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 (IN)EFFECTIVENESS OF CAPITAL MARKET AND ANOMALIES  
 IN VALUE AT RISK DISTRIBUTION IN TIME \*

*This paper aims at verifying whether potential anomalies in return rates as reflected in the behavior of Value at Risk. VaR determinants are modelled here on the data of Warsaw Stock Exchange, 2010 to 2014 and the WIG30 index in particular. The month-of-the-year effect is the most negative and explicit for September data. In terms of commercial weeks, the highest probable losses are observed for the 5th group, or the turn of the month. And the day-of-the-week effect is hard to determine.*

*Keywords:* value-at-risk; Warsaw Stock Exchange; return rates; time anomalies; potential losses.

Ґжеґож Ментель, Ришард Радванський  
 (НЕ)ЕФЕКТИВНІСТЬ РИНКУ КАПІТАЛУ ТА АНОМАЛІЇ  
 РОЗПОДІЛУ "VALUE AT RISK" У ЧАСІ

*У статті зроблено спробу описати потенційні аномалії у рівні прибутків в умовах схильності фондової біржі до ризику. Схильність до ризику змодельовано за даними Варшавської фондової біржі, 2010–2014 рр., зокрема, за індексом WIG30. Негативний ефект місяця року відчутно спостерігається для вересня. Щодо ефекту тижня, найбільші потенційні втрати спостерігаються для п'ятої групи, тобто для стику місяців. Ефект дня тижня для даної вибірки однозначно визначити не вдалось.*

*Ключові слова:* вартість під ризиком; Варшавська фондова біржа; рівень прибутків; часові аномалії; потенційні збитки.

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Ґжеґож Ментель, Ришард Радванський  
 (НЕ)ЭФФЕКТИВНОСТЬ РЫНКА КАПИТАЛОВ И АНОМАЛИИ  
 РАСПРЕДЕЛЕНИЯ "VALUE AT RISK" ВО ВРЕМЕНИ

*В статье сделана попытка описать потенциальные аномалии в уровне прибылей в условиях склонности фондовой биржи к рискам. Моделирование потенциальных рисков и убытков проведено по данным Варшавской фондовой биржи, 2010–2014 гг., в частности, по индексу WIG30. Отрицательный эффект месяца года отчетливо заметен для сентября. Эффект недели особенно заметен для пятой группы, т.е. для стыка месяцев. Эффект дня недели для данной выборки однозначно определить не удалось.*

*Ключевые слова:* стоимость под риском; Варшавская фондовая биржа; уровень прибыли; временные аномалии; потенциальные убытки.

**Introduction.** While referring to the classical hypothesis of capital markets effectiveness, which says that the analysis of past return rates should provide useful information, allowing to forecast the return rates in the future, it seems that under effective market, permanent seasonal dependencies should not take place. However, there are numerous works on world stock exchange suggesting the presence of a certain time distribution of return rates from stock exchange instruments. Numerous studies prove that the discussed return rate may depend on a part of a day, week or month. These are the so-called "day-of-the-week" or e.g. "the-month-of-the-year" effects,

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often referred to in literature. It is broadly ascertained that such notes may give rise to some controversies, but despite sizeable groups of proponents and opponents of those theories, it is worth taking a closer look at certain market behaviours, if they really exist. Because the fact that certain dependencies and regularities are present, they might provide a fair amount of information for investors.

As research on (in)effectiveness of capital market, in the context of return rates, was also performed on assets of domestic stock exchange market, this paper aims at verifying whether potential anomalies, which, according to some researchers, take place in relation to return rates and can be reflected in behaviour of *Value at Risk*. This measurement is directly connected with percentage changes of prices of instruments listed at stock exchange. Hence, this paper constitutes a fragment of a cycle of articles on the *VaR* model determinants, and effectiveness of their estimations (Mentel, 2011, 2013; Mentel and Brozyna, 2014, 2015; Brozyna and Mentel, 2015).

**The review of research on "effects" in time distribution of return rates.** While reviewing the already performed research on time anomalies of return rates, it is worth conducting it in terms of separate effects. Therefore, it would be a good idea to start with "the month-of-the-year" often referred to as the "January effect". Such an effect belongs to the group of most recognized calendar anomalies for return rates. Information on studies on American market may be found in (Fama, 1991; Haugen and Lakoniskok, 1988; Dimison, 1988). "Turn-of-the-year" effect was observed even earlier (Glutekin and Glutekin, 1983). The discussed regularity was then noticed in case of capital markets in 16 highly industrialized states. Although, those studies did not point to such a significant connection between return rates seasonality and company size, which took place at American market. Specific activity of market, which can be observed during the first 5 sessions of a new year, when the highest return rates were recorded, was noticed in (Keuim, 1983). The January effect was also observed in Japan (Kiyoshi, 1985), Great Britain (Reinganum and Shapiro, 1987) and Australia (Brown et al., 1983). More recent research in this field often denies the existence of "January effect" rather than confirms it. As an example, 50 studies of stock markets can be mentioned (Giovanis, 2009), in which the January effect was detected only for 7 markets. In these tests at 12 markets greater gains actually occurred for December. For the analysis of eleven Asian markets (Keong, 2010) with the application of GARCH (1,1) model indications were also not clear. Thus, effects were noticeable but in different months. As in Giovanis the effect of December was often noticeable. Only for Hong Kong, Japan, Korea and China it was not clear. The studies of the Australian Stock Exchange (Marett and Worthington, 2011) indicate quite different months as those with the highest incomes. Patel (2012) argues that the "January effect" does not exist.

A widely analyzed dependency is posed by differences in return rates for various countries. As it was proven for American market, the average Monday return rates are significantly lower than the average percentage changes in the remaining days. An additional observed regularity is that in majority of the studied periods, return rates adopted a negative value in Mondays (French, 1980; Gibbson and Hess, 1981; Keim and Stambaugh, 1985). The reason for negative Monday return rates was researched by (Rogalski, 1984), and a confirmation of his achievement may be found in (Smirlock and Starks, 1986). The studies over "the day-of-the week effect" were also

performed in Great Britain, Canada, Japan and Australia (Jaffe and Westerfield, 1985). Solnik and Bousquet (1990) also showed a strong and consistent negative return on Tuesday. Their studies have been conducted based on Paris stock exchange. Barone (1990) confirmed these results by finding the biggest decline in Italian share prices regularly on Tuesday. Mills and Coutts (1995) also investigated the effect of the day of the week as well as Arsad and Coutts (1996). Their research was related to British stock exchange. Apolonario et al. (2006) provides evidence of the occurrence of the day of the week at European stock markets. Similarly, Choudhry (2000) examining this phenomenon at 7 Asian emerging markets (India, Indonesia, Malaysia, the Philippines, South Korea, Taiwan and Thailand).

Studies on time dependencies in shares prices behaviour were also conducted in relation to the return rates realized within an hour. They were inspired by the willingness to explore the "day-of-the-week" effect more deeply. The abovementioned Smirlock and Starks analyzed the hourly data. They proved that returns were averagely negative during the first hour of a Monday session. In remaining days, the average returns during the first hours were positive. Some researchers went further in their studies, breaking periods into 15-minute time fragments. Thus, Harris (1986) confirmed the effectiveness of the previous research. He narrowed down the existence of average negative returns during Monday sessions to their first 45 minutes.

Here, it needs to be emphasized that potential presence of certain regularities in the distribution of return rates theoretically undermined the hypothesis on capital market effectiveness. At the same time, it ought to be noted that while the presence of a potential month-of-the-year effect could be applied in practice, potential dependencies recorded with regard to percentage changes of prices during a week or a day, have limited practical meaning. Potential profits would be burdened with numerous commissions arising from a significant frequency of placing market orders.

**Value at Risk and anomalies in time.** As the amount of research on time "effects" of percentage changes in prices of financial instruments has already been significant, it is worth turning to potential regularities that may appear within the above deliberated anomalies, with regard to the *VaR*. This measurement is strictly based on return rates, and it may be undoubtedly stated that it depends on them directly. The observed potential anomalies in behaviour of this measurement would provide considerable support to the process of expanding knowledge on market risk. Information, which would arise from potential, notices "effects", would be highly precious for investors. It needs to be borne in mind that *Value at Risk* means such a loss in the value of an instrument or a portfolio that a probability to experience or exceed it is equal to the presumed level of significance. Hence, in case any potential time tendencies in suggestions of losses appear, we would obtain valuable information on the periods of increased threats, thus the often elevated aversion towards risk, seen in investors, would be supported by real market behaviour.

To identify the existence, or lack, of regularities in *VaR* behaviours, estimations of this measurement were exploited on the basis of Monte Carlo simulation. This method was selected as it requires some assumptions that pertain to the distribution of the instrument, for which it is determined. Its potential suggestions do not deviate drastically from the values obtained during the estimation with parametric methods (Mentel, 2011, 2013). What is more, estimations of *Value at Risk*, obtained as a result

of its application are highly flexible, i.e. they follow real market changes. Therefore, changes that appear in market listing become reflected in *VaR* suggestions quickly, not after a long time. Average *VaR*, specified for the deliberated research sample, oscillated around the threshold value, which in this case was accepted on the significance level of 0.05 for daily return rates. In turn, for weekly percentage changes in prices, it did not go beyond the 6% level, which seems to be equally satisfactory.

The mentioned research group constituted 30 entities, the WIG30 index of the Warsaw Stock Exchange for December 2014. The deliberated time horizon is the period between 2010 and 2014. A five-year-long research period seems to be sufficiently long to confirm potential regularities. Estimations of *Value at Risk* were performed on the basis of both daily and weekly return rates.

***VaR* distributions in time. Study results.** While looking at the research on the distribution of *VaR* in the context of the "month-of-the-year" effect, some clear, negative regularities can be noticed for September (Table 1). More than a half of the subjected entities "reached" their maximum average losses in that month. When it comes to positive aspects of *Value at Risk*, there was no distinct repeated behaviour found. The lowest average losses are distributed differently in the analyzed sample.

What is more, it seems that significant majority of maximum losses can be recorded in the second half of the year. When it comes to analysis of *VaR* average values in the group of all companies, ING BSK<sup>3</sup> and Boryszew<sup>4</sup> companies were omitted in each considered variant. It is caused mainly by the presence of splits in listings for those entities, which exerted clear influence on ramming up losses, thus interfering in calculations.

Analysis of the results for weekly return rates confirms the previous observations. September may be again perceived as a negative leader. Distribution of losses in division into the first and the second half of the year also seem analogical as it was with analysis of daily changes in prices.

Analysis of the discussed effect within the course of specific years (Table 3) does not point to September so clearly, as the period in the year, when we deal with increased values of anticipated threats. It is true that the general average value is maximal in this case, however, it is mainly caused by negative changes that took place in the second half of 2011. The rammed up average monthly losses in September may arise mainly from the fact that during the preceding months (June-August) negative return rates were recorded in the same section. It needs to be borne in mind that *Value at Risk* forecasts are prepared on the basis of historical data, the significance of which diminishes as the process of reaching future advances. Hence, the directly preceding periods decide about *VaR* estimations to a significant extent.

No estimations for the period January-June 2010 result from the fact that determination of *VaR* by Monte Carlo method was performed on the basis of historical data reaching 150 past observations (Mentel and Brozyna, 2014).

The study of the "week-in-the-month" effect may be considered in two variants. The first one assumes that determined *VaR* values are classified into one – out of five

<sup>3</sup> In case of the ING BSK company, there was a split performed in November 2011 in the ratio of 1:10.

<sup>4</sup> In case of Boryszew, we deal with two events that interfered the *VaR* estimations. The first one is the resolution on increase in capital (November 2010), which resulted in exchange rate reduction by 3.19 PLN. The second one is a split of company's securities in the ration of 10:1 (April 2014).

– groups, regarding the day, when the last session of a given week took place. The first group encompasses the first commercial weeks of each month, ending between the 5th and 11th day of the month. The second group is full commercial week, second in the month, when the last session takes place between 12th and 18th day of the month. The second and fourth groups were determined analogically. The fifth group embraces the weeks a the turn of calendar months, when the last session takes place before the 5th day of the month. It is the smallest group, as there were some months, when observations in this period were insufficient. The results are presented in Table 4.

*Table 1. Average monthly VaR for WIG30 index, between 2010 and 2014, daily return rates, own work*

	January	February	March	April	May	June	July	August	September	November	October	December
	Percentage loss – daily return rate											
Pekao	2.52	2.61	2.70	2.64	2.78	2.89	3.23	3.28	3.29	3.15	2.80	2.51
PZU	2.00	2.22	1.98	2.51	2.99	2.70	2.45	2.26	2.38	2.21	2.10	1.86
PKO BP	2.51	2.14	2.23	2.01	2.18	2.46	2.44	2.82	3.03	2.99	2.71	2.44
KGHM	3.55	3.08	3.39	3.53	3.25	3.05	3.77	3.69	3.67	3.83	3.84	3.81
PKN Orlen	3.33	2.86	3.05	3.00	2.71	2.74	2.85	3.41	3.51	3.06	2.96	3.13
PGE	2.52	2.43	2.54	2.30	2.23	2.62	2.85	2.97	3.35	3.00	2.71	2.71
BZWBK	2.06	2.17	1.87	1.67	1.83	1.98	1.90	2.41	2.62	2.21	1.93	2.00
LPP	2.97	2.80	3.47	3.41	3.29	3.12	2.99	3.34	3.52	3.26	2.99	2.86
PGNiG	2.89	2.69	2.75	2.42	2.56	2.72	3.02	2.80	2.76	2.43	2.55	2.96
mBank	2.93	2.84	2.76	2.50	2.34	2.81	2.54	3.33	3.76	3.53	3.14	2.99
Orange	3.18	4.32	3.86	2.99	2.72	2.88	3.12	2.68	2.74	3.22	3.29	3.02
Tauron	2.62	2.63	2.94	2.72	2.74	2.83	3.11	3.14	2.97	2.62	2.72	2.81
Cyfrowy Polsat	2.90	2.67	2.97	3.12	3.08	3.20	3.03	3.11	3.39	3.00	2.96	2.90
ING BSK*	9.13	5.88	4.09	3.26	2.93	2.50	2.29	2.87	3.12	2.68	9.20	13.3
Energa							1.80	2.23	3.12	2.45	2.11	2.31
AssecoPol	2.46	2.44	2.69	2.42	2.79	2.82	2.77	2.83	3.11	3.06	2.81	2.63
Bogdanka	2.71	2.58	2.68	2.57	2.68	2.68	2.67	2.45	2.79	3.17	3.02	2.72
Enea	3.04	2.71	2.52	3.02	2.69	2.96	2.76	3.02	3.04	2.67	2.64	2.50
Handlowy	3.05	2.96	2.83	2.58	2.79	2.97	3.62	3.64	3.65	3.35	3.09	3.11
Alior	2.56	2.17	2.79	2.68	2.35	1.83	2.23	2.70	3.00	4.59	5.00	3.66
CCC	2.67	2.90	3.04	2.68	2.94	2.86	2.59	3.05	3.47	3.47	3.33	2.79
EUROCASH	3.87	3.47	3.51	3.33	3.37	3.45	3.87	3.91	4.25	3.78	3.71	3.99
Grupa Azoty	4.11	3.96	3.87	3.54	4.57	4.55	4.73	4.46	4.21	3.88	3.48	3.61
TVN	3.19	3.12	3.22	3.03	3.10	3.18	3.83	4.00	4.40	3.52	3.62	3.63
Synthos	3.48	3.12	3.47	4.25	3.98	3.69	3.62	3.58	4.31	3.86	3.33	3.38
Lotos	3.20	3.02	3.09	3.10	2.83	2.88	3.27	3.80	3.59	3.31	3.29	3.23
GTC	3.60	4.27	4.26	3.81	3.85	4.31	3.82	3.78	4.17	3.58	3.29	3.12
Kernel	4.12	3.78	5.05	4.49	4.68	4.64	3.74	3.60	3.78	3.80	4.11	4.60
JSW	2.87	3.02	3.40	3.77	3.65	3.55	3.99	3.68	4.03	3.70	3.60	3.59
Boryszew**	4.13	3.68	3.50	22.5	16.0	9.72	6.45	5.25	5.47	8.87	6.61	4.62
Average	<b>3.00</b>	<b>2.92</b>	<b>3.07</b>	<b>2.97</b>	<b>3.00</b>	<b>3.05</b>	<b>3.09</b>	<b>3.21</b>	<b>3.43</b>	<b>3.24</b>	<b>3.11</b>	<b>3.03</b>

In case of the considered anomaly, some regularities may be initially pointed. In majority, the maximal average losses for the last from the analyzed periods become

visible. Almost 2/3 of the research sample reached the highest average *VaR* values in this period. In turn, in half of the cases we deal with minimal average losses for the first commercial week connected with the beginning of each month. We deal here with a reversed dependency when compared to classic average return rates in that periods. In the 5th group, the maximal average percentage changes in prices were recorded on the level of 0.12%, while in the 1st group, the minimal average return rates oscillated around -0.06%.

**Table 2. Average monthly *VaR* for WIG30 index, between 2010 and 2014, weekly return rates, own work**

	January	February	March	April	May	June	July	August	September	November	October	December
	Percentage loss – weekly return rate											
Pekao	4.64	5.08	4.59	4.52	4.81	5.41	6.16	7.09	6.73	5.94	5.04	4.90
PZU	4.74	4.52	4.06	3.85	4.11	4.44	4.36	4.93	6.20	6.13	5.10	4.41
PKO BP	5.06	4.71	4.68	4.19	4.30	4.46	4.62	6.06	6.40	5.99	5.21	4.74
KGHM	8.23	7.08	8.03	8.25	7.06	6.83	9.28	8.81	8.11	8.41	7.86	9.37
PKN Orlen	7.73	7.18	6.75	6.23	5.69	5.83	6.99	8.80	7.72	6.11	6.53	7.31
PGE	4.99	5.07	4.91	4.08	4.25	5.02	5.73	6.34	6.39	6.30	5.40	5.20
BZWBK	4.06	4.90	3.40	3.26	3.69	3.93	3.67	4.49	5.19	4.64	3.53	3.50
LPP	5.94	5.43	7.11	7.61	7.23	6.38	5.31	7.08	7.98	7.22	6.51	6.37
PGNiG	5.78	5.81	5.52	5.20	5.60	5.92	5.63	5.50	5.36	4.50	4.67	5.86
mBank	5.96	5.73	4.99	4.23	4.06	4.93	4.71	7.17	7.55	7.19	6.34	6.38
Orange	5.11	9.25	9.51	6.17	5.53	5.70	6.56	6.54	5.59	6.66	7.45	6.13
Tauron	5.40	5.26	5.76	5.08	5.23	4.78	5.96	6.79	6.30	5.67	5.39	5.85
Cyfrowy Polsat	6.55	5.88	5.53	5.66	5.30	5.07	5.29	5.74	6.35	6.10	6.57	6.61
ING BSK*	21.2	13.4	8.73	6.50	5.06	4.71	4.62	6.18	6.23	5.61	19.6	32.6
Energa							3.63	4.26	7.00	5.52	4.23	3.94
AssecoPol	4.86	4.57	5.12	4.91	5.52	6.79	4.96	5.68	5.85	7.07	6.11	5.93
Bogdanka	5.60	5.41	5.13	4.87	5.13	5.70	6.02	5.55	5.84	6.47	6.76	6.34
Enea	5.37	4.86	4.78	6.74	5.98	6.06	5.43	6.08	6.53	5.45	5.35	5.44
Handlowy	6.53	6.03	5.67	5.60	4.93	5.29	6.41	7.77	7.95	7.33	7.10	6.77
Alior	6.15	5.65	5.90	5.30	5.65	4.45	3.24	5.02	6.70	8.50	9.16	7.20
CCC	6.40	6.78	6.48	5.74	6.64	6.19	4.93	6.75	7.72	7.98	8.00	6.82
EUROCASH	9.74	8.60	8.44	7.06	6.70	6.73	7.34	8.51	9.45	8.29	9.18	10.4
Grupa Azoty	10.3	9.57	7.31	7.11	9.25	9.38	9.69	10.3	9.05	7.88	7.18	7.63
TVN	8.01	7.31	6.44	6.65	7.31	7.24	8.76	9.92	10.1	7.78	8.42	9.01
Synthos	8.71	7.94	9.15	9.50	8.51	8.18	7.64	8.16	9.43	8.58	7.61	8.00
Lotos	7.09	6.72	6.70	6.15	5.76	6.48	7.83	9.17	8.07	6.95	6.84	7.05
GTC	8.89	9.54	8.88	7.97	7.48	9.77	8.18	8.52	9.80	8.64	8.22	8.04
Kernel	8.27	7.01	10.4	9.30	9.66	9.43	7.92	7.64	8.43	7.77	9.59	10.7
JSW	7.32	7.03	7.21	7.57	6.73	7.27	9.44	8.98	10.4	9.47	9.07	9.40
Boryszew**	10.3	8.57	7.64	47.0	37.8	22.4	14.7	13.7	13.9	20.9	16.5	11.6
Average	<b>6.57</b>	<b>6.41</b>	<b>6.39</b>	<b>6.03</b>	<b>6.00</b>	<b>6.21</b>	<b>6.27</b>	<b>7.06</b>	<b>7.43</b>	<b>6.95</b>	<b>6.73</b>	<b>6.76</b>

The results from Table 5 confirm that estimations of potential losses, obtained for the last separated group, are the most disadvantageous. The 1st group, as above, is a period, when average *VaR* values were the most optimal.

Similarly to the previous case, the section analysis was performed with regard to the discussed variant, in relation to the considered years (Table 6). Despite a short period, the negative effect of the last commercial week in the month, is confirmed much earlier than the previous effect of September.

**Table 3. Average monthly VaR for WIG30 index, between 2010 and 2014, in years, own work**

	January	February	March	April	May	June	July	August	September	November	October	December
Percentage loss – daily return rate												
2010								2.49	2.42	2.59	2.68	2.91
2011	3.00	2.73	2.51	2.50	2.48	2.41	2.71	4.56	5.23	4.67	4.03	3.85
2012	3.33	3.08	3.00	3.01	3.13	3.46	3.30	3.08	2.90	2.64	2.65	2.73
2013	2.67	2.92	3.01	3.25	3.49	3.68	3.93	3.42	3.83	3.47	3.36	2.96
2014	3.07	3.04	3.73	3.08	2.92	2.76	2.60	2.72	2.84	2.79	2.79	2.81
Average	<b>3.02</b>	<b>2.94</b>	<b>3.06</b>	<b>2.96</b>	<b>3.01</b>	<b>3.08</b>	<b>3.14</b>	<b>3.26</b>	<b>3.44</b>	<b>3.23</b>	<b>3.10</b>	<b>3.05</b>
Percentage loss – weekly return rate												
2010								5.25	5.18	5.52	6.07	6.32
2011	6.27	5.63	5.19	5.17	4.89	4.85	5.25	10.72	11.22	10.04	8.76	8.63
2012	7.49	7.17	6.51	5.81	6.22	7.23	6.80	6.65	6.44	5.78	5.63	5.89
2013	5.71	6.13	6.66	6.96	7.23	7.54	8.16	7.59	8.02	7.34	7.16	6.86
2014	6.85	6.71	7.14	6.16	5.66	5.36	5.15	5.71	6.30	6.00	6.16	6.45
Average	<b>6.58</b>	<b>6.41</b>	<b>6.37</b>	<b>6.03</b>	<b>6.00</b>	<b>6.25</b>	<b>6.34</b>	<b>7.18</b>	<b>7.43</b>	<b>6.93</b>	<b>6.76</b>	<b>6.83</b>

The "week-of-the-month" problem may also be approached from a slightly different angle, in the manner presented in Table 7. This time, 4 groups were established. The first one is comprised of indications for the first 7 calendar days of the month. The subsequent groups are formed by *Value at Risk*, estimated between the 8th and 15th and 16th and 22nd day. The last, fourth group is comprised of potential losses values, experienced from the 23rd day.

It is hard to find any potential regularities with such a division. It might be concluded that the third from the determined periods is burdened with probably the highest risk, however, such an observation would be a little far-fetched. Differences in average values in the section of the analyzed entities are truly marginal. While considering each entity separately, we will not find any significant deviations, maybe apart from two or three cases, which seem relatively insignificant with such a sizeable sample. The only thing that can be confirmed is that estimations of potential losses for weekly return rates are clearer than in the first variant. What is more, a conclusion could be drawn that the second half of the month is burdened with negative effects to a much more considerable extent.

The analogical analysis, but by years (Table 8), confirms the above mentioned observations. Again, clearer results were obtained for *Value at Risk*, based on the weekly return rates. The effect of the third week is significantly separated in this case.

The analysis of daily sub-periods (Table 9) confirms the observations from numerous studies at the example of returns. Average *Value at Risk* reaches the lowest levels in Mondays, and the highest in Tuesdays/Thursdays. It is not a significant dif-

ference, however, it is compliant with general observations that refer to percentage changes in prices. It was concluded in their case that the average Monday return rates were positive, and in majority significantly higher from the ones obtained for other days of the week. This opinion is also confirmed for the considered research group. Generally, there are numerous researchers that confirm the fact that percentage changes in prices reached the lowest levels in Tuesdays, which is also confirmed in *VaR* suggestions obtained for that day. However, such conclusions should be drawn with certain attention, as general average values are only marginally different. This is mainly caused by the fact that the *VaR* itself is a smoothed value when compared to the original "element" – return rates in this case. However, while analyzing separate entities, more than half of them reach the maximal *VaR* level on Tuesday or Thursday.

**Table 4. Average weekly *VaR* for WIG30 index, between 2010 and 2014, for daily return rates, own work**

	1st group	2nd group	3rd group	4th group	5th group
	Percentage loss – daily return rate				
Pekao	2.86	2.91	2.89	2.90	2.93
PZU	2.31	2.29	2.28	2.26	2.43
PKO BP	2.51	2.53	2.53	2.54	2.58
KGHM	3.46	3.51	3.63	3.58	3.83
PKN Orlen	3.07	3.07	3.05	3.08	3.15
PGE	2.70	2.71	2.73	2.68	2.69
BZWBK	2.06	2.08	2.08	2.01	2.11
LPP	3.13	3.25	3.18	3.02	3.33
PGNiG	2.72	2.74	2.69	2.64	2.74
mBank	2.97	2.99	2.99	2.90	3.19
Orange	3.06	3.13	3.22	3.15	2.98
Tauron	2.81	2.80	2.80	2.87	2.90
Cyfrowy Polsat	2.97	3.03	3.09	3.02	3.03
ING BSK*	4.98	4.67	6.01	5.51	3.97
Energa	2.37	2.45	2.37	2.35	2.96
AssecoPol	2.69	2.73	2.80	2.73	2.88
Bogdanka	2.70	2.81	2.74	2.62	2.79
Enea	2.78	2.79	2.84	2.69	2.77
Handlowy	3.15	3.17	3.17	3.17	3.17
Alior	3.12	3.13	3.44	3.26	2.68
CCC	2.95	3.00	3.05	3.03	3.00
EUROCASH	3.75	3.72	3.72	3.68	3.66
Grupa Azoty	3.97	3.97	4.14	4.15	4.22
TVN	3.44	3.57	3.56	3.52	3.58
Synthos	3.62	3.66	3.72	3.69	3.85
Lotos	3.19	3.22	3.27	3.28	3.32
GTC	3.77	3.79	3.80	3.79	3.85
Kernel	4.26	4.18	4.09	4.17	4.11
JSW	3.53	3.62	3.57	3.60	3.71
Boryszew**	8.45	8.28	7.89	7.03	7.86
Average	<b>3.07</b>	<b>3.10</b>	<b>3.12</b>	<b>3.09</b>	<b>3.16</b>

The correlational dependency between the Monday *VaR* suggestions, obtained for daily return rates and these kind of results for percentage changes is 0.325129.



Significance of dependencies between the discussed variables could be considered, but they are certainly positive what suggests direct proportionality. Higher positive values of Monday return rates formally generate higher *VaR* values in this period, and the other way round.

*Table 5. Average weekly VaR for WIG30 index, between 2010 and 2014, for daily return rates, own work*

	1st group	2nd group	3rd group	4th group	5th group
	Percentage loss – weekly return rate				
Pekao	5.40	5.48	5.46	5.45	5.60
PZU	4.62	4.80	4.81	4.70	4.93
PKO BP	4.90	5.14	5.14	5.05	5.44
KGHM	7.95	7.93	8.27	8.32	8.64
PKN Orlen	6.79	6.94	7.03	6.91	7.33
PGE	5.35	5.37	5.44	5.33	5.23
BZWBK	3.99	4.05	4.09	3.97	4.10
LPP	6.56	6.93	6.92	6.49	6.74
PGNiG	5.40	5.53	5.46	5.34	5.39
mBank	5.76	5.94	5.97	5.63	6.21
Orange	6.52	6.39	6.80	6.84	6.31
Tauron	5.52	5.56	5.63	5.71	6.35
Cyfrowy Polsat	5.76	5.83	6.13	5.98	5.97
ING BSK*	11.22	10.40	12.78	12.54	8.15
Energa	4.59	4.93	5.25	4.94	6.65
AssecoPol	5.64	5.53	5.74	5.71	5.93
Bogdanka	5.71	5.83	5.82	5.60	6.25
Enea	5.63	5.55	5.71	5.66	5.84
Handlowy	6.52	6.52	6.68	6.51	6.54
Alior	6.15	6.52	6.82	6.61	5.45
CCC	6.60	6.80	6.93	6.76	6.56
EUROCASH	8.40	8.33	8.55	8.40	8.21
Grupa Azoty	8.49	8.35	8.75	8.79	9.41
TVN	8.05	8.14	8.28	8.16	8.60
Synthos	8.30	8.39	8.62	8.38	8.66
Lotos	6.92	7.10	7.28	7.10	7.25
GTC	8.50	8.63	8.76	8.60	8.99
Kernel	8.91	8.94	8.86	8.68	8.55
JSW	8.14	8.25	8.48	8.60	8.39
Boryszew**	19.51	19.48	18.95	16.97	16.69
Average	<b>6.47</b>	<b>6.56</b>	<b>6.70</b>	<b>6.58</b>	<b>6.77</b>

**Conclusions.** The hypothesis presented at the beginning of the paper, pertaining to effectiveness of capital markets, suggests among others that changes in shares prices take place randomly, thus the analysis of price levels in the future does not provide any information that would pose a basis for return rates higher than those resulting solely from the level of risk of a given security, measured through the beta coefficient. A challenge for this fundamental principle is constituted by numerous studies, pointing to the presence of certain seasonal dependencies in distribution of return rates. As it turns out, even highly developed markets, which have the largest opportunity to meet the effectiveness criteria, the percentage price change may depend on a month, day etc.

Table 6. Average weekly VaR for WIG30 index, between 2010 and 2014, by years, own work

	1st group	2nd group	3rd group	4th group	5th group
Percentage loss – daily return rate					
2010	2.59	2.59	2.63	2.35	2.65
2011	3.26	3.36	3.44	3.42	3.72
2012	3.04	3.03	3.04	3.04	3.04
2013	3.34	3.37	3.40	3.41	3.26
2014	2.92	2.93	2.92	2.90	2.93
Average	<b>3.03</b>	<b>3.05</b>	<b>3.09</b>	<b>3.03</b>	<b>3.12</b>
Percentage loss – weekly return rate					
2010	5.57	5.52	5.73	4.83	5.48
2011	6.85	7.21	7.40	7.23	8.10
2012	6.45	6.36	6.52	6.56	6.60
2013	7.11	7.08	7.23	7.35	6.89
2014	6.00	6.10	6.22	6.12	6.24
Average	<b>6.40</b>	<b>6.45</b>	<b>6.62</b>	<b>6.42</b>	<b>6.66</b>

Table 7. Average weekly VaR for WIG30 index, between 2010 and 2014, own work

	1st – 7th day	8th – 15th day	16th – 22nd day	23+	1st – 7th day	8th – 15th day	16th – 22nd day	23+
Percentage loss								
daily return rate					weekly return rate			
Pekao	2.85	2.90	2.91	2.86	5.41	5.44	5.49	5.47
PZU	2.32	2.30	2.29	2.27	4.64	4.80	4.83	4.68
PKO BP	2.51	2.54	2.53	2.51	4.92	5.14	5.19	5.10
KGHM	3.50	3.53	3.63	3.59	8.04	8.00	8.25	8.36
PKN Orlen	3.06	3.09	3.06	3.05	6.76	6.99	7.06	6.97
PGE	2.70	2.73	2.71	2.71	5.34	5.38	5.41	5.35
BZWBK	2.08	2.07	2.08	2.07	4.04	4.02	4.11	4.04
LPP	3.14	3.25	3.20	3.09	6.51	6.95	6.98	6.52
PGNiG	2.73	2.76	2.70	2.67	5.37	5.56	5.50	5.35
mBank	3.00	3.01	3.00	2.95	5.76	5.92	6.02	5.80
Orange	3.08	3.12	3.22	3.20	6.59	6.37	6.83	6.95
Tauron	2.82	2.81	2.80	2.87	5.59	5.61	5.69	5.70
Cyfrowy Polsat	2.97	3.03	3.09	3.02	5.77	5.78	6.17	5.98
ING BSK*	5.13	4.75	5.15	5.62	11.60	10.56	10.80	12.62
Energa	2.38	2.48	2.50	2.34	4.70	5.00	5.22	4.87
AssecoPol	2.73	2.73	2.78	2.76	5.68	5.56	5.69	5.74
Bogdanka	2.69	2.82	2.75	2.68	5.75	5.89	5.82	5.71
Enea	2.79	2.78	2.84	2.77	5.68	5.58	5.71	5.78
Handlowy	3.14	3.16	3.19	3.15	6.45	6.46	6.69	6.59
Alior	3.14	3.10	3.17	3.25	6.21	6.36	6.51	6.60
CCC	2.96	2.99	3.04	3.01	6.59	6.70	6.96	6.81
EUROCASH	3.76	3.74	3.71	3.71	8.45	8.40	8.48	8.46
Grupa Azoty	4.01	3.97	4.10	4.19	8.66	8.40	8.64	8.96
TVN	3.46	3.53	3.59	3.50	8.11	8.04	8.33	8.23
Synthos	3.63	3.67	3.71	3.67	8.21	8.43	8.65	8.42

Continuation of Table 7

	1st – 7th day	8th – 15th day	16th – 22nd day	23+		1st – 7th day	8th – 15th day	16th – 22nd day	23+
Lotos	3.20	3.23	3.29	3.23		6.94	7.11	7.31	7.14
GTC	3.75	3.80	3.82	3.81		8.56	8.59	8.80	8.71
Kernel	4.26	4.20	4.11	4.15		8.94	8.92	8.88	8.68
JSW	3.56	3.63	3.61	3.59		8.20	8.28	8.51	8.60
Boryszew**	7.92	8.52	8.03	7.31		17.70	19.89	19.24	17.55
Average	<b>3.08</b>	<b>3.11</b>	<b>3.12</b>	<b>3.10</b>		<b>6.50</b>	<b>6.56</b>	<b>6.70</b>	<b>6.63</b>

Table 8. Average weekly VaR for WIG30 index, between 2010 and 2014, by years, own work

	1st – 7th day	8th – 15th day	16th – 22nd day	23+
Percentage loss – daily return rate				
2010	2.58	2.60	2.63	2.58
2011	3.30	3.37	3.44	3.30
2012	3.04	3.04	3.03	3.04
2013	3.36	3.36	3.37	3.36
2014	2.92	2.94	2.94	2.92
Average	<b>3.04</b>	<b>3.06</b>	<b>3.08</b>	<b>3.04</b>
Percentage loss – weekly return rate				
2010	5.40	5.54	5.73	5.40
2011	6.93	7.24	7.41	6.93
2012	6.47	6.39	6.50	6.47
2013	7.14	7.05	7.23	7.14
2014	6.04	6.10	6.25	6.04
Average	<b>6.40</b>	<b>6.46</b>	<b>6.62</b>	<b>6.40</b>

The performed research on the *Value at Risk* for the Warsaw Stock Exchange, as a "derivative" measurement for return rates, also suggests certain differences in time distribution. They might not be as clear as in the case of return rates, but several reasons of such a state of affairs can be found. One of these reasons is considerable smoothening of the *VaR* value in relation to percentage changes in prices of the instrument, for which the anticipated potential changes were determined. Therefore, changes in *Value at Risk* from period to period are not as significant as it may take place in the case of return rates. The longer the considered periods, the more observable are the differences in suggestions.

Taking the "month-of-the-year" effect into account, it is possible to specify the month of September as the most negative case, as in this period the forecasts of losses are maximal. While considering the positive aspect of *VaR* in such terms, it seems that the period with the lowest values of the anticipated losses is May. This is no longer so obvious as in the case of the abovementioned September as we get other indications for the *VaR* based on daily returns and a bit different in terms of weekly percentage changes in prices. One thing that can be emphasized in this case is the fact that the first half of the year is much more optimistic than the period of July-December. It is worth noting that differences in the indications for each month are statistically significant. Indeed, the application of ANOVA Kruskal-Wallis test, as a comparison of

the so-called many independent samples, we obtain the p-value equal to 0.0492 for  $VaR$  based on the daily rates of return and 0.0204 for the corresponding estimates for weekly returns.

**Table 9. Average daily  $VaR$  for WIG30 index, between 2010 and 2014, for the total sample, own work**

	Monday	Tuesday	Wednesday	Thursday	Friday	Monday	Tuesday	Wednesday	Thursday	Friday
	Percentage loss									
	daily return rate					weekly return rate				
Pekao	2.07	2.09	2.07	2.08	2.08	5.50	5.49	5.46	5.49	5.50
PZU	3.18	3.19	3.19	3.17	3.16	4.75	4.74	4.75	4.79	4.78
PKO BP	2.70	2.72	2.71	2.73	2.73	5.11	5.12	5.10	5.13	5.14
KGHM	2.99	3.02	3.01	3.02	3.01	8.11	8.22	8.15	8.25	8.22
PKN Orlen	3.13	3.14	3.17	3.17	3.14	6.93	7.00	6.96	6.97	6.97
PGE	2.83	2.84	2.82	2.83	2.83	5.38	5.41	5.37	5.41	5.40
BZWBK	3.03	3.02	3.04	3.05	3.03	4.06	4.07	4.06	4.07	4.06
LPP	5.16	5.40	5.26	5.24	5.12	6.74	6.78	6.76	6.73	6.71
PGNiG	2.45	2.49	2.42	2.35	2.43	5.42	5.44	5.42	5.45	5.47
mBank	2.76	2.77	2.76	2.75	2.77	5.86	5.92	5.90	5.93	5.89
Orange	2.73	2.74	2.73	2.74	2.76	6.65	6.66	6.64	6.67	6.61
Tauron	2.77	2.81	2.81	2.82	2.80	5.63	5.65	5.61	5.68	5.67
Cyfrowy Polsat	3.17	3.18	3.16	3.17	3.19	5.92	5.91	5.94	6.01	5.93
	Percentage loss									
	daily return rate					weekly return rate				
ING BSK	3.20	3.21	3.17	3.17	3.12	10.96	11.84	11.69	11.75	11.59
Energa	3.01	3.02	3.02	3.02	3.00	5.02	5.12	5.13	5.01	5.08
AssecoPol	3.72	3.73	3.72	3.75	3.74	5.65	5.66	5.70	5.70	5.72
Bogdanka	4.10	4.10	4.06	4.07	4.06	5.78	5.82	5.80	5.80	5.84
Enea	3.51	3.54	3.51	3.55	3.53	5.65	5.68	5.69	5.74	5.66
Handlowy	3.67	3.66	3.70	3.70	3.69	6.56	6.57	6.57	6.60	6.57
Alior	3.23	3.23	3.24	3.27	3.24	6.39	6.46	6.44	6.44	6.35
CCC	3.81	3.82	3.81	3.82	3.83	6.75	6.78	6.80	6.79	6.76
EUROCASH	4.16	4.21	4.17	4.17	4.13	8.38	8.47	8.43	8.51	8.44
Grupa Azoty	3.61	3.61	3.61	3.59	3.56	8.74	8.75	8.66	8.66	8.70
TVN	7.72	7.94	7.82	8.05	7.88	8.10	8.20	8.20	8.28	8.25
Synthos	2.07	2.09	2.07	2.08	2.08	8.42	8.46	8.51	8.55	8.44
Lotos	3.18	3.19	3.19	3.17	3.16	7.12	7.11	7.13	7.18	7.15
GTC	2.70	2.72	2.71	2.73	2.73	8.64	8.69	8.73	8.77	8.73
Kernel	2.99	3.02	3.01	3.02	3.01	8.77	8.89	8.84	8.82	8.78
JSW	3.13	3.14	3.17	3.17	3.14	8.44	8.37	8.33	8.37	8.37
Boryszew	2.83	2.84	2.82	2.83	2.83	18.09	18.77	18.76	18.34	18.20
Average	<b>3.10</b>	<b>3.12</b>	<b>3.11</b>	<b>3.11</b>	<b>3.11</b>	<b>6.59</b>	<b>6.62</b>	<b>6.61</b>	<b>6.64</b>	<b>6.61</b>

Relatively clear regularities can be noticed in case of analyses for a given month. However, they are not statistically relevant. The performed research suggests that significantly lower average potential losses take place in the initial period of each month, regardless the variant of division of "stock exchange market weeks". The highest average

levels of the *Value at Risk* are present in differently considered weekly variants. If we take full commercial weeks into account, the highest probable losses are experienced in the 5th group, i.e. at the turn of a month. In the second variant, here the period of maximal *VaR* estimations takes place between the 16th and the 22nd day of each month.

*Table 10. Average daily VaR for WIG30 index, between 2010 and 2014, for the whole sample, own work*

	Monday	Tuesday	Wednesday	Thursday	Friday
	Percentage loss – daily return rate				
2010	2.59	2.58	2.59	2.60	2.58
2011	3.36	3.41	3.39	3.43	3.43
2012	3.03	3.03	3.04	3.02	3.02
2013	3.39	3.40	3.37	3.36	3.37
2014	2.91	2.93	2.92	2.92	2.92
Average	<b>3.06</b>	<b>3.07</b>	<b>3.06</b>	<b>3.07</b>	<b>3.06</b>
	Percentage loss – weekly return rate				
2010	5.62	5.62	5.63	5.60	5.54
2011	7.11	7.25	7.25	7.35	7.29
2012	6.47	6.49	6.47	6.49	6.47
2013	7.22	7.22	7.18	7.16	7.18
2014	6.09	6.12	6.09	6.13	6.11
Average	<b>6.50</b>	<b>6.54</b>	<b>6.52</b>	<b>6.55</b>	<b>6.52</b>

The "day-of-the-week" effect seems to be the hardest to determine. Since we may point Monday as the most optimistic day, when it comes to forecasting potential threats, it is hard to unequivocally point a negative leader in this context.

Here, it needs to be borne in mind that any anomalies of *Value at Risk* in time, were based on a specific sample in a particular period. Only deeper analysis of other entities at Warsaw Stock Exchange or other markets could potentially confirm our observations. It would also be useful to consider another time period.

However, if their presence would be confirmed in the future, then it would constitute a premise proving ineffectiveness of the market in the *VaR* context.

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