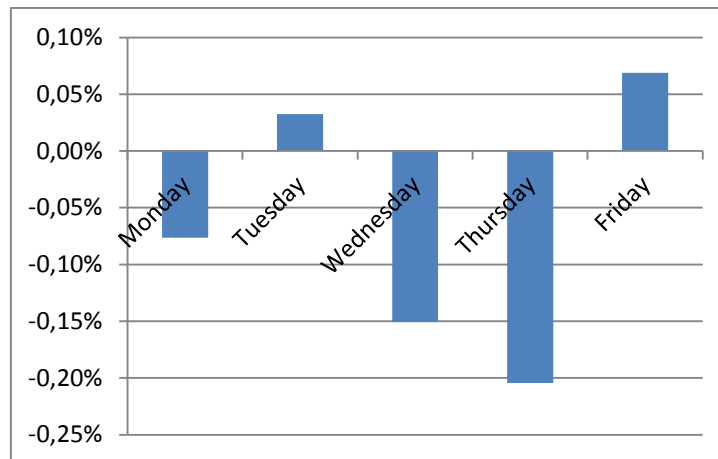


Figure B.3 – Average analysis case of UX futures

Parametric tests: Student's t-test

Table B.1: T-test of the Day of the Week Effect for PFTS index

Parameter	Monday	Tuesday	Wednesday	Thursday	Friday
Population 1 (data without day of analysis)					
Mean,%	0,15%	0,20%	0,16%	0,12%	0,14%
Standard deviation,%	2,13%	2,11%	2,16%	2,16%	2,15%
Number of observations	1623	1582	1579	1580	1588
Population 2 (data for the day of analysis)					
Mean,%	0,19%	-0,03%	0,14%	0,27%	0,20%
Standard deviation,%	2,21%	2,25%	2,06%	2,09%	2,12%
Number of observations	365	406	409	408	400
T-test results					
t-criterion	0,36	-1,84	-0,19	1,27	0,49
t-critical (p=0,95)	1,96				
Null hypothesis	Accepted	Accepted	Accepted	Accepted	Accepted

Table B.2: T-test of the Day of the Week Effect for UX index

Parameter	Monday	Tuesday	Wednesday	Thursday	Friday
Population 1 (data without day of analysis)					
Mean,%	-0,08%	-0,04%	-0,05%	-0,06%	-0,08%
Standard deviation,%	2,43%	2,45%	2,56%	2,54%	2,60%
Number of observations	1145	1118	1115	1118	1124
Population 2 (data for the day of analysis)					
Mean,%	0,00%	-0,15%	-0,10%	-0,08%	0,02%
Standard deviation,%	2,86%	2,77%	2,33%	2,43%	2,15%
Number of observations	260	287	290	287	281
T-test results					
t-criterion	0,43	-0,63	-0,34	-0,13	0,71
t-critical (p=0,95)	1,96				
Null hypothesis	Accepted	Accepted	Accepted	Accepted	Accepted

Table B.3: T-test of the Day of the Week Effect for UX index futures

Parameter	Monday	Tuesday	Wednesday	Thursday	Friday
Population 1 (data without day of analysis)					
Mean,%	-0,06%	-0,09%	-0,04%	-0,03%	-0,10%
Standard deviation,%	2,08%	2,20%	2,29%	2,34%	2,32%
Number of observations	1145	1118	1115	1118	1124
Population 2 (data for the day of analysis)					
Mean,%	-0,08%	0,03%	-0,15%	-0,20%	0,07%
Standard deviation,%	2,88%	2,42%	2,05%	1,85%	1,94%
Number of observations	260	287	290	287	281
T-test results					
t-criterion	-0,06	0,79	-0,76	-1,34	1,26
t-critical (p=0,95)	1,96				
Null hypothesis	Accepted	Accepted	Accepted	Accepted	Accepted

Parametric tests: ANOVA

Table B.4: ANOVA test of the Day of the Week Effect for PFTS index

	F	p-value	F critical	Null hypothesis
Overall	1,04	0,39	2,38	Accepted
Monday	0,60	0,44	3,85	Accepted
Tuesday	3,84	0,05	3,85	Accepted
Wednesday	0,07	0,80	3,85	Accepted
Thursday	0,45	0,50	3,85	Accepted
Friday	0,09	0,77	3,85	Accepted

Table B.5: ANOVA test of the Day of the Week Effect for UX index

	F	p-value	F critical	Null hypothesis
Overall	0,32	0,87	2,38	Accepted
Monday	0,02	0,88	3,85	Accepted
Tuesday	0,49	0,49	3,85	Accepted
Wednesday	0,02	0,89	3,85	Accepted
Thursday	0,04	0,84	3,85	Accepted
Friday	1,04	0,31	3,85	Accepted

Table B.6: ANOVA test of the Day of the Week Effect for UX futures

	F	F critical	p-value	Null hypothesis
Overall	0,77	0,55	2,38	Accepted
Monday	0,01	0,91	3,86	Accepted
Tuesday	0,60	0,44	3,86	Accepted
Wednesday	0,53	0,47	3,86	Accepted
Thursday	1,62	0,20	3,86	Accepted
Friday	1,45	0,23	3,86	Accepted

Non-parametric tests: Kruskal -Wallis test

Table B.7: Kruskal -Wallis test of the Day of the Week Effect for PFTS index

Parameter	Overall	Monday	Tuesday	Wednesday	Thursday	Friday
Adjusted H	4,32	3,59	3,56	0,04	0,04	0,26
d.f.	4	1	1	1	1	1
P value:	0,36	0,06	0,06	0,84	0,84	0,61
Critical value	9,48	3,84	3,84	3,84	3,84	3,84
Null hypothesis	Accepted	Accepted	Accepted	Accepted	Accepted	Accepted

Table B.8: Kruskal -Wallis test of the Day of the Week Effect for UX index

Parameter	Overall	Monday	Tuesday	Wednesday	Thursday	Friday
Adjusted H	2,24	0,01	0,36	0,50	1,27	0,35
d.f.	4	1	1	1	1	1
P value:	0,69	0,94	0,55	0,48	0,26	0,55
Critical value	9,48	3,84	3,84	3,84	3,84	3,84
Null hypothesis	Accepted	Accepted	Accepted	Accepted	Accepted	Accepted

Table B.9: Kruskal -Wallis test of the Day of the Week Effect for UX futures

Parameter	Overall	Monday	Tuesday	Wednesday	Thursday	Friday
Adjusted H	4,54	0,02	0,01	0,17	1,74	0,78
d.f.	4	1	1	1	1	1
P value:	0,34	0,88	0,91	0,68	0,19	0,38
Critical value	9,48	3,84	3,84	3,84	3,84	3,84
Null hypothesis	Accepted	Accepted	Accepted	Accepted	Accepted	Accepted

Regression analysis with dummy variables

Table B.10: Regression analysis with dummy variables of the Day of the Week Effect for PFTS index, UX index and UX index*

Parameter	PFTS index	UX index	UX futures
Monday (a_0)	0,0019 (0.0869)	-0,0002 (0.8680)	-0,0008 (0.5870)
Tuesday (a_1)	-0,0022 (0.1587)	-0,0012 (0.4700)	0,0012 (0.5331)
Wednesday (a_2)	-0,0004 (0.7763)	-0,0003 (0.8612)	0,0002 (0.9048)
Thursday (a_3)	0,0007 (0.6593)	-0,0005 (0.7478)	-0,0007 (0.7126)
Friday (a_4)	0,0001 (0.9542)	0,0006 (0.7370)	0,0029 (0.1414)
F-test	1,04 (0.3868)	0,32 (0.8653)	1,01 (0.4004)
Multiple R	0,05	0,03	0,06
Anomaly	Not confirmed	Not confirmed	Not confirmed

* P-values are in parentheses

Appendix C

Empirical results for the Turn of the Month Effect

Average analysis

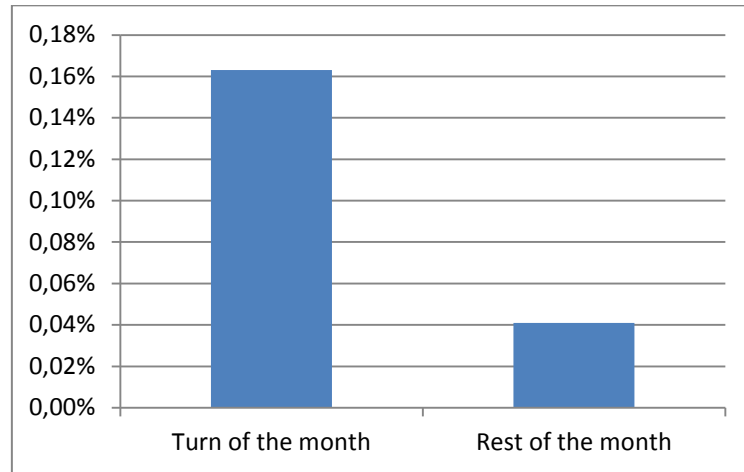


Figure C.1 – Average analysis case of PFTS index

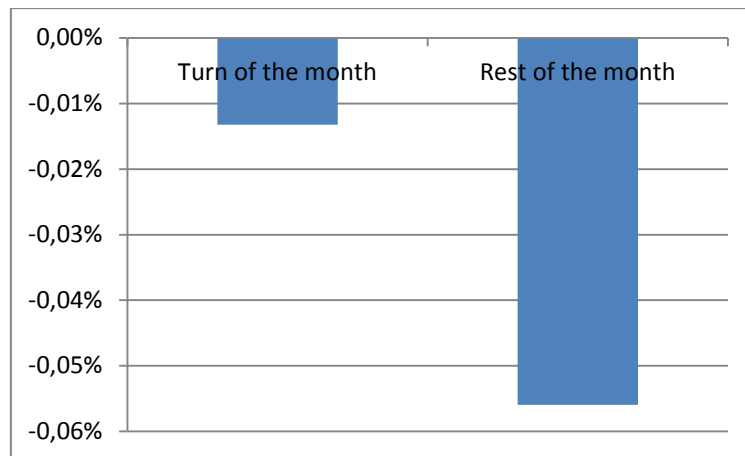


Figure C.2 – Average analysis case of UX index

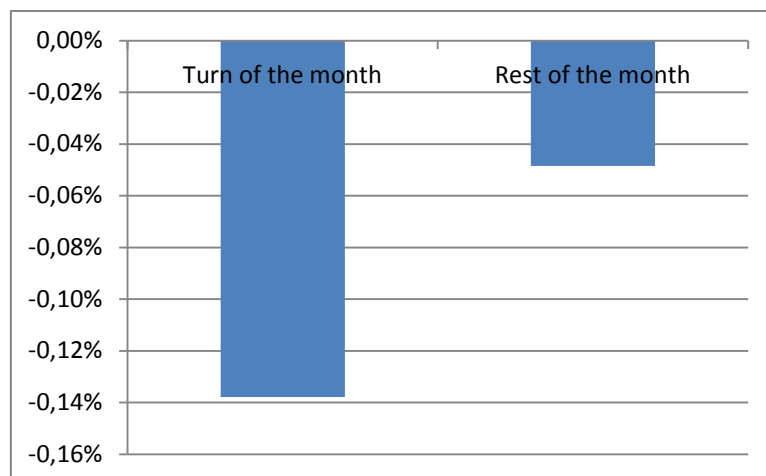


Figure C.3 – Average analysis case of UX futures

Parametric tests: Student's t-tests

Table C.1: T-test of the Turn of the Month Effect for PFTS index, UX index and UX futures

Parameter	PFTS index		UX index		UX futures	
	Turn of the month [-1+3]	Rest of the month [+4-2]	Turn of the month [-1+3]	Rest of the month [+4-2]	Turn of the month [-1+3]	Rest of the month [+4-2]
Mean,%	0,16%	0,04%	-0,01%	-0,06%	-0,14%	-0,05%
Standard deviation,%	2,31%	1,82%	2,40%	2,28%	2,24%	2,25%
Number of observations	680	2840	380	1610	270	1134
t-criterion	1,29		0,31		0,59	
t-critical (p=0,95)	1.96		1.96		1.96	
Null hypothesis	Accepted		Accepted		Accepted	

Parametric tests: ANOVA

Table C.2: ANOVA test of the Turn of the Month Effect for PFTS index, UX index and UX index

Instrument	F	p-value	F critical	Null hypothesis
PFTS index	2,22	0,14	3,84	Accepted
UX index	0,11	0,74	3,85	Accepted
UX futures	0,35	0,56	3,85	Accepted

Non-parametric tests: Kruskal -Wallis test

Table C.3: Kruskal -Wallis test of the Turn of the Month Effect for PFTS index, UX index and UX index

Instrument	Adjusted H	d.f.	P value:	Critical value	Null hypothesis
PFTS index	0,06	1	0,81	3.84	Accepted
UX index	0,02	1	0,89	3.84	Accepted
UX futures	0,21	1	0,65	3.84	Accepted

Regression analysis with dummy variables

Table C.4: Regression analysis with dummy variables of the Turn of the Month Effect for PFTS index, UX index and UX index*

Parameter	PFTS index	UX index	UX futures
Turn of the Month (a_0)	0,0016 (0.03)	-0,0001 (0.91)	-0,0014 (0.31)
Rest of the Month (a_1)	-0,0012 (0.14)	-0,0004 (0.74)	0,0009 (0.56)
F-test	2,22 (0.14)	0,11 (0.74)	0,35 (0.55)
Multiple R	0,03	0,01	0,02
Anomaly	Confirmed	Not confirmed	Not confirmed

* P-values are in parentheses

Appendix D

Empirical results for the Turn of the Year Effect

Average analysis

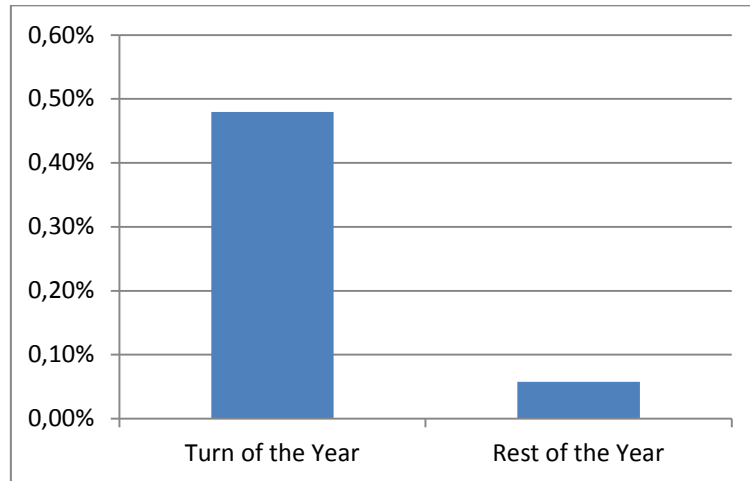


Figure D.1 – Average analysis case of PFTS index

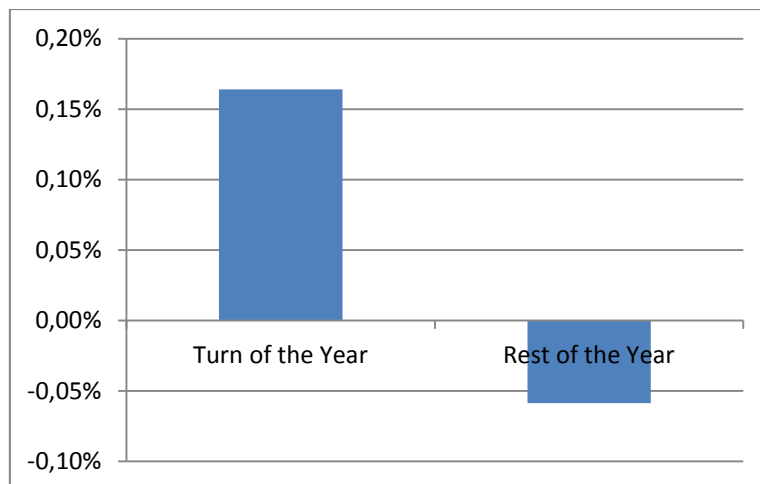


Figure D.2 – Average analysis case of UX index

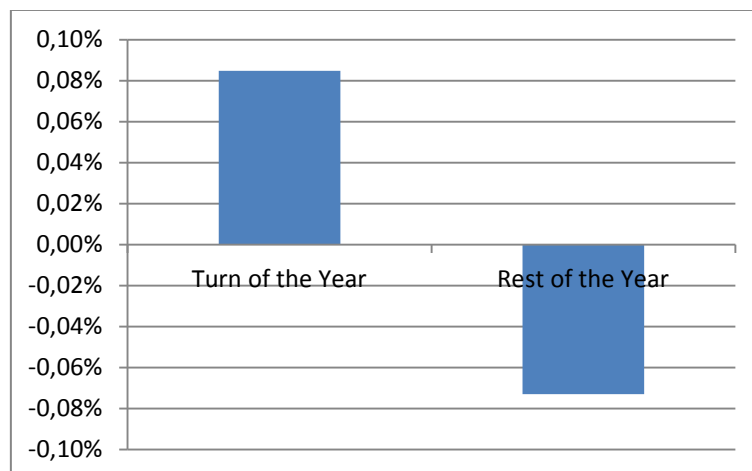


Figure D.3 – Average analysis case of UX futures

Parametric tests: Student's t-tests

Table D.1: T-test of the Turn of the Year Effect for PFTS index, UX index and UX futures

Parameter	PFTS index		UX index		UX futures	
	Turn of the Year	Rest of the Year	Turn of the Year	Rest of the Year	Turn of the Year	Rest of the Year
Mean,%	0,48%	0,06%	0,16%	-0,06%	0,08%	-0,07%
Standard deviation,%	2,29%	1,95%	1,35%	2,34%	1,30%	2,28%
Number of observations	680	2840	98	1898	62	1345
t-criterion	4.43		1.52		0.89	
t-critical (p=0,95)	1.96		1.96		1.96	
Null hypothesis	Rejected		Accepted		Accepted	

Parametric tests: ANOVA

Table D.2: ANOVA test of the Turn of the Year Effect for PFTS index, UX index and UX index

Instrument	F	p-value	F critical	Null hypothesis
PFTS index	8,94	0,00	3,84	Rejected
UX index	0,87	0,35	3,85	Accepted
UX futures	0,29	0,59	3,85	Accepted

Non-parametric tests: Kruskal-Wallis test

Table D.3: Kruskal -Wallis test of the Turn of the Year Effect for PFTS index, UX index and UX index

Instrument	Adjusted H	d.f.	P value:	Critical value	Null hypothesis
PFTS index	4,10	1	0,04	3.84	Rejected
UX index	0,85	1	0,36	3.84	Accepted
UX futures	0,51	1	0,47	3.84	Accepted

Regression analysis with dummy variables

Table D.4: Regression analysis with dummy variables of the Turn of the Year Effect for PFTS index, UX index and UX index*

Parameter	PFTS index	UX index	UX futures
Turn of the Year (a_0)	0,0048 (0.0008)	0,0016 (0.48)	0,0008 (0.76)
Rest of the Year (a_1)	-0,0044 (0.0028)	-0,0022 (0.35)	-0,0016 (0.59)
F-test	8,94 (0.0028)	0,87 (0.35)	0,29 (0.59)
Multiple R	0,05	0,02	0,01
Anomaly	Confirmed	Not confirmed	Not confirmed

* P-values are in parentheses

Appendix E

Month of the Year Effect

Empirical results for the Month of the Year Effect

Average analysis

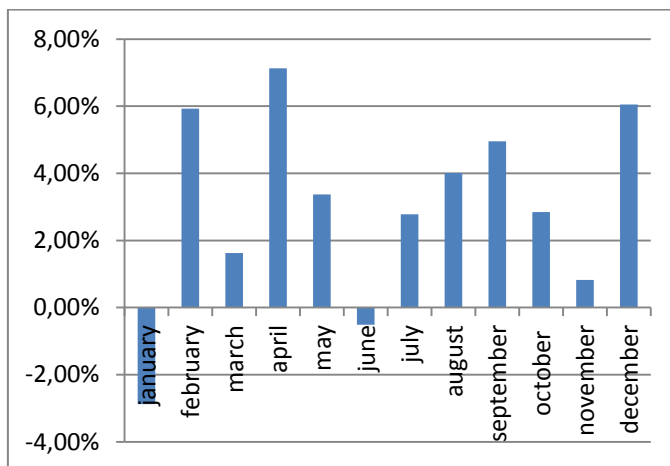


Figure E.1 – Average analysis case of PFTS index

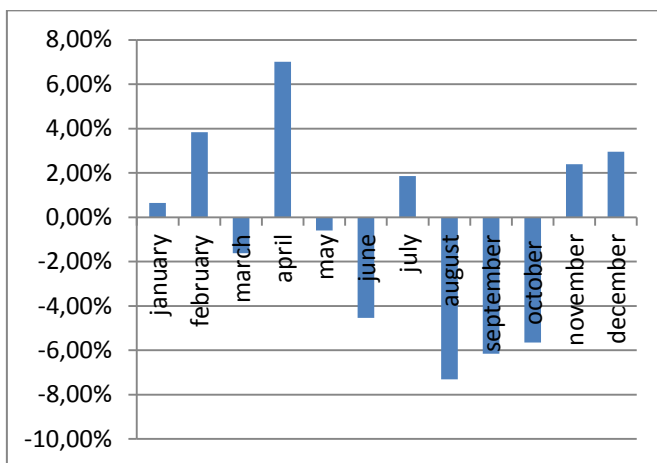


Figure E.2 – Average analysis case of UX index

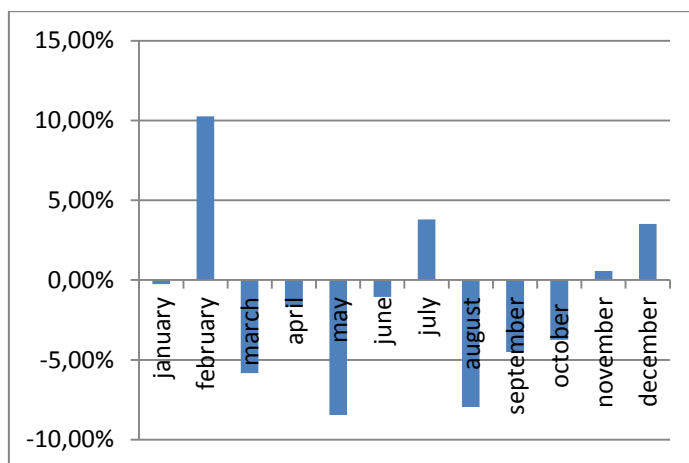


Figure E.3 – Average analysis case of UX futures

Parametric tests: Student's t-tests

Table E.1: T-test of the Month of the Year Effect (t-critical (p=0,95) = 2.15)

Month	PFTS index		UX index		UX futures	
	t-criterion	Null hypothesis	t-criterion	Null hypothesis	t-criterion	Null hypothesis
January	-1,50	Accepted	0,55	Accepted	0,64	Accepted
February	0,68	Accepted	1,11	Accepted	4,30	Rejected
March	-0,43	Accepted	-0,28	Accepted	-2,85	Rejected
April	0,92	Accepted	1,46	Accepted	-0,27	Accepted
May	0,17	Accepted	0,00	Accepted	-1,76	Accepted
June	-1,58	Accepted	-2,22	Rejected	0,29	Accepted
July	-0,08	Accepted	0,98	Accepted	3,68	Rejected
August	0,27	Accepted	-2,42	Rejected	-3,12	Rejected
September	0,52	Accepted	-1,57	Accepted	-1,52	Accepted
October	-0,06	Accepted	-1,71	Accepted	-1,34	Accepted
November	-0,91	Accepted	1,12	Accepted	0,77	Accepted
December	0,74	Accepted	1,66	Accepted	1,51	Accepted

Parametric tests: ANOVA

Table E.4: ANOVA test of the Month of the Year Effect for PFTS index

	F	p-value	F critical	Null hypothesis
Overall	0,67	0,77	1,85	Accepted
January	2,03	0,17	4,23	Accepted
February	0,44	0,51	4,23	Accepted
March	0,16	0,69	4,23	Accepted
April	0,77	0,39	4,23	Accepted
May	0,02	0,88	4,23	Accepted
June	2,46	0,13	4,23	Accepted
July	0,00	0,95	4,23	Accepted
August	0,07	0,80	4,23	Accepted
September	0,25	0,62	4,23	Accepted
October	0,00	0,96	4,23	Accepted
November	0,66	0,43	4,23	Accepted
December	0,51	0,48	4,23	Accepted

Table E.5: ANOVA test of the Month of the Year Effect for UX index

	F	p-value	F critical	Null hypothesis
Overall	0,91	0,54	1,90	Accepted
January	0,14	0,71	4,60	Accepted
February	0,64	0,44	4,60	Accepted
March	0,04	0,84	4,60	Accepted
April	1,19	0,29	4,60	Accepted
May	0,00	1,00	4,60	Accepted
June	1,88	0,19	4,60	Accepted
July	0,50	0,49	4,60	Accepted
August	3,06	0,10	4,60	Accepted
September	1,36	0,26	4,60	Accepted
October	1,57	0,23	4,60	Accepted
November	0,61	0,45	4,60	Accepted
December	1,30	0,27	4,60	Accepted

Table E.6: ANOVA test of the Month of the Year Effect for UX futures

	F	p-value	F critical	Null hypothesis
Overall	2,03	0,04	1,96	Accepted
January	0,16	0,69	5,12	Accepted
February	8,08	0,02	5,12	Rejected
March	3,59	0,09	5,12	Accepted
April	0,06	0,81	4,96	Accepted
May	1,39	0,27	4,96	Accepted
June	0,05	0,83	4,96	Accepted
July	6,44	0,03	4,96	Rejected
August	4,38	0,06	4,96	Accepted
September	1,08	0,32	4,96	Accepted
October	0,89	0,37	4,96	Accepted
November	0,25	0,63	4,96	Accepted
December	0,99	0,34	4,96	Accepted

Non-parametric tests: Kruskal-Wallis test

Table E.7: Kruskal-Wallis test of the Month of the Year Effect for PFTS index

	Adjusted H	d.f.	P value	Critical value	Null hypothesis
Overall	8,09	11	0,71	19,68	Accepted
January	4,09	1	0,04	3,84	Rejected
February	0,41	1	0,52	3,84	Accepted
March	0,00	1	0,96	3,84	Accepted
April	0,14	1	0,71	3,84	Accepted
May	0,21	1	0,65	3,84	Accepted
June	3,21	1	0,07	3,84	Accepted
July	0,30	1	0,58	3,84	Accepted
August	0,54	1	0,46	3,84	Accepted
September	0,03	1	0,85	3,84	Accepted
October	0,01	1	0,93	3,84	Accepted
November	0,76	1	0,38	3,84	Accepted
December	0,01	1	0,93	3,84	Accepted

Table E.8: Kruskal-Wallis test of the Month of the Year Effect for UX index

	Adjusted H	d.f.	P value	Critical value	Null hypothesis
Overall	12,76	11	0,31	19,68	Accepted
January	0,04	1	0,83	3,84	Accepted
February	2,48	1	0,12	3,84	Accepted
March	1,33	1	0,25	3,84	Accepted
April	0,89	1	0,34	3,84	Accepted
May	0,01	1	0,92	3,84	Accepted
June	1,10	1	0,29	3,84	Accepted
July	1,33	1	0,25	3,84	Accepted
August	2,82	1	0,09	3,84	Accepted
September	1,10	1	0,29	3,84	Accepted
October	0,71	1	0,40	3,84	Accepted
November	0,71	1	0,40	3,84	Accepted
December	0,89	1	0,34	3,84	Accepted

Table E.9: Kruskal-Wallis test of the Month of the Year Effect for UX futures

	Adjusted H	d.f.	P value	Critical value	Null hypothesis
Overall	19,39	11	0,05	19,68	Accepted
January	0,01	1	0,92	3,84	Accepted
February	4,80	1	0,03	3,84	Rejected
March	1,32	1	0,25	3,84	Accepted
April	0,03	1	0,87	3,84	Accepted
May	1,26	1	0,26	3,84	Accepted
June	0,41	1	0,52	3,84	Accepted
July	3,69	1	0,05	3,84	Accepted
August	5,03	1	0,02	3,84	Rejected
September	0,92	1	0,34	3,84	Accepted
October	0,10	1	0,75	3,84	Accepted
November	1,26	1	0,26	3,84	Accepted
December	0,92	1	0,34	3,84	Accepted

Regression analysis with dummy variables

Table E.10: Regression analysis with dummy variables of the Month of the Year Effect for PFTS index, UX index and UX futures *

Parameter	PFTS index	UX index	UX futures
January (a_0)	-0,0288 (0.4215)	0,0065 (0.8920)	-0,0025 (0.9504)
February (a_1)	0,0880 (0.0832)	0,0318 (0.6363)	0,1051 (0.0666)
March (a_2)	0,0450 (0.3737)	-0,0227 (0.7363)	-0,0558 (0.3244)
April (a_3)	0,1000 (0.0493)	0,0636 (0.3457)	-0,0143 (0.7912)
May (a_4)	0,0624 (0.2185)	-0,0125 (0.8531)	-0,0820 (0.1331)
June (a_5)	0,0237 (0.6401)	-0,0519 (0.4413)	-0,0080 (0.8820)
July (a_6)	0,0566 (0.2642)	0,0120 (0.8580)	0,0406 (0.4540)
August (a_7)	0,0688 (0.1748)	-0,0795 (0.2393)	-0,0770 (0.1580)
September (a_8)	0,0783 (0.1230)	-0,0681 (0.3131)	-0,0425 (0.4329)
October (a_9)	0,0572 (0.2589)	-0,0630 (0.3501)	-0,0350 (0.5178)
November (a_{10})	0,0370 (0.4645)	0,0175 (0.7950)	0,0082 (0.8798)
December (a_{11})	0,0893 (0.0789)	0,0231 (0.7319)	0,0377 (0.4559)
F-test	0,67 (0.7685)	0,91 (0.5367)	2,03 (0.0418)
Multiple R	0,21	0,33	0,53
Anomaly	Partially confirmed	Not confirmed	Not confirmed

Appendix F

Empirical results for the Holiday Effect

Average analysis

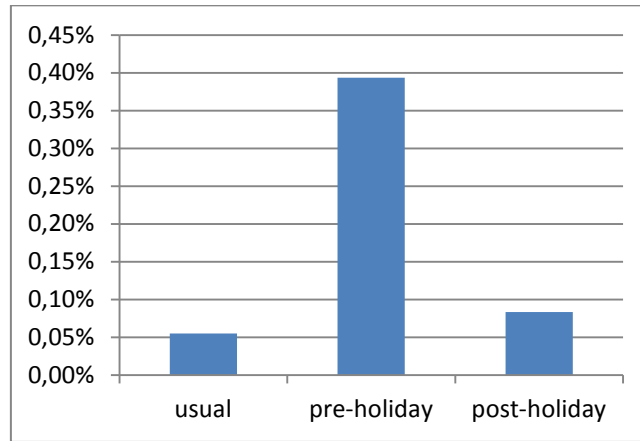


Figure F.1 – Average analysis case of PFTS index

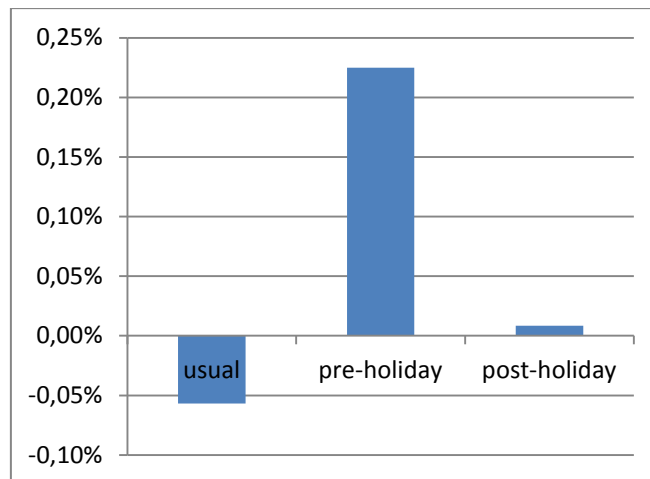


Figure F.2 – Average analysis case of UX index

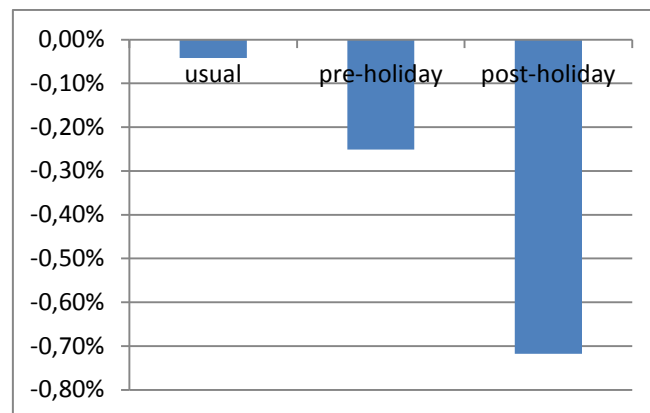


Figure F.3 – Average analysis case of UX futures

Parametric tests: Student's t-tests

Table F.1: T-test of the Holiday Effect for PFTS index, UX index and UX futures (t-critical ($p=0,95$) = 1.96)

Parameter	PFTS index		UX index		UX futures	
	t-criterion	Null hypothesis	t-criterion	Null hypothesis	t-criterion	Null hypothesis
Pre-holiday	1,10	Accepted	1,04	Accepted	0,98	Accepted
Post-holiday	0,12	Accepted	0,15	Accepted	-1,70	Accepted

Parametric tests: ANOVA

Table F.2: ANOVA test of the Holiday Effect for PFTS index, UX index and UX futures

Instrument	F	p-value	F critical	Null hypothesis
PFTS index	1,37	0,25	3,00	Accepted
UX index	0,40	0,67	3,00	Accepted
UX futures	1,81	0,16	3,00	Accepted

Non-parametric tests: Kruskal -Wallis test

Table F.3: Kruskal -Wallis test of the Holiday Effect for PFTS index, UX index and UX futures

Instrument	Adjusted H	d.f.	P value:	Critical value	Null hypothesis
PFTS index	0,08	2	0,96	5,99	Accepted
UX index	1,74	2	0,42	5,99	Accepted
UX futures	5,33	2	0,07	5,99	Accepted

Regression analysis with dummy variables

Table F.4: Regression analysis with dummy variables of the Holiday Effect for PFTS index, UX index and UX futures *

Parameter	PFTS index	UX index	UX futures
Usual (a_0)	0,0006 (0.10)	-0,0006 (0.28)	-0,0004 (0.49)
Pre-holiday (a_1)	0,0034 (0.10)	0,0028 (0.38)	-0,0021 (0.57)
Post-holiday (a_2)	0,0003 (0.89)	0,0007 (0.84)	-0,0068 (0.07)
F-test	1,37 (0.25)	0,40 (0.67)	1,81 (0.16)
Multiple R	0,03	0,02	0,05
Anomaly	Not confirmed	Not confirmed	Not confirmed

* P-values are in parentheses

Appendix G

Empirical results for the Halloween Effect

Average analysis

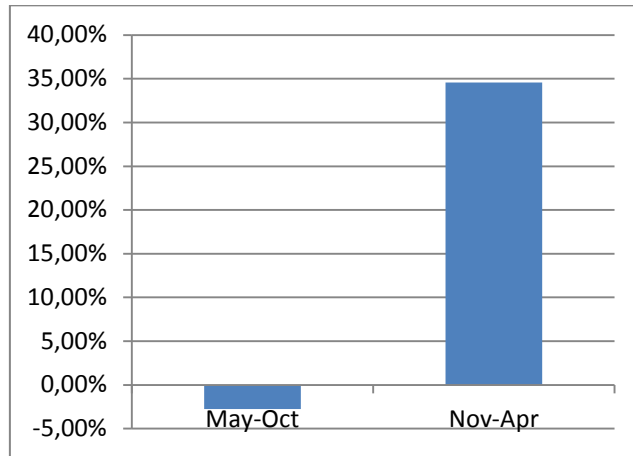


Figure G.1 – Average analysis case of PFTS index

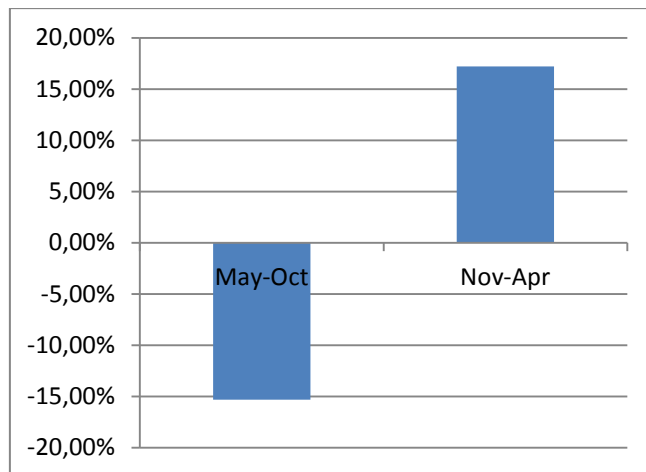


Figure G.2 – Average analysis case of UX index

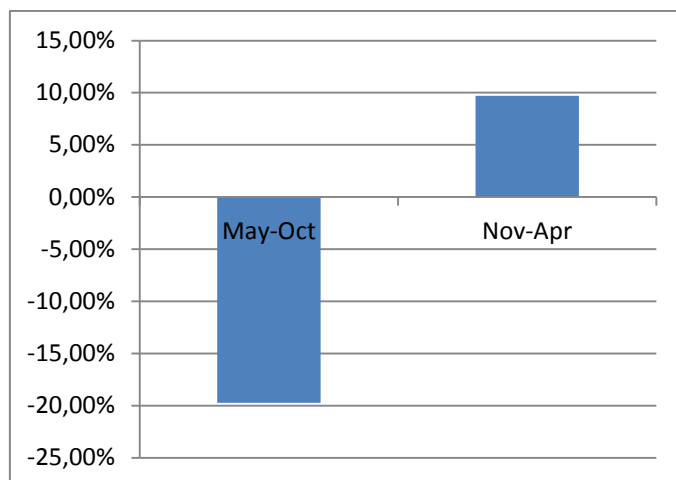


Figure G.3 – Average analysis case of UX futures

Parametric tests: Student's t-test

Table G.1: T-test of the Halloween Effect for PFTS index, UX index and UX futures

Instrument	PFTS index		UX index		UX futures	
	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr
Mean,%	-2,73%	34,58%	-15,30%	17,21%	-19,73%	9,70%
Standard deviation,%	38,50%	43,31%	44,55%	34,34%	22,27%	23,53%
Number of observations	14	14	8	8	6	5
t-criterion	2.41		1.63		2.11	
t-critical (p=0,95)	2.14		2.3		2.45	
Null hypothesis	Rejected		Accepted		Accepted	

Parametric tests: ANOVA

Table G.2: ANOVA test of the Month of the Year Effect for PFTS index

Instrument	F	p-value	F critical	Null hypothesis
PFTS index	5,80	0,02	4,23	Rejected
UX index	2,67	0,12	4,60	Accepted
UX futures	4,53	0,06	5,12	Accepted

Non-parametric tests: Kruskal -Wallis test

Table G.3: Kruskal -Wallis test of the Holiday Effect for PFTS index, UX index and UX futures

Instrument	Adjusted H	d.f.	P value:	Critical value	Null hypothesis
PFTS index	3,55	1	0,06	3,84	Accepted
UX index	3,19	1	0,07	3,84	Accepted
UX futures	2,70	1	0,10	3,84	Accepted

Regression analysis with dummy variables

Table G.4: Regression analysis with dummy variables of the Holiday Effect for PFTS index, UX index and UX futures *

Parameter	PFTS index	UX index	UX futures
May-Oct (a_0)	-0,03 (0.80)	-0,15 (0.29)	-0,20 (0,06)
Nov-Apr (a_1)	0,37 (0.02)	0,33 (0.12)	0,29 (0,06)
F-test	5,80 (0.02)	2,67 (0.12)	4,53 (0,06)
Multiple R	0,43	0,40	0,58
Anomaly	Confirmed	Not confirmed	Not confirmed

* P-values are in parentheses