

Computational Model for Utilizing Impact of Intra-Week Seasonality and Taxes to Stock Return

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Abstract— In this work we explore impact of trading taxes on intra-week stock return seasonality. The concept of stock return seasonality, also known as day-of-the-week effect, attracts attention of many researchers and traders, though there is a lack of investigation on impact of taxes to seasonality. In order to evaluate the dependencies of the days of investment to the expected stock returns we suggested the computational model, constructed for implementing stock trading strategy, based on changing content of stock portfolio during particular days of the week, and estimation of the return excluding trading taxes. The suggested shares trading strategy allows to reveal presence of the day-of-the-week anomaly, and its influence to final return of selected share. The research was performed with the financial trading data of 24 shares of Vilnius Stock Exchange (from 2003-01-01 to 2006-11-21) for calculating shares return, generated by making investment operations only on the fixed day of the week. The taxes applied for operations are calculated form the sum of investment, therefore the suggested algorithm had to minimize the number of operations. Application of the suggested method revealed significance of this effect for majority of the shares of the Vilnius Stock Exchange (20 out of 24 analysed). The validity of the research results is analysed by presenting comparative evaluation of effectiveness of variety of methods, used for investigation of the day-of-the week anomaly in the earlier research works by the authors, including artificial neural networks, the traditional statistical and econometric methods.

Index Terms— stock return, day-of-the-week effect, seasonality, neural networks, discriminant analysis.

I. INTRODUCTION

The day-of-the-week effect is understood as significant difference of stock returns, regularly occurring for some particular trading day of the week. The day-of-the-week effect anomaly attracts attention of many researchers and traders of securities in the stock markets. Reliable forecast of the expected risk rate, return or loss could help to implement profitable trading strategies. The most desirable time for buying stocks occurs when the stock prices touch the bottom, and the most attractive moment to sell is on the highest price increase. Indicating the days of the week with the return,

which regularly significantly differs from the other days, we could manage the profitability of the stock portfolio. The day-of-the-week effect is one of the most popular calendar effects, analysed in the research literature [7,13,14].

The research results of US, UK and Asian stock markets [1,3,4,5,8,16] state, that the day-of-the-week is an important factor, and the lowest daily stock market returns are mostly peculiar for the first trading day, whereas the highest returns are expected on the last trading day of the week, usually Friday. On the other hand, in some markets the day-of-the-week effect is confirmed as fading starting from 1990s (Korea, UK stock markets) [6,7,13]. Therefore, documenting and testing of anomalies across various markets is the interesting and ultimate task.

Basher in [14] has studied the day of week effect in 21 emerging stock market by using both unconditional and conditional risk analysis and applying different analysis models, and has confirmed the evidence of day-of-the-week effect only for Philippines, Pakistan and Taiwan, even after adjusting research results for the market risk.

Day-of-the-week week effect in Lithuanian Stock market was investigated by authors in [9,10], using several computational analysis methods. Lithuanian stock market according to its financial data can be entitled as small emerging securities markets with low turnover and comparatively small number of market players. The research lead to the conclusion, that day-of-the-week effect had no significant influence to Vilnius Stock OMX Index return, and there were only few equities (not more than 4 from 24, according to the results of applied different analysis methods), where this effect could be substantiated by using the computational tools of traditional statistical analysis.

More sensitive investigation results of the day-of-the-week effect were obtained by using artificial neural networks [11]. Two standard types of neural networks were applied: MLP (Multilayer Perceptrons) and RBF (Radial Basis Function Networks). The research outcomes revealed better effectiveness of application of the neural networks, as the influence of the day-of-the-week effect was significantly confirmed in more cases, than it was possible to achieve by traditional statistical analysis. Monday effect was present for 11 shares, and Friday effect was present for 9 shares out of total list of the 24 analysed stocks.

In this article we analyse the overall return on investment of stock trading, including taxes, by exploring impact of the day-of-the-week effect. The discussion of the research results include comparative evaluation of effectiveness of variety of

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methods, used for investigation of the day-of-the-week anomaly in the earlier research works by the authors [9-11], including neural networks, the traditional statistical and econometric methods.

In the following section we define the organization of research data set and suggest the computational model, constructed for implementing stock trading strategy, based on estimation of the return on investment, if the trading transactions are performed only on particular days of the week. In section 3 by using the presented model we explored the investment return for 24 most actively traded stocks from the official listing of the Vilnius OMX. The obtained research results enabled to substantiate hypothesis of the significant influence of the day-of-the-week effect to the return of particular securities of the Vilnius stock exchange.

II. DATA AND METHODOLOGY

This research presents analysis of the possible accumulated return of stock trading in Lithuanian Stock market by executing trading operations only for the particular days of the week. The research data set was prepared out of the financial data of the Vilnius Stock Exchange, which can be described by the following characteristics [15]: market value is 7 EUR billions, near 2 million EUR of share trading value per business day, approximately 600 trading transactions per business day, and 45 shares in the equity list. According to these financial indicators, Vilnius Stock Exchange belongs to the category of small emerging securities markets.

For ensuring validity of the research, the trading data set of 24 listed stocks of the time interval from 2003-01-01 to 2006-11-21 on daily basis have been selected for analysis. The shares selected for the analysis and the time interval of financial data are the same as in papers [9-11], and allow providing the comparative analysis of the research results. In this article the prepared data set was used to analyse if the day-of-the-week anomaly can be confirmed with significant confidence for the value of overall return with the taxes, for particular days of the week.

The selected set of stock data represents all variety of the list, according to the capitalization, number of shares, daily turnover, profitability and risk. The trading data is assigned to the variables, named according to their acronyms in Vilnius Stock Exchange [15].

During the analyzed period quite big fluctuations of the stock data was observed. In Fig. 1 the price changes of one particular share TEO during 2003-2006 are shown. The price dynamics of the other stocks of the research data set had similar shape.

The uses of designed shares trading strategy require cleaning trading data set. Therefore we remove of time series the holidays, 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 800, thus ensuring necessary amount of experimental data for getting significant findings.

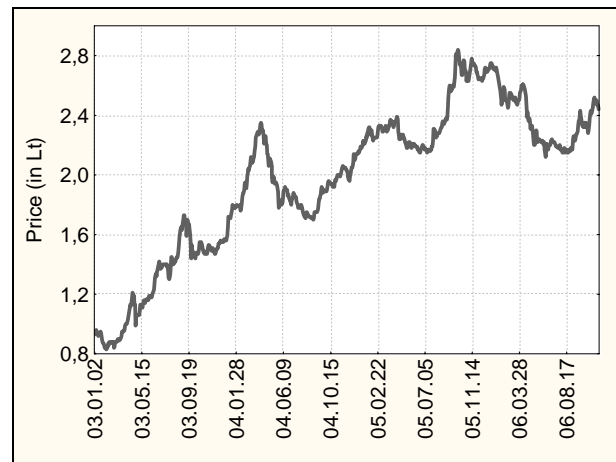


Fig. 1. Price changes of TEO security.

Our task was to design computational method of shares trading strategy, which could allow evaluating the interdependence of total return and particular investment day. The task was not formulated as the goal to create optimal investment strategy with the maximal return on investment. The main goal was to implement such trading algorithm, which could reveal presence the day-of-the-week effect, and to check if there was financial worth to take into account the day of the week of the transaction, and the frequency of trading operations. Most research works neglect the impact of taxes for the trading operations, or do not check the influence of this condition. The trading frequency is very important parameter, as each operation bears the taxes, which lower the return. The tax rate of trading in the Vilnius Stock Exchange is equal to 0.3 % of the invested sum. Therefore the positive return of particular trading day cannot be illustrated by trade operations made on the opening and close moments of that day, as the trading taxes could exceed the generated profit.

Our trading strategy is based on fixing the day of the week of the trading operation till the moment of its fulfilment: buying only when the market is raising and selling on the moment of the falling prices. For realisation the trading algorithm we selected the initial investment sum 100 Lt. In this case the final earned sum will be equal to the return percent rate. The trading algorithm is presented in the Fig. 2. By using this strategy we significantly reduced the number of trading operations and the total impact of taxes. By applying the algorithm we make on average 50 buy/sell operations with one share during the three trading years. This number of operations is comparatively low and allows expecting profitable outcome of trading stocks.

For mining the data and calculations we used Statistica and Mathcad software. The results and comparative evaluation with the research conclusions, presented in [9-11] are discussed in the 3rd section.

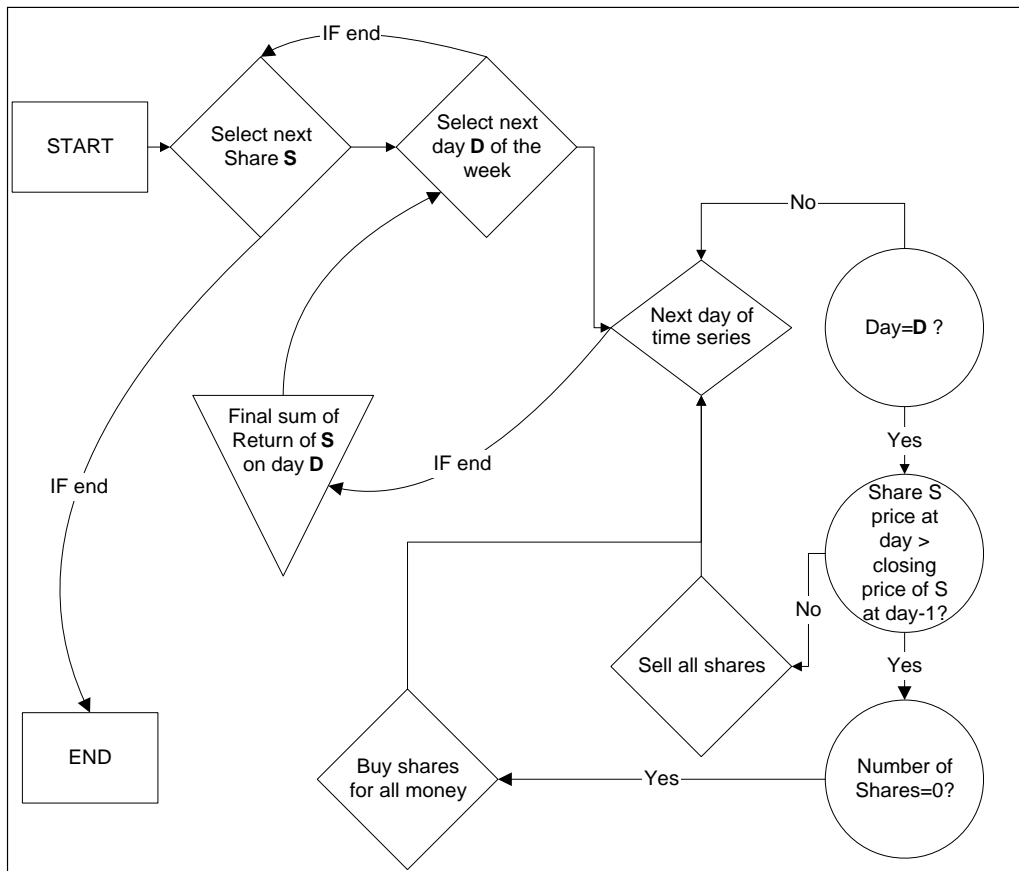


Fig. 2. Trading strategy algorithm.

III. INVESTIGATION RESULTS

By using the computational method, outlined in section 2, and share trading strategy, as presented in Fig.2, we calculated the final return of selected shares for all days of the week. The calculations include the trading taxes of 0.3 % of the invested sum. The calculation results are presented in the Table 1.

As we can see the average profitability of all days of the week is near to the average value of 215.29. This result supports the conclusion of the [10] stating that the mean return value of the Vilnius Stock OMX Index is not impacted by the day-of-the-week effect.

In the Table 1, the final return value of the stocks, which are significantly different ($p < 0.05$) from the values of other days of the week are marked in bold font. In the researched data set there were only several shares (MNF, ZMP, LJL) don't having significantly different days. It can be noticed, that the stock trading in Vilnius Stock Exchange is impacted by the day-of-the-week effect. The most exclusive trading day is in Monday, as the day-of-the-week anomaly for this share is confirmed for eight shares. The Friday effect is noticed for five shares. The other days are only occasionally marked as significantly different, thus Monday and Friday effects have important trading impact in the observed market, similarly to the developed markets. On the other hand, our experiment did not confirm traditional understanding of trading in the developed markets, that the return is lowest in Monday, and the biggest - on Fridays. In the research data the

exclusive days of the week were outlined by denoting the biggest return value, except one case per each day, where the stock return values were significantly lower.

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 shares in Table 1 were sorted according to the daily turnover data. It can be checked, if the stocks, grouped according to different trading volumes, had different profitability, and if the day-of-the-week effect was related to the trading volume. The analysis could not confirm, that the presence of the effect was related to the trading volume, although the results in the Table 1 could hint that Mondays, marked as affected by the day-of-the-week anomaly more often occurred for the shares with higher daily turnover.

In the articles [9,10] the day-of-the-week anomaly was explored by applying traditional statistical research methods for the same shares of Vilnius Stock Exchange. By applying t-test, one-way ANOVA, Levene and Brown-Forsythe test of homogeneity of variances, the statistically significant difference among Monday and the other days of the week was observed only for some shares 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.

Table 1. Final trading results after investing 100 Lt, by days of the week (in Lt)

	1	2	3	4	5	6
	Monday	Tuesday	Wednesday	Thursday	Friday	MEAN
LEL	273,26	332,82	373,17	310,95	282,62	314,56
KBL	110,66	119,78	86,80	133,67	172,00	124,58
LNS	44,52	81,41	84,91	88,04	153,41	90,46
LEN	149,14	113,99	247,51	293,60	182,09	197,26
VBL	194,96	117,48	100,23	260,43	159,99	166,62
LJL	125,88	164,67	186,83	140,64	190,10	161,62
LLK	302,85	183,10	180,17	161,63	199,26	205,40
KJK	171,63	328,80	227,56	239,51	378,18	269,14
ZMP	171,93	161,48	157,74	120,38	126,63	147,63
LDJ	105,91	176,01	172,16	117,56	161,80	146,69
RST	306,06	153,77	211,37	162,24	233,29	213,35
UTR	110,37	93,07	142,61	80,90	72,42	99,87
NDL	283,33	328,11	298,20	232,06	124,82	253,31
SAN	334,69	117,71	296,32	252,66	179,25	236,13
KNF	139,37	120,08	66,94	103,65	132,61	112,53
PTR	1062,85	343,40	371,95	509,48	221,31	501,80
PZV	267,90	131,86	152,01	199,96	214,78	193,30
APG	153,93	132,17	95,29	440,43	150,00	194,36
MNF	157,55	488,15	332,86	201,49	419,76	319,96
SNG	105,20	90,09	90,99	79,69	92,42	91,68
UKB	447,37	155,88	299,55	208,53	312,68	284,80
RSU	658,73	357,92	317,95	925,47	341,83	520,38
LFO	218,39	171,43	191,62	137,31	156,44	175,04
TEO	161,68	121,45	120,95	132,10	196,03	146,44
MEAN	252,42	191,03	200,24	230,52	202,24	215,29

Comparing the results of the research with the findings in [9,10] let us to conclude that traditional statistical research methods cannot effectively identify this anomaly.

Considerably more shares, with exclusive average return for Monday and Friday could be identified by using the method, based on application of neural networks [11]. In the

Table 2 we present the results of application of artificial neural networks for stock trading data [11]. The confirmed presence of Monday and Friday effect is marked by bold font. The significant records (in bold) were selected for the cases, where the performance of neural network exceeded 0.6 (see [12]).

Table 2. Results of application of neural network for stock trading data (the presence of Monday and Friday effect is marked by bold font).

	1	2	3	4	5	6	7	8	9
	Performance	Error	Performance	Error		Performance	Error	Performance	Error
	Monday		Friday			Monday		Friday	
LEL	0,5623	0,3909	0,5770	0,3849	NDL	0,6656	0,3419	0,6748	0,3426
KBL	0,6501	0,3590	0,5214	0,3994	SAN	0,5671	0,3682	0,5855	0,3924
LNS	0,6066	0,3656	0,5436	0,3961	KNF	0,7058	0,3554	0,6671	0,3734
LEN	0,5576	0,3815	0,7291	0,3590	PTR	0,5707	0,3760	0,6820	0,3475
VBL	0,5943	0,3640	0,5814	0,3870	PZV	0,6282	0,3639	0,5734	0,3953
LJL	0,5193	0,3918	0,6409	0,3910	APG	0,6453	0,3633	0,5668	0,3964
LLK	0,6281	0,3683	0,6638	0,3563	MNF	0,6346	0,3622	0,5569	0,3916
KJK	0,6738	0,3526	0,5778	0,3829	SNG	0,5571	0,3936	0,5447	0,3951
ZMP	0,5776	0,3807	0,6007	0,3566	UKB	0,5795	0,3818	0,5906	0,3767
LDJ	0,4850	0,3857	0,5795	0,3869	RSU	0,5709	0,3828	0,5456	0,3918
RST	0,5713	0,3927	0,5245	0,3953	LFO	0,6583	0,3720	0,6761	0,3480
UTR	0,5854	0,3736	0,6161	0,3717	TEO	0,6234	0,3682	0,5563	0,3912

By comparing results of Table 2 and Table 1 we have to admit obvious difference of performance of various methods for indicating the day-of-the-week effect. Only four shares were marked as affected by the day-of-the-week anomaly by both methods: applying artificial neural networks and by using the computational method for shares trading, described in Section 2. There could be several reasons for the low compatibility of the results, obtained by both methods. One of them is quite vague and superficial indications of the day-of-the-week effect on the Vilnius Stock Exchange. The other reason is based on using algorithm for trading stocks where taxes were taken into consideration, whereas the taxes were not counted by applying method of artificial neural network.

IV. 4. CONCLUSIONS

The recent scientific research works noted the diminishing tendency of the day-of-the-week effect in developed and emerging stock markets due to market evolution. In this work we explore impact of this effect in the Vilnius Stock Exchange. We designed the computational method for realization the trading strategy, which allows highlighting the dependency of shares return from the week day, selected for making trading transaction (buy/sell). The suggested shares trading strategy allows to reveal presence of the day-of-the-week anomaly, and its influence to final return of selected share. The research was performed with the financial trading data of 24 shares of Vilnius Stock Exchange (from 2003-01-01 to 2006-11-21) for calculating shares return, generated by making investment operations only on the fixed day of the week.

In this work we took into account the trading taxes (0.3 % in the Vilnius Stock Exchange). The taxes applied for operations are calculated from the sum of investment, therefore the suggested algorithm had to minimize the number of operations.

Application of the suggested method revealed significance of this effect for majority of the shares of the Vilnius Stock Exchange (20 out of 24 analysed).

As distinct from the previous research findings obtained by applying statistical analysis methods, the significant difference of the shares was determined by the biggest return value. Though the effect was indicated on Fridays and Mondays, as reported in the research works, but on Mondays the return value was not significantly lower. In contrast, the difference was recognized by the biggest value of return even for 7 shares (out of 8). The other difference of findings was observed dependency of the effect from the trading volume. Monday effect was more frequently indicated from the shares with bigger trading volume.

Comparing the presence of the day-of-the-week effect obtained in this work and paper [11] using artificial neural networks we conclude that only four shares were marked as affected by both methods. The low compatibility of the results can be explained by the diminishing tendency of the day-of-the-week effect on the Vilnius Stock Exchange.

The further research work for analysis of impact of the day-of-the-week effect, and explore tendencies of its significance at the Vilnius Stock Exchange could extent the research data set with newest trading data, and research the

stability of obtained results

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