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THE IMPACT OF DAILY TRADE VOLUME ON THE DAY-OF-THE-WEEK EFFECT IN EMERGING STOCK MARKETS

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Abstract. In this article we examine the impact of daily trade turnover on the day-of-the-week effect in emerging stock markets. The empirical analysis was made by using Vilnius Stock OMX equities return data. The main method suggested for analysis was based on formation of three portfolios with equities having low, medium and high daily turnover. By applying traditional statistical research methods, such as t-test, one-way ANOVA, Levene and Brown-Forsythe test of homogeneity of variances the statistically significant difference among Monday and the other week days was observed only for some equities with medium trading volume. Analyzing influence of higher moments to mean return distribution (Kolmogorov-Smirnov test) we concluded, that day-of-the-week effect had influence on stocks with medium turnover. We have also applied Kolmogorov-Smirnov test for different days of the week to investigate the effect to daily turnover of shares. By applying test to all possible pairs of the days, it was defined that volumes of RSU, LDJ, KJK, PZV shares had significant difference for some days of the week.

Keywords: day-of –the-week effect, trade volume, return, statistical methods, ANOVA, t-test, Kolmogorov-Smirnov test.

1. Introduction

Investigations of the day-of-the-week effect anomaly are the question of interest for the traders of security markets. Successful forecasting of the returns increase or decrease and the implied risk of trading decisions along the days of the week could lead to formation of profitable trading strategy [10]. The most attractive days for buying securities are those when the stock price and risk are the lowest. The stocks are usually traded on the days of sufficient price rise. The market fluctuations are quite extensively researched in the developed security markets. A lot of research in US and UK stock markets [1,3,4,6,15] state that daily stock market returns are sensitive to the day-of-the-week. They are lowest on Mondays and reach the highest level on Fridays.

Observations of the day-of-the-week effect anomaly made some economists doubt the hypothesis of market efficiency, and, at the same time, deny the capital asset pricing model (CAPM) and asset pricing theory (APT). In some research works, the ideas of creating alternative models of asset pricing were presented [9]. As it was stated in Arsad and Copurts 1997 [1], there is a lack of research for confirming regularities of stock exchange data, leading to controversial conclusions. More and more recent research articles present argumentation of diminishing influence of day-of-the-week effect in various markets [8,2], such as Korea, UK, starting from the 1990s [7,12], and in US stock markets, where this tendency can be watched even from 1975, as is analysed by Connoly (1989) in his extensive study [3], which has been adjusted for sample size, heteroscedasticity and serial correlation. Thus the danger for the market efficiency hypothesis is decreasing, yet it is still evident that the day-of-the-week effect and other stock market anomalies depend on individual markets and economics, where they operate. In this case, the analysis of the day-of-the-week effect by taking into account the features of specific markets is interesting task of scientific research.

In this article, the day-of-the-week effect is analysed for the case of emerging stock markets for testing if the dependencies of developed stock markets are still important in the small securities markets with low turnover and comparatively small number of market players. There is quite a few research works in this sphere, both in variety of the markets analysed, as well as the methods applied for the research. Sayd Basher(2006) [13] studied the day of week effect in 21 emerging stock markets by using both unconditional and conditional risk analysis. By applying different analysis models, it was found that the day of the week effect was present only for Philippines, Pakistan and Taiwan stock markets, even after adjusting for market risk.

In this work we shall analyse the influence of day-of-the-week effect anomaly for the case of emerging stock market with low liquidity, by using empirical

research data of Vilnius Stock OMX [14] Index return and also return data of 24 equities from the time interval 2003-01-01 to 2006-11-21. The computational methods, used in the article, include traditional analysis, based on research of differences of first moments, calculated for the days of the week, and the methods based on analysis of the higher moments [5]. The three main research tasks were aimed

- to reveal the presence of day-of-the-week effect for various stocks traded in Vilnius stock exchange,
- to analyse whether the strength of effect depends on daily turnover of the security and
- to investigate whether the daily turnover of the security is different on the specific days of the week.

The research results lead to the conclusions that day-of-the-week effect had no significant influence on Vilnius Stock OMX Index return, and there were only a few equities (not more than 4 out of 24, according to the results of applied different analysis methods), where this effect could be substantiated. The impact of day-of-the-week effect on the daily turnover of the 24 securities could not be validated as well.

In the following section the research methodology is defined and organization of research data set is presented. Then the research results of application of traditional analysis methods, such as t-test, one-way ANOVA, Levene and Brown-Forsythe test of homogeneity of variances, are analysed. In Section 3, the results of application of nonparametric statistics are revealed. The significance of the day of the week effect is evaluated by using tests of Kolmogorov-Smirnov and Mann-Whitney U. The research outcomes and conclusions are covered in Section 4. All calculations are made with the STATISTICA 6.0 for Windows software.

2. Data and methodology

Data for empirical research were taken from Vilnius Stock Exchange information (The Nordic Exchange, 2006) [14].Vilnius Stock Exchange is the only regulated securities market in Lithuania, which provides trading, listing and information services. It is part of OMX, which through its exchanges in Copenhagen, Stockholm, Helsinki, Riga, Tallinn and Vilnius offers access to approximately 80 percent of the Nordic and Baltic securities markets. The main financial indicators of Vilnius stock exchange are: market value of 7 billions EUR, near 2 million EUR share trading value per business day, approximately 600 number of trades per business day, and the equity list consising of 44 shares. According to these financial indicators, Vilnius Stock Exchange belongs to the category of small emerging securities markets. The OMX Vilnius Stock Index 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.

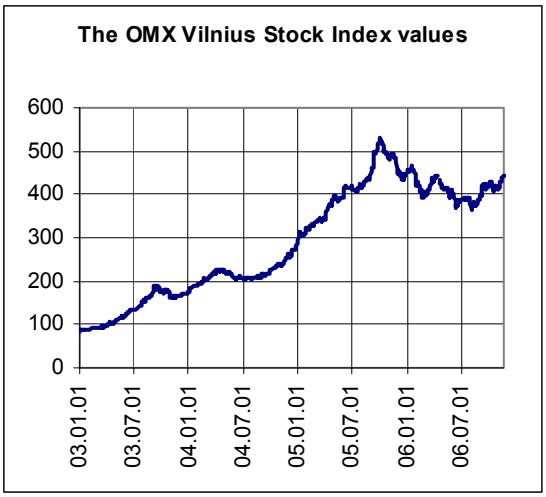

Figure 1. The OMX Index values

For the further calculations in this research we used the OMX Vilnius Stock Index and data of daily turnover values of 24 shares (out of 44 listed), covering the time interval since 2003-01-01 till 2006-11-21 (Figure 1). Those shares were selected in order to represent a variety of Vilnius Stock Exchange equity list by capitalization, number of shares, daily turnover, profitability and risk, and to ensure the validity and generalizability of the results of the research.

The traditional understanding of return is presented by expression (1), where return on time moment *t,* R_t is evaluated by logarithmic difference of stock price over time interval (t-1,t]:

$$R_t = \ln(\frac{P_t}{P_{t-1}}) = \ln(P_t) - \ln(P_{t-1}), \qquad (1)$$

where P_t indicates the price of financial instrument at time moment t.

The primary data set of OMX Vilnius Stock Index return was assigned to the variable **RETURN.** The 24 equity return values were assigned to the variables, named correspondingly to their symbolic notation of Vilnius Stock Exchange. The initial analysis of the data set, by presenting their summary statistics, revealed quite big differences of average trading volume of stocks (Table 1). The following task of the research was to check if differences of trade volume of stocks could indicate different significance of the day-of-the-week effect. For this purpose the shares were sorted by daily turnover and divided into three groups according to mean average of the daily trading volume (Table 1).

The first group - 7 equities with the lowest mean trading volume of 14 to 51 thousand LTL (1EUR=3.45 LTL) and average daily turnover equal to 34 511.3 LTL

The second group – 10 equities with average daily trade volume from 81 000 to 228 000 LTL, mean value of the group 129 719.2 LTL

The third group – 7 equities with trading volume 375 000 to 700 000 LTL, mean value of the group 527 152.0 LTL.

Table 1. Day of the week Summary Statistics

	Descriptive Statistics (Return)											
Variable	**All day Mean**	All day Std.Dev	Monday Mean	Monday Std.Dev	Tuesday Mean	Tuesday Std.Dev	W-day Mean	W-day Std.Dev.	Thursday Mean	Thursday Std.Dev.	Friday Mean	Friday Std.Dev.
RETURN	0,166	0,940	0,161	1,026	0,151	1,000	0,082	0,893	0,228	0,862	0,195	0,916
LEL	0,253	2,786	0,245	2,553	0,227	3,046	0,297	2,694	0,041	2,794	0,465	2,822
KBL	0,052	3,049	0,253	3,204	0,028	2,713	-0,186	3,326	0,112	2,961	0,056	3,043
LNS	-0,055	3,453	-0,041	3,821	-0,017	3,027	0,356	3,459	-0,099	3,517	-0,501	3,391
LEN	0,137	2,185	0,076	1,943	0,049	2,029	0,332	2,337	0,035	2,230	0,190	2,362
VBL	0,129	2,398	0,413	2,459	-0,100	2,620	0,127	2,298	0,012	2,084	0,209	2,478
LJL	0,141	2,774	0,409	2,865	0,072	2,774	0,132	2,858	0,214	2,784	-0,122	2,576
LLK	0,228	2,928	0,172	2,754	0,150	2,916	-0,001	2,978	0,201	3,268	0,614	2,722
I Average	0,127	2,796	0,218	2,800	0,059	2,732	0,151	2,850	0,074	2,805	0,130	2,771
KJK	0,336	4,135	0,757	4,433	0,650	4,395	0,057	3,714	-0,171	3,783	0,408	4,321
ZMP	0,092	2,389	-0,227	2,022	0,092	2,889	0,184	2,498	0,149	2,312	0,261	2,084
LDJ	0,099	2,111	-0,310	2,147	0,140	2,163	0,017	1,819	0,471	2,104	0,150	2,250
RST	0,152	2,054	0,117	2,339	0,254	1,750	0,327	1,844	0,006	2,128	0,055	2,161
UTR	-0,019	2,314	-0,084	2,243	-0,203	1,782	0,682	2,350	-0,626	2,186	0,117	2,772
NDL	0,536	4,501	-0,060	4,513	0,610	4,669	0,826	4,634	1,470	4,782	-0,192	3,704
SAN	0,198	6,852	0,190	2,745	0,376	2,411	-0,242	14,142	0,160	2,839	0,525	2,599
KNF	0,009	1,679	-0,084	1,763	0,146	1,505	-0,050	1,530	-0,131	1,837	0,166	1,737
PTR	0,581	3,461	0,005	3,022	0,242	3,385	0,605	3,717	1,153	3,407	0,924	3,644
PZV	0,156	1,701	-0,024	1,541	0,271	1,596	0,145	1,944	0,133	1,612	0,250	1,787
II Average	0,214	3,120	0,028	2,677	0,258	2,655	0,255	3,819	0,261	2,699	0,266	2,706
APG	0,205	5,618	-0,444	11,812	0,477	2,537	0,307	2,267	0,175	2,675	0,477	2,021
MNF	0,260	2,393	0,216	2,397	0,181	2,385	0,454	2,461	0,136	2,395	0,311	2,336
SNG	-0,249	9,215	-0,032	1,771	0,145	1,538	0,121	1,944	0,068	1,479	-1,572	20,469
UKB	-0,008	9,695	0,575	3,430	-0,200	3,419	0,276	3,706	-1,096	20,712	0,403	3,039
RSU	0,071	1,497	-0,001	1,549	0,049	1,442	0,097	1,656	0,033	1,197	0,171	1,603
LFO	0,313	3,953	-0,323	3,887	-0,001	4,001	0,956	4,241	0,714	3,917	0,218	3,617
TEO	0,097	1,356	0,071	1,301	0,071	1,560	0,122	1,290	0,108	1,302	0,114	1,315
III Average	0,098	4,818	0,009	3,735	0,103	2,412	0,333	2,509	0,020	4,811	0,017	4,914

In Table 1, the similar tendencies for emerging securities markets as in the developed stock markets could be noticed: most equities had the lowest trading average returns on Mondays, and the highest- on Fridays. This situation could be explained mainly by psychological factors, such as the effect of Monday 'drowse', low level of market news flow in small securities markets the during the weekend, which cannot make big impact on the Monday trading intensity, and the effect of Friday increase because of hightened moods of traders before weekend.

By analysing standard deviation, we could notice that there was no difference in trading volatility between days of the week, and among volatility of different variables. Comparative analysis of the groups indicated that the highest value of return and lowest volatility were characteristics to the equities of the group with medium daily turnover. The lowest return and the biggest standard deviation values were in the third group with the highest trading volume. These tendencies correspond to the observed tendency that the biggest speculative trading transactions in Vilnius Stock Exchange are made with the stock of highest turnover and best liquidity.

The day-of-the-week effect was not as evident from the arranged turnover data in Table 1. Some more complicated statistical methods were applied for this purpose, starting from the traditional statistical analysis methods, such as t-test and one-way ANOVA, which were used to define significant differences among mean returns of the days of the week. The t-test revealed that the fluctuations of return according to the days of the week could be more or less confirmed only for several stocks (out of 24). In Figure 2, we can see that only three shares had statistically significant difference between Monday and Thursday mean returns. By applying t-test for OMX Vilnius Stock Index return (variable RETURN), the day-of-the-week effect was not confirmed for any pairs of weekdays. Similar results were obtained by applying analysis of variance (Figure 3).

The research results confirmed significant difference among days of the week for only two shares out of 24. Application of analysis of variance allowed us to reject the hypothesis of absence the difference among mean return different days of the week only for LDJ and UTR shares.

This fact was also confirmed by the results of application of Kruskal-Wallis test to the variables of our research. The test assessed the correctness of hypothesis, if the different samples, taken for comparison, were drawn from the same distribution, or from distributions with the same median. Thus, the

interpretation of the Kruskal-Wallis test was basically identical to that of the parametric one-way ANOVA, except that it was based on ranks, rather than means [11].

Variable	T-tests; Grouping: Var2 (Return) Group 1: Monday Group 2: Thursday				
	Mean 1	Mean 4	t-value	df	p
RETURN	0,161	0,228	-0,696	388	0,487
LEL	0,245	0,041	0,682	321	0,496
KBL	0,253	0,112	0,387	286	0,699
LNS	-0,041	-0,099	0,147	346	0,883
LEN	0,076	0,035	0,185	349	0,853
VBL	0,413	0,012	1,520	297	0,130
LJL	0,409	0,214	0,644	346	0,520
LLK	0,172	0,201	-0,073	235	0,942
KJK	0,757	-0,171	1,565	191	0,119
ZMP	-0,227	0,149	-1,514	303	0,131
LDJ	-0,310	0,471	-3,457	352	0,001
RST	0,117	0,006	0,484	374	0,629
UTR	-0,084	-0,626	1,779	210	0,077
NDL	-0,060	1,470	-1,862	126	0,065
SAN	0,190	0,160	0,086	251	0,932
KNF	-0,084	-0,131	0,222	287	0,825
PTR	0,005	1,153	-2,672	223	0,008
PZV	-0,024	0,133	-0,933	347	0,352
APG	-0,444	0,175	-0,626	296	0,532
MNF	0,216	0,136	0,323	376	0,747
SNG	-0,032	0,068	-0,567	346	0,571
UKB	0,575	-1,096	0,949	283	0,344
RSU	-0,001	0,033	-0,226	331	0,821
LFO	-0,323	0,714	-2,005	226	0,046
TEO	0,071	0,108	-0,279	382	0,780

Figure 2. T-test Results

In order to prove the validity of the obtained results, the important assumption of equality (homogeneity) of variances in the different groups had to be 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 test is generally used to analyse deviations of the group medians, instead of means as in Levene test. The results of application of Levene test let us suppose equality (homogeneity) of variances in the different groups.

Application of the Brown-Forsythe test led to analogous results. In this way, the hypothesis of homogeneity of the variance could not be rejected for none of the variables.

The extensive analysis by applying different methods and tests revealed that daily trade volume has no significant effect for the occurrence of day-of-the-week effect to trading stocks, but had influence on the liquidity of the stock and increased volatility and risk.

This conclusion could also be presented in the reverse manner- whether the daily trade volume itself is dependent on the day-of-the-week effect? In this case, we could expect significant difference in investment mean return and volatility among days of the week. For this purpose, new variable VOLUME was formed from the daily turnover data of the security in LTL. One- way ANOVA test was applied to test the hypothesis H0: day-of-the-week effect has no influence on the daily trade volume (variable VOLUME). It is indicated, that only one share out of 24 used for analysis denotes a significant difference between days of the week. Application of analysis of variance allowed us to reject the hypothesis of absence differences in volume of the different days of the week only for RSU share.

Variable	Analysis of Variance (Return) Marked effects are significant			
	MS Effect	MS Error	F	p
RETURN	0,588	0,887	0,663	0,618
LEL	3,787	7,780	0,487	0,745
KBL	3,625	9,327	0,389	0,817
LNS	16,098	11,907	1,352	0,249
LEN	2,808	4,781	0,587	0,672
VBL	5,921	5,748	1,030	0,391
LJL	6,534	7,699	0,849	0,494
LLK	6,216	8,591	0,724	0,576
KJK	14,652	17,116	0,856	0,490
ZMP	5,353	5,710	0,938	0,442
LDJ	13,987	4,414	3,169	0,013
RST	3,432	4,224	0,813	0,517
UTR	23,968	5,211	4,600	0,001
NDL	29,072	20,145	1,443	0,219
SAN	11,027	47,178	0,234	0,919
KNF	2,700	2,818	0,958	0,430
PTR	24,994	11,885	2,103	0,079
PZV	2,448	2,894	0,846	0,496
APG	21,783	31,617	0,689	0,600
MNF	3,051	5,738	0,532	0,712
SNG	95,702	84,863	1,128	0,342
UKB	64,851	94,153	0,689	0,600
RSU	0,773	2,249	0,344	0,849
LFO	31,388	15,513	2,023	0,090
TEO	0,117	1,846	0,063	0,993

Figure 3. ANOVA results

3. Results of application of nonparametric methods

In this section two non parametric tests were used for investigating significance of the day-of-the-week effect to investment mean return. By applying Kolmogorov-Smirnov test we verify hypothesis if two samples were drawn from the same population. Mann-Whitney U test was used to explore location characteristics of two samples. The Kolmogorov-Smirnov test is generally applied for testing the influence of higher moments for the distribution [11], and it is sensitive to the differences of the general shapes of the distributions of the two samples (expressed by differences of dispersion, skewness, kurtosis etc.).

By applying this test to all possible pairs of the days, it was defined that only the variables LDJ, PZV and UTR had significant difference for particular days of the week. In Figure 5, the Kolmogorov-Smirnov test values for indicating difference among Monday and Thursday return distributions were presented. In

Figure 4, we can see that only the variable PZV indicated presence of the day-of-the-week effect.

variable	Kolmogorov-Smirnov Test (Return) Marked tests are significant at p <,05				
	Max Neg Differnc	Max Pos Differnc	p-level	Mean Monday	Mean Thursday
RETURN	-0,08	0,05	p > .10	0,16	0,19
LEL	-0,05	0,06	p > .10	0,24	0,47
KBL	-0,03	0,05	p > .10	0,25	0,06
LNS	-0,02	0,08	p > .10	-0,04	-0,50
LEN	-0,08	0,02	p > .10	0,08	0,19
VBL	-0,04	0,07	p > .10	0,41	0,21
LJL	-0,01	0,09	p > .10	0,41	-0,12
LLK	-0,08	0,02	p > .10	0,17	0,61
KJK	-0,08	0,06	p > .10	0,76	0,41
ZMP	-0,14	0,01	p > .10	-0,23	0,26
LDJ	-0,10	0,01	p > .10	-0,31	0,15
RST	-0,05	0,06	p > .10	0,12	0,06
UTR	-0,06	0,04	p > .10	-0,08	0,12
NDL	-0,09	0,18	p > .10	-0,06	-0,19
SAN	-0,09	0,01	p > .10	0,19	0,52
KNF	-0,15	0,02	p < .10	-0,08	0,17
PTR	-0,14	0,01	p > .10	0,00	0,92
PZV	-0,15	0,01	p < .05	-0,02	0,25
APG	-0,11	0,04	p > .10	-0,44	0,48
MNF	-0,05	0,03	p > .10	0,22	0,31
SNG	-0,05	0,03	p > .10	-0,03	-1,57
UKB	-0,09	0,10	p > .10	0,57	0,40
RSU	-0,14	0,05	p < .10	-0,00	0,17
LFO	-0,11	0,03	p > .10	-0,32	0,22
TEO	-0,07	0,03	p > .10	0,07	0,11

Figure 4. Kolmogorov-Smirnov test for return

variable	Kolmogorov-Smirnov Test (VOLUME) By variable Var2 Marked tests are significant at p <,05000				
	Max Neg Differnc	Max Pos Differnc	p-level	Mean Group 1	Mean Group 2
LEL	-0,107	0,037	p > .10	17478	14105,0
KBL	-0,071	0,021	p > .10	26102	27419,9
LNS	-0,040	0,046	p > .10	32300	34833,4
LEN	-0,095	0,021	p > .10	31337	31167,9
VBL	-0,027	0,088	p > .10	37737	33088,9
LJL	-0,036	0,071	p > .10	49205	44609,3
LLK	-0,070	0,102	p > .10	39266	60168,0
KJK	-0,144	0,010	p > .10	42737	16505,9
ZMP	-0,059	0,089	p > .10	140521	84245,2
LDJ	-0,162	0,022	< .025	60093	104073,0
RST	-0,005	0,112	p > .10	106872	80958,1
UTR	-0,102	0,045	p > .10	112312	36805,8
NDL	-0,159	0,079	p > .10	24550	129345,1
SAN	-0,050	0,088	p > .10	232416	52560,7
KNF	-0,096	0,081	p > .10	119974	191733,8
APG	-0,109	0,039	p > .10	239722	170462,9
PZV	-0,117	0,015	p > .10	64475	566642,9
PTR	-0,009	0,148	p > .10	524356	241920,9
MNF	-0,117	0,026	p > .10	399905	488490,6
SNG	-0,089	0,077	p > .10	327645	315470,4
UKB	-0,023	0,058	p > .10	420932	415213,3
RSU	-0,149	0,012	p < .05	232391	251099,5
LFO	-0,108	0,053	p > .10	1003015	157834,6
TEO	-0,073	0,015	p > .10	647718	811034,0

Figure 5. Kolmogorov-Smirnov test for volume

Similar tendency also was valid for the other days of the week. Further we applied Kolmogorov-Smirnov test for different days of the week to investigate the effect to daily turnover of shares. By applying test to all possible pairs of the days, it was defined that volumes of RSU, LDJ, KJK, PZV shares had significant difference for some days of the week. In Figure 5, the Kolmogorov-Smirnov test values for indicating difference among Monday and Thursday return distributions are presented.

By applying Mann-Whitney U test for exploring the location characteristics of two samples (means, average ranks, respectively), we observed a significant difference only for variables and for particular day of the week, similarly as analysing investment mean return or daily turnover.

4. Summary and Conclusions

Despite quite extensive analysis of day-of-the-week effect in the scientific literature, its influence on the small securities markets is not sufficiently explored. In this work we analyse the influence of day-of-the-week effect anomaly for the case of emerging stock market with low liquidity, by using empirical research data of Vilnius Stock Exchange OMX Index return and also return data of 24 equities from the time interval 2003-01-01 to 2006-11-21

The task of the article were to define if the day-of-the-week effect is valid for various stocks and for the Index return of Vilnius Stock Exchange OMX . The research revealed that day-of-the-week effect has no significant influence on Vilnius Stock Exchange OMX Index return, and there were only few equities (not more than 4 out of 24, according to the results of applied different analysis methods), where this effect could be substantiated. The results were validated by applying Kolmogorov-Smirnov test, which is generally applied for testing the influence of higher moments for the distribution. The significant influence of the day-of-the-week effect could be denoted only for a few of stocks.

The second task was to analyse if the strength of day-of-the-week effect depends on daily turnover of the securities. For this purpose, the stocks were ranked into three groups, according to mean average of the daily trading volume. Comparative analysis of the groups indicated that the highest value of return and lowest volatility were characteristic to the equities of the group with medium daily turnover. The lowest return and the biggest standard deviation values were in the third group with the highest trading volume. These tendencies well correspond to the observed tendency that the biggest speculative trading transactions in Vilnius Stock Exchange are made with the stock of highest turnover and best liquidity. The extensive analysis by applying various methods and tests revealed that daily trade volume had no significant effect for the occurrence of day-of-the-week effect to trading

stocks, but had influence on the liquidity of the stock and increased volatility and risk.

The third research aspect deal with the question if the daily turnover of the security is different on the specific days of the week. Application of analysis of variance allowed us to reject the hypothesis of absence of the differences in volume of the different days of the week only for one, namely RSU share. We have also applied Kolmogorov-Smirnov test for different days of the week to investigate the effect to daily turnover of shares. By applying the test to all possible pairs of days, it was defined that only volumes of RSU, LDJ, KJK, PZV shares had significant difference for some days of the week.

According to the results of the research, we can conclude that day-of-the-week effect in emerging stock markets has similar tendency to vanish, as it has been researched in the developed markets. This tendency could be supported by the increasing stock markets globalization and increasing penetration of information technologies and their applications to the financial markets.

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