Research of the Calendar Effects in Stock Returns

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Abstract. In this article we investigate the problem of detection of the statistically significant dependences of stock trading return, which occur in particular days of the month and which could be important for creating profitable investment strategies. This problem is formulated as two hypotheses, stating that the stock trading return of the last five days of the month is greater than the average total monthly return, and the return generated over the first half of the month is significantly larger than that of the second half. By using the advanced methods of statistical analysis we researched the indications of these calendar effects for 24 stocks of the Vilnius stock exchange. The investigation did not fully confirm any of the hypotheses, but found out strong relation of risk level to the researched periods of the month. We explored the dependency of this effect to the volatility and volume of the traded stocks. The research results revealed that stocks of small and moderate volume have high volatility on the last days of the month, and the stocks of high volume have high volatility on the first part of month.

Keywords: calendar effect, F-test, mean return, Kolmogorov-Smirnov test, stock market.

1 Introduction

The profitablity of the financial markets is one of the most complicated scientific problems, which attract the attention of numerous researchers. The two main research directions include technical and fundamental analysis. The methods of technical analysis investigate influence of historical prices deviation and price shape regularity [1]. The supporters of the fundamental analysis concentrate attention to development of the financial indicators, which could evaluate stock price changes, and reveal the underlying reasons of the stock price fluctuations [2].

Any of these approaches can be given priority by their forecasting results, achieved by numerous researchers. The observed phenomena of price dynamics or their anomalies can be explained only by the integrative application of both methods.

One group of such phenomena is based of exploring various calendar effects, which could be employed for modelling profitable investment strategies and reducing risk of investment.

The biggest attention of the researchers is aimed at the influence of the day-of-the-week anomaly. Most researchers' state that on Mondays mean returns are lower, contrarily to Fridays, when the bigger returns are more likely, comparing to the other days of the week. [3-13].

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By analysing the mean return anomalies related to the monthly periods, researchers have notified several anomalies: the January effect, distinguished by the largest stock returns as compared to the returns of the other months; the turn-of-the-month effect, where the average return of the last days of the month is greater than the average total monthly return; the intramonth effect with the significantly larger mean return of the first half of a month than the mean return of the second half [14-17].

A great variety of the statistical analysis techniques have been employed by numerous researchers in order to detect such anomalies, and to use them for profitable investment strategies. The most prevalent of them are traditional statistical investigation methods, such as t-test, ANOVA, regression analysis or some advanced methods on influence of higher moments of mean return distribution [8-11]. In recent years the methods of discriminant analysis and artificial neural networks were applied for the identification of calendar anomalies [3,4].

A number of scientific papers [10,18-20] have disclosed that from 1990's calendar effect has faded away. Yet this tendency was not supported by the results obtained of the research of the young emerging stock markets with less available historical data and bigger fluctuations of the financial indicators. Aggarwal and Rivoli [21] studied four Asian emerging stock markets (Hong Kong, Singapore, Korea, Taiwan) and found that the day-of-the-week effect existed in all four markets. The extensive study of 21 emerging stock markets by Syed A. Basher and Perry Sadorsky [13], could not confirm the effect for all the markets, but most of them exhibited strong day-of-the-week effects even for the research model with the conditional market risk included. In [3] the research by the authors revealed that in the Vilnius Stock Exchange only approximately 30% of stocks are influenced by the day of the week effect.

In this work we examine the influence of turn-of-the-month and intramonth effects for the stocks traded in the Vilnius Stock Exchange [22], by analysing Index and return data of 24 most actively traded equities from the time interval 2003-01-01 to 2008-01-14. The computational methods include traditional statistical analysis, based on research of differences of mean return and standard deviation, calculated for the corresponding parts of the month, and the methods based on analysis of the higher moments. The following three main research tasks were aimed:

- to reveal the presence of turn-of-the-month and intramonth effects for various stocks traded in the Vilnius stock exchange,
- to analyse whether the strength of effect depends on daily turnover of the security and
- to investigate influence of the higher moments to the mean return distribution on this effect.

In the next section the organization of research data set is presented, and the investigation methodology is defined. Then in section 3 the research results of the application of traditional analysis methods, such as t-test, one-way ANOVA, Levene and Brown-Forsythe test of homogeneity of variances, are analysed. Also this section covers the results of application of nonparametric statistics. The significance of the turn-of-the-month and intramonth effect is evaluated by using tests of Kolmogorov-Smirnov and Mann-Whitney U. The research outcomes and conclusions are covered in Section 4.

2 Data and Methodology

The data for empirical research was driven from information base of Vilnius Stock Exchange which belongs to NASDAQ OMX Group (NASDAQ OMX, 2009 [20]). The NASDAQ OMX stock exchanges in Tallinn, Riga and Vilnius compound the Baltic Market for implementing the core idea to minimize to the possible extent the differences between the three Baltic markets, facilitate cross-border trading, and to attract more investments to the region [22]. Vilnius Stock Exchange belongs to the category of small emerging securities markets as it is expressed by its main financial indicators: market value of 7 billion EUR, share trading value- near 2 million EUR per business day, number of trade transactions per business day of approximately 600, the total equity list consisting of 44 shares.

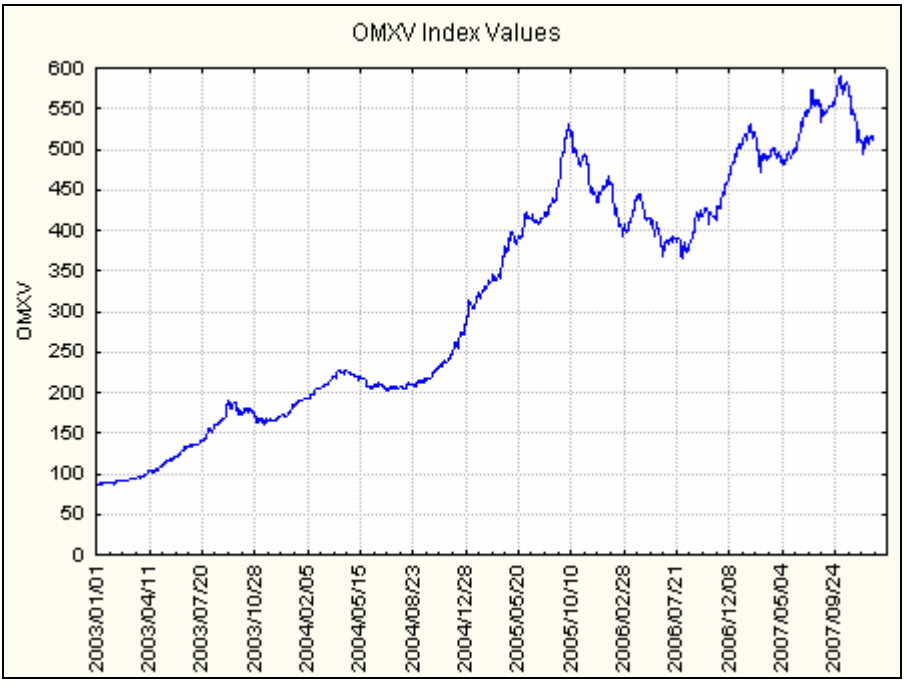

Fig. 1. OMXV Index Values from 2003.01.01-2008.01.14

The Vilnius Stock Exchange is mirrored by the OMX Vilnius Stock Index, which is a capitalization weighted chain linked total-return index. It is calculated on a continuous basis using the most recent prices of all shares that are listed on the Vilnius Stock Exchange. The dynamics of the stock prices during the period of analysis can be summarized by the profile of OMX Vilnius Stock Index (Fig.1), where big variety of economical situations is well reflected. In Fig.1 the period of 2003.01 to 2005.10 can be characterized by the increase of average stock prices, which went up to about 5 times with moderate fluctuations. Starting from 2005.10 till 2006.08 was the period of quite harsh decrease, followed by significant increase of price level during the whole

following year. At the same time the price volatility increased as well. The stock market price crisis of the end of 2007 had major influence on theVilnius Stock Exchange in Lithuania. The recent period of more stable stock price level still shows quite big price fluctuations.

To identify the presence of turn-of-the-month and intramonth effects we used the data of daily return values of actively traded 24 shares (out of 44 listed), from the period of 2003-01-01 till 2008-01-14. The selected shares represent the variety of the Vilnius Stock Exchange equity list by capitalization, daily turnover, trade volume, return and risk. The selected time span of historical development for designing the database of the stock trading records substantiates the validity of the experimental research, as it covers sufficient amount of financial data and wide variety of real trading situations in the analysed financial market.

In the paper the logarithmic understanding of return is applied $R_t = \ln(P_t / P_{t-1})$, where return R_t of time moment *t,* is evaluated by logarithmic difference of stock price over time interval [t-1,t]. P_t indicates stock price at time moment *t*.

The return values of 24 equities were assigned to the variables, named correspondingly to their symbolic notation of Vilnius Stock Exchange.

The data cleansing procedures of the stock information time series included removal of non-trading records during the holidays or weekends, and the records of the trading days with zero number of deals. After processing the data set, the average number of daily trading records for each share was approximately 1100, thus ensuring the necessary amount of experimental data for getting significant findings. For mining the data and calculations we used STATISTICA and MS EXCEL software [23].

We prepared two sets of stock trading data. The first list (I) is used for the research of turn-of-the-month effect, and it contains data of each stock, assigned to two variables. The computed values of average daily return of the starting 25 days of the month are assigned to the first variable, and the values of average daily return of the last five days of the month make the second variable. The other list (II) is designed in a similar way for validation of the intramonth effect. The first variable of this list denotes the average daily return computed for the first half of the month and the second variable – mean value computed for the last half of the month. The corresponding variables of the first list will be marked by the symbolic notation of the stock, followed by 1, and adding the 2 for the variables of the list II. E.g. Index1_2 denotes average daily return of the OMXV index values during last 5 days of the month, and the TEO2_1 denotes average daily return of the first half of the month, calculated for the stocks of TEO company.

Our goal was to check, if the turn-of-the-month and intramonth effects had influence on the profitability and volatility of stocks, and if these effects could be related to the trading volume of stocks, by observing the occurrence of the effects in groups, formed of stocks according to different trading volumes.

The difference in trading volume of the stocks was quite evident, as the daily turnover of the stocks LEL and KBL was up to 15 thousand LTL (1 EUR=3.45 LTL), and the TEO stock trading turnover reached 700 thousand LTL. Therefore the set of stocks was sorted, and arranged into three groups according to their daily turnover data (Table 1).

The initial analysis by summary statistics of the data set revealed quite big differences of average daily volatility among the variables of the list I, as contrarily to list II, where the differences among values of mean return and the standard deviation were insignificant for both parts of the month (Table1).

Table 1. The summary statistics of occurrence of turn-of-the-month and intramonth effects

Variable	Descriptive Statistics							
	I part Mean	II part Mean	I part Std.D.	II part Std.D.	I half Mean	II half Mean	I half Std.D.	II half Std.D.
Index	0,122	0,097	0,258	0,731	0,149	0,089	0,316	0,334
LEL	0,249	-0,130	0,700	1,540	0,289	0,147	1,029	0,953
KBL	0,032	-0,394	0,798	2,716	-0,043	-0,235	2,121	1,229
LNS	0,003	-0,021	1,000	2,340	-0,156	0,068	1,246	0,963
LEN	0,118	-0,123	0,588	1,757	0,040	0,191	0,620	0,885
VBL	0,175	-0,061	0,697	2,105	0,235	-0,058	0,940	0,957
LJL	0,120	0,042	0,490	1,990	0,084	0,145	0,604	0,743
LLK	0,104	0,810	0,768	2,318	0,005	0,272	2,042	1,730
Average I	0,115	0,017	0,720	2,109	0,065	0,076	1,229	1,066
KJK	0,270	0,349	1,349	2,641	0,097	0,415	2,161	2,212
ZMP	0,112	-0,327	0,680	1,297	0,070	0,081	0,840	1,054
LDJ	0,087	-0,099	0,453	1,212	0,025	0,094	0,595	0,514
RST	0,132	0,045	0,456	2,339	0,228	0,036	0,635	0,746
UTR	-0,205	0,152	0,817	2,025	-0,031	-0,128	0,773	1,057
NDL	0,504	-0,499	2,261	3,381	0,032	0,437	3,279	2,318
SAN	0,163	0,248	2,557	1,471	0,426	-0,000	1,795	2,682
KNF	0,020	-0,054	0,472	0,923	0,020	-0,018	0,543	0,622
PTR	0,440	0,482	1,284	3,278	0,765	0,425	1,865	2,159
PZV	0,159	0,071	0,456	1,227	0,157	0,118	0,554	0,461
Average II	0,168	0,037	1,079	1,979	0,179	0,146	1,304	1,382
APG	0,185	0,363	1,592	1,649	0,105	0,579	2,782	1,571
MNF	0,234	0,262	0,560	1,455	0,256	0,169	0,978	0,684
SNG	-0,154	0,154	1,326	1,384	-0,609	-0,043	5,127	0,604
UKB	-0,261	0,212	3,983	2,440	-0,869	0,226	8,318	1,204
RSU	-0,005	-0,249	1,139	1,081	-0,365	0,030	3,746	0,585
LFO	0,535	-0,218	2,705	2,461	0,446	0,462	3,593	2,385
TEO	0,081	0,065	0,392	0,893	0,090	0,061	0,419	0,575
Average II	0,088	0,084	1,671	1,623	-0,135	0,212	3,566	1,087

The results mean that the turn-of-the-month effect does not directly influence neither OMXV index, nor mean return values of separate stocks. But it is quite obvious that average volatility of the last days of the month is much higher, as compared to the starting 25 days of the month. This observation is not so evident for the stocks with

high trading volume, where there was only slight difference among the mean values of the standard deviation calculated for the last days and the remaining part of the month. The analysis of the list II variables showed that the trading risk on the first half of the month comparing to the second half was evidently more high for the stocks with the highest trading volume (Table 1). Those outcomes confirmed the general observation that the biggest speculative trading transactions in the Vilnius Stock Exchange were performed for the stocks with the highest turnover and best liquidity, and they tend to occur in the first half of the month.

The main research tasks and the influence of the initial observations are further discussed and analysed by applying methods of the statistical analysis.

3 Statistical Investigations

The analysis of the impact of the turn-of-the-month and the intramonth effects included the application of the traditional statistical methods, such as t-test, one-way ANOVA, Levene and Brown-Forsythe test of homogeneity of variances. Further the nonparametric Kolmogorov-Smirnov test, used for analysis of impact of the higher moments of return distribution was applied.

The initial analysis by the application of the t-test was used to check presence of the turn-of-the-month and intramonth effects for daily mean return. As it was already hinted by the results displayed in Table 1, where there was only a very slight difference among the values of average mean return, the t-test did not denote any significant results for any of the 24 stocks from the data set and for any of the explored effects. Only one stock (ZMP), was marked for the possible impact of turn-of-the-month effect with the significance level $p=0.0125$. The possibility to apply this analysis criteria was checked by the Shapiro-Wilk W test for normality.

The following step of the research was to analyse the impact of the turn-of-the-month and intramonth effects for the volatility of the variables. The summary table of F-test results indicating significance of the differences of standard variation is presented in Table 2. In the Table 2 the occurrence of the significant effect is marked in bold, therefore we can summarize that the turn-of-the-month effect has impact for all the stock from the groups of low and medium trading volume, but only for the few stocks which belong to the group of high volume.

The opposite results were revealed by analysing the intramonth effect. The significant difference of volatility was indicated only for the group of high volume stocks. Only few stocks of lower volume group were marked as affected by this calendar anomaly, according to the higher variance in the first half of the month (the stocks KBL, LEN, UTR and SAN).

How can changes in volatility and the periods of the month be interrelated, it is not clearly evident merely by data analysis. There could be a psychological interpretation of the investors' behaviour which is supported by the insight that during the starting part of the month there is a prevailing tendency to invest to less risky stocks with sufficient liquidity, which further cause such big difference in the standard variance of the first and the second parts of the month. Nevertheless this insight can explain the visibility of the turn-of-the-month effect for stocks which have higher risk, low volume and high volatility at the same time. On the turn of the month, their popularity among traders together with their level of risk raises significantly (Table 2).

Table 2. The turn-of-the-month and intramonth effects for variance

	F-test for Variance Marked tests are significant at p <,05000				
Part 1 vs. Part 2	F-ratio Varian	p Varian	Half 1 vs. Half 2	F-ratio Varian	p Varian
Index1_1 vs. Index1_2	**8,047**	**0,000**	Index2_1 vs. Index2_2	1,116	0,675
LEL1_1 vs. LEL1_2	**4,839**	**0,000**	LEL2_1 vs. LEL2_2	1,166	0,561
KBL1_1 vs. KBL1_2	**11,569**	**0,000**	KBL2_1 vs. KBL2_2	**2,978**	**0,000**
LNS1_1 vs. LNS1_2	**5,475**	**0,000**	LNS2_1 vs. LNS2_2	1,675	0,052
LEN1_1 vs. LEN1_2	**8,938**	**0,000**	LEN2_1 vs. LEN2_2	**2,037**	**0,008**
VBL1_1 vs. VBL1_2	**9,127**	**0,000**	VBL2_1 vs. VBL2_2	1,038	0,889
LJL1_1 vs. LJL1_2	**16,476**	**0,000**	LJL2_1 vs. LJL2_2	1,513	0,117
LLK1_1 vs. LLK1_2	**9,121**	**0,000**	LLK2_1 vs. LLK2_2	1,393	0,222
KJK1_1 vs. KJK1_2	**3,832**	**0,000**	KJK2_1 vs. KJK2_2	1,048	0,866
ZMP1_1 vs. ZMP1_2	**3,637**	**0,000**	ZMP2_1 vs. ZMP2_2	1,575	0,087
LDJ1_1 vs. LDJ1_2	**7,153**	**0,000**	LDJ2_1 vs. LDJ2_2	1,337	0,272
RST1_1 vs. RST1_2	**26,305**	**0,000**	RST2_1 vs. RST2_2	1,380	0,223
UTR1_1 vs. UTR1_2	**6,147**	**0,000**	UTR2_1 vs. UTR2_2	**1,867**	**0,035**
NDL1_1 vs. NDL1_2	**2,235**	**0,018**	NDL2_1 vs. NDL2_2	2,002	0,016
SAN1_1 vs. SAN1_2	**3,021**	**0,000**	SAN2_1 vs. SAN2_2	**2,231**	**0,003**
KNF1_1 vs. KNF1_2	**3,816**	**0,000**	KNF2_1 vs. KNF2_2	1,311	0,351
PTR1_1 vs. PTR1_2	**6,514**	**0,000**	PTR2_1 vs. PTR2_2	1,340	0,299
PZV1_1 vs. PZV1_2	**7,236**	**0,000**	PZV2_1 vs. PZV2_2	1,443	0,165
APG1_1 vs. APG1_2	1,073	0,800	APG2_1 vs. APG2_2	**3,136**	**0,000**
MNF1_F vs. MNF1-L	**6,748**	**0,000**	MNF2_F vs. MNF2_L	**2,046**	**0,010**
SNG1_1 vs. SNG1_2	1,089	0,750	SNG2_1 vs. SNG2_2	**72,169**	**0,000**
UKB1_1 vs. UKB1_2	**2,664**	**0,000**	UKB2_1 vs. UKB2_2	**47,707**	**0,000**
RSU1_1 vs. RSU1_2	1,112	0,694	RSU2_1 vs. RSU2_2	**40,957**	**0,000**
LFO1_1 vs. LFO1_2	1,208	0,529	LFO2_1 vs. LFO2_2	**2,269**	**0,004**
TEO1_1 vs. TEO1_2	**5,183**	**0,000**	TEO2_1 vs. TEO2_2	**1,884**	**0,017**

In order to confirm validity of the obtained results, an important requirement that the variances in the different groups are equal (homogeneous) were tested. For this research two powerful and most commonly used tests for exploring this assumption were applied: Levene test and Brown-Forsythe modification of this test. The latter performs the analysis on the deviations of the group medians, instead of means as in Levene test. The results of using Levene test and the application of the Brown-Forsythe test gave equivalent results: the hypothesis of homogeneity could not be rejected for none of the variables [23].

The significance of the turn-of-the-month and intramonth effects to the mean return of investment was explored by applying two nonparametric tests. Kolmogorov-Smirnov test was used to verify the hypothesis, if two samples were drawn from the

same population. The Mann-Whitney U test was used to explore the location characteristics of two samples. The Kolmogorov-Smirnov test is generally applied for testing the influence of higher moments for the distribution [23], and it is sensitive to the differences of the general shapes of the distributions of the two samples [9] (expressed by differences of dispersion, skewness, kurtosis etc.).

Table 3. Results of application of Kolmogorov-Smirnov tests for the turn-of-the-month and intramonth effects

	Kolmogorov-Smirnov Test Marked tests are significant at p <,05000						
Part 1 vs. Part 2	Neg Differ.	Pos Differ.	p-level	Half 1 vs. Half 2	Neg Differ.	Pos Differ.	p-level
Index1_1/Ind1_2	**-0,283**	**0,167**	**p < .02**	Index2_1/Ind2_2	-0,050	0,167	p > .10
LEL1_1/LEL1_2	**-0,102**	**0,271**	**p < .05**	LEL2_1/LEL2_2	-0,051	0,136	p > .10
KBL1_1/KBL1_2	-0,145	0,200	p > .10	KBL2_1/KBL2_2	-0,068	0,169	p > .10
LNS1_1/LNS1_2	**-0,121**	**0,276**	**p < .02**	LNS2_1/LNS2_2	-0,153	0,068	p > .10
LEN1_1/LEN1_2	**-0,153**	**0,305**	**p < .01**	LEN2_1/ LEN2_2	-0,169	0,136	p > .10
VBL1_1/VBL1_2	-0,208	0,226	p > .10	VBL2_1/VBL2_2	0,000	0,224	p > .10
LJL1_1/LJL1_2	-0,121	0,224	p > .10	LJL2_1/LJL2_2	-0,085	0,068	p > .10
LLK1_1/LLK1_2	**-0,362**	**0,170**	**p < .05**	LLK2_1/ LLK2_2	-0,107	0,125	p > .10
KJK1_1/KJK1_2	-0,130	0,109	p > .10	KJK2_1/KJK2_2	-0,130	0,074	p > .10
ZMP1_1/ZMP1_2	-0,051	0,237	p < .10	ZMP2_1/ZMP2_2	-0,102	0,119	p > .10
LDJ1_1/LDJ1_2	-0,086	0,224	p > .10	LDJ2_1/LDJ2_2	-0,136	0,034	p > .10
RST1_1/RST1_2	-0,190	0,138	p > .10	RST2_1/RST2_2	-0,034	0,203	p > .10
UTR1_1/UTR1_2	-0,277	0,085	p < .10	UTR2_1/UTR2_2	-0,063	0,208	p > .10
NDL1_1/NDL1_2	-0,081	0,243	p > .10	NDL2_1/ NDL2_2	-0,118	0,059	p > .10
SAN1_1/SAN1_2	-0,056	0,167	p > .10	SAN2_1/SAN2_2	-0,136	0,068	p > .10
KNF1_1/KNF1_2	-0,120	0,200	p > .10	KNF2_1/KNF2_2	-0,061	0,122	p > .10
PTR1_1/PTR1_2	-0,102	0,102	p > .10	PTR2_1/PTR2_2	-0,058	0,154	p > .10
PZV1_1/PZV1_2	-0,143	0,187	p > .10	PZV2_1/PZV2_2	-0,085	0,085	p > .10
APG1_1/APG1_2	-0,113	0,208	p > .10	APG2_1/APG2_2	-0,193	0,035	p > .10
MNF1_1/MNF1-L2	-0,189	0,133	p > .10	MNF2_1/MNF2_2	-0,091	0,164	p > .10
SNG1_1/SNG1_2	-0,155	0,103	p > .10	SNG2_1/SNG2_2	-0,051	0,186	p > .10
UKB1_1/UKB1_2	-0,204	0,130	p > .10	UKB2_1/UKB2_2	-0,086	0,155	p > .10
RSU1_1/RSU1_2	-0,053	0,175	p > .10	RSU2_1/RSU2_2	-0,034	0,153	p > .10
LFO1_1/LFO1_2	-0,043	0,174	p > .10	LFO2_1/LFO2_2	-0,196	0,039	p > .10
TEO1_1/TEO1_2	-0,153	0,186	p > .10	TEO2_1/TEO2_2	-0,102	0,102	p > .10

In our case Kolmogorov-Smirnov test was applied to reveal the impact of the turn-of-the-month and intramonth effects for the stocks belonging to the groups with different trading turnovers. The results of the investigation are presented in Table 3.

As we can see from Table 3, only the variable Index and the stocks LEL, LNS, LEN, and LLK (marked in bold) indicated the presence of the turn-of-the-month effect.

Therefore we can reject the hypothesis of the equal mean return distributions only for those particular stocks. The main characteristic of these stocks is their very low trading volume. By applying Mann-Whitney U test for exploring the location characteristics of the two samples (means, average ranks, respectively) we observed significant results for the same stocks.

4 Conclusions

In this research the two types of calendar effects, such as turn-of-the-month and intramonth, were explored for stocks drawn from the Vilnius Stock Exchange. The research methods were selected in order to disclose if these anomalies affect certain stocks, and to explore their dependency from trading volume and volatility. The research outcomes could confirm the hypotheses of the presence of the turn-of-the-month and intramonth effects only by their impact on the volatility of stocks. We can state that the direct impact of these effects to the mean return indicator of the stocks was not visible and could not be confirmed by any applied methods.

The strongest relationship of the explored effects to the trading volume could be explained only by changes in volatility. It was detected that the turn-of-the-month effect for the volatility of the variables was significant for all stocks which belong to the group of low and medium turnover. Only few stocks from the high trading volume group were marked as affected by these calendar anomalies. The analysis of the intramonth effect gave opposite results, as the significant difference of volatility could be observed only for high volume stocks. Only four stocks of the low volume group had significantly higher variance in the first half of the month.

The analysis of the impact of the higher moments to the calendar effects for the mean return was performed by applying Kolmogorov-Smirnov test. Only several stocks (LEL, LNS, LEN, and LLK) showed positive impact of the turn-of-the-month effect to the mean return.

The effectiveness level of the Vilnius stock exchange market is quite high, therefore the effective trading strategies can be based only on quite sensitive methods, able to discover various trading anomalies. The research of the turn-of-the-month and intramonth effects revealed, that they have to be differently interpreted for groups of stocks accordingly to their trading volume. The trading strategies should be based on the analysis of stocks risk, expressed as variance, because the mean return indicator was not directly affected by the explored calendar anomalies.

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