

## Journal of Economics and Management

ISSN 1732-1948

Vol. 21 (3) • 2015

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### Analysis of selected seasonality effects in market of barley, canola, rough rice, soybean oil and soybean meal future contracts

#### Abstract

Likely to the equity market, the problem of anomalies in the commodities market is becoming an interesting phenomenon, particularly in the segment of the agricultural market. This paper tests the hypothesis of daily, the day-of-the week, the first and the second half of monthly effects on the market of futures contract of: barley, canola, rough rice, soybean oil and soybean meal, quoted in the period of 12.12.2006-31.06.2015 (barley) and 01.09.1998-31.06.2015 (the other commodities). Calculations presented in this paper indicate the existence of monthly effect: in September (canola), February and September (soybean oil) and July, September and October (soybean meal) as well as the day-of-the-week effect: on Tuesdays (canola) and on Thursdays (rough rice).

The seasonal effects were also observed in the case of testing the statistical hypothesis for daily averaged rates of return for different days of the month: 4<sup>th</sup> (barley), 12<sup>th</sup> (canola), 5<sup>th</sup> (rough rice) and 9<sup>th</sup> (soybean oil and soybean meal). The seasonal effects were no registered for the daily average rates of return in the first and in the second half of the month.

Keywords: market efficiency, calendar effects, commodity market. JEL Codes: G14, G15, C12.

#### Introduction

According to Efficient Market Hypothesis (EMH), introduced by Fama [1970], the security prices fully reflect all available information. This theory has been subjected to many analysis and has become a main source of disagreement between academics and practitioners. The problem of the financial markets efficiency, especially of equity markets, has become a main topic of number of scientific works, which has led to a sizable set of publications examining this issue. In many empirical work dedicated to the time series analysis of rates of return and stock prices, statistically significant effects of both types were found, i.e. calendar effects and effects associated with the size of companies. These effects are called "anomalies", because their existence testifies against market efficiency. Discussion of the most common anomalies in the capital markets can be found, among others, in Simson [1988] or Latif et al. [2011].

One of the most common calendar anomalies observed on the financial markets are:

- Day-of-the-week effect different distributions of expected rates of return can be observed for different days of the week [Keim and Stambaugh 1984]. On the Polish market, findings regarding the day-of-the-week effect were conducted among others by: Buczek [2005, pp. 51-55] and Szyszka [2007, pp.141-146].
- II. Monthly effect achieving by portfolio replicating the specified stock index, different returns in each month. For the first time, this effect was observed by Keim [1983], who noted that the average rate of return on stocks with small capitalisation is the highest in January.
- III. **Other seasonal effects** in the financial literature, the following calendar effects can be found:
  - The weekend effect Cross [1973] found that markets tend to raise on Fridays and fall on Mondays. His findings generated a flood of research [Lakonishok and Levi 1982; Jaffe and Westerfield 1985; Condoyanni et al. 1987; Connolly 1991; Abraham and Ikenberry 1994].
  - 2. The holiday effects markets before holidays or other trading breaks tend to rise.
  - 3. Within-the-month effect positive rates of returns only occur in the first half of the month [Ariel 1987; Kim and Park 1994].
  - 4. Turn-of-the month effect average rate of return calculated for the last day of the month and for three days of the next month, was higher than the average rate of return calculated for the month, for which the rate of return of only one session, was taken.

Commodity market is one of the segments of the financial market, characterised by high heterogeneity of assets compared to the stock or bond markets [Johnson and Soenen 1997]. It is often perceived as a separate asset class, which in turn leads to low correlation of commodity market rates of return in comparison to the returns on the stock or bonds markets. The consequence of this fact is the possibility of constructing more diversified investment portfolio compared to a portfolio solely consisting of shares or bonds. In the world literature, in contrast to the stock market, relatively little attention has been dedicated to the occurrence of the seasonality effects on the agricultural commodity market. This fact was one of the reasons encouraging the author to undertake empirical studies.

The aim of this article is to examine the prevalence of selected seasonality effects on the markets of: barley, canola, rough rice, soybean oil and soybean meal future contracts. The prices of barley and canola futures contracts, quoted on the Canadian ICE Futures Exchange are expressed in Canadian dollars and the contract unit is equal to 20 tons. The prices of soybean oil futures, soybean meal futures and rough rice futures are quoted on Chicago Mercantile Exchange in USD dollars and the contract unit is defined as: 60 000 lbs (~ 27 metric tons), 100 short tons (~ 91 metric tons) and 2 000 hundredweight (CWT) (~ 91 metric tons), respectively.

Analysis of the seasonality effects will apply to returns over various days of the week, over various days of the month, and as well as to average daily rates of return in the first (days from the  $1^{st}$  to the  $15^{th}$ ) and in the second half of month (from  $16^{th}$  to the end of the month). Statistical tests were conducted for barley futures in the periods of: 12.12.2006-31.06.2015, but for canola, soybean oil, soybean meal and rough rice futures in the period of: 01.09.1998-31.06.2015.

#### 1. Literature review

In the scientific literature a statement can be found that the stock market is somehow predestined to record number of anomalies, whereas the foreign exchange is the most effective of all the markets [Froot and Thaler 1990]. It is worth noting that the number of scientific papers dedicated to commodity market efficiency is lower than those relating to the stock market. Numerous research has examined the price efficiency of agricultural markets. However, many of the studies differ with respect to the analysed commodity, the covered time period and implemented method of analysis, and the type of data employed in the research [Garcia et al. 1988].

Tests of price market efficiency in a weak form were conducted among others by Bigman et al. [1983], Kofi [1972], Leath and Garcia [1983], Springs [1981] and Tomek and Gray [1970]. All of these studies focused on the following agricultural commodities: wheat, corn, soybeans [Bigman et al. 1983], wheat, corn, soybeans, cocoa, coffee [Kofi 1972], corn [Leath and Garcia 1983], corn [Springs 1981], corn, soybeans and potatoes [Tomek and Gray 1970], rice [McKenzie et al. 2002]. In turn, test of price market efficiency in a semi-strong form were performed by Canarella and Pollard [1985], Just and Rausser [1975], Rausser and Carter [1983] and regarded markets of: wheat, corn, soybeans, soybean oil (the two first papers) and markets of soybean and soybean oil (the third paper). The price inefficiency of some agriculture commodity markets was proved by [Garcia et al. 1988].

Lokare [2007] found an evidence concerning sugar and cotton markets in India, but Sahoo and Kumar [2009] concluded that the commodity futures markets of soybean oil was efficient in the same country. Ali and Gupta [2011] examined the efficiency of the futures markets of twelve agricultural commodities quoted at NCDEX with the use of Johansen's cointegration analysis. They proved that there was a long-term relationship between futures and spot prices for all of the selected commodities except wheat and rice. Sehgal et al. [2012], during the analysis of ten agricultural prices, in the period of June 2003 – March 2011, quoted on NCDEX, observed that all commodity markets were efficient except one (turmeric).

In summary, there has not been consensus about the efficiency of agricultural commodities. One reason for the heterogeneous results are the different test setups and the second: a single-market perspective [Otto 2011].

#### 2. Data and methods

The test for equality of two average rates of return will be applied in the case of hypothesis testing. According to the adopted methodology, the survey covers two populations of returns, characterised by normal distributions. On the basis of two independent populations of rate of returns, which sizes are equal  $n_1$  and  $n_2$ , respectively, the hypotheses  $H_0$  and  $H_1$  should be tested with the use of statistics *z* [Osińska 2006, pp. 43-44]:

$$z = \frac{\overline{r_1 - r_2}}{\sqrt{\left(\frac{s_1^2 + s_2^2}{n_1 + n_2}\right)}}$$
(1)

where:

- $\overline{r_1}$  average rate of return in the first population,
- $\overline{r_2}$  average rate of return in the second population,
- $n_1$  number of rates of return in the first population,
- $n_2$  number of rates of return in the second population,
- $S_1^2$  variance of rates of returns in the first population,
- $S_2^2$  variance of rates of returns in the second population.

The Formula 1 can be used in the case of normally distributed populations, when the populations variances are unknown but assumed equal. The number of degrees of freedom is equal to:  $df(1) = n_1 + n_2 - 2$ .

Because the population variances are unknown, it might occur that the populations variances are unequal. In such a case we can use the Formula 1 to calculate the *z* statistics, but the number of degrees should be modified according to the following formula [Defusco et al. 2001, p. 335]:

$$df(2) = \frac{\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right)^2}{\frac{\left(S_1^2/n_1\right)^2}{n_1} + \frac{\left(S_2^2/n_2\right)^2}{n_2}}$$
(2)

In the case of two populations, both with equal or unequal variances, the null hypothesis  $H_0$  and alternative hypothesis  $H_1$  regarding equality of rates of return in two populations, can be formulated as follows:

$$H_0: E(r_1) = E(r_2) H_1: E(r_1) \neq E(r_2)$$
(3)

In particular:

- 1. For the analysis of the monthly rates of return, if  $\overline{r_1}$  is the monthly average rate of return in month X (the first population), then  $\overline{r_2}$  is the monthly average rate of return in all other months, except month X (the second population).
- 2. For the analysis of the daily rates of return, if  $\overline{r_1}$  is the daily average rate of return in month X (the first population), then  $\overline{r_2}$  is the daily average rate of return in all other months, except month X (the second population).
- 3. For the analysis of the daily rates of return for individual days of the week, if  $\overline{r_1}$  is the daily average rate of return on day *Y* (the first population), then  $\overline{r_2}$  is the daily average rate of return in all other days, except day *Y* (the second population).
- 4. For the analysis of the rates of return for individual days of month, if  $\overline{r_1}$  is the daily average rate of return on day *Y* (the first population), then  $\overline{r_2}$  is the daily average rate of return in all other days, except day *Y* (the second population).
- 5. For the analysis within-the-month effect, if  $\overline{r_1}$  is the average rate of return in the first half of the analysed months (days from the 1<sup>st</sup> to the 15<sup>th</sup> the first population), then  $\overline{r_2}$  is the average rate of return in the second half (days from 16<sup>th</sup> to the end of the analysed month the second population).

In all analysed cases, the p-values will be calculated with the assumption that the populations variances are unknown, but:

- a) population variances are assumed equal p-value(1),
- b) population variances are assumed unequal p-value(2).

If the p-value is less than or equal to 0.05; then the hypothesis  $H_0$  is rejected in favour of the hypothesis  $H_1$ . Otherwise, there is no reason to reject hypothesis  $H_0$ .

As the last part of the calculation will be carried out using the F-statistics (so called Fisher-Snadecor statistics) for equality of variances of two population rates of return, where  $F = \frac{S_i^2}{S_j^2}$ , with the condition that:  $S_i^2 > S_j^2$  and that i, j = 1,2; and the degrees of freedom are equal:

 $n_i$  – for variance in the numerator of F,

 $n_i$  – for variance in the denominator of F.

If F-test (computed for  $\alpha = 0.05$ ) is lower than F-statistics, there is no reason to reject the null hypothesis, which can be formulated as follows:

$$S_0 H: S_1^2 = S_2^2$$
 (4)

The alternative hypothesis may be defined by the ensuing equation:

$${}_{1}^{F}H:S_{1}^{2} \neq S_{2}^{2}$$
 (5)

In the case, when there is no reason to reject the null hypothesis about equality of variances of two observed returns, the p-value(1) should be compared with the critical value 0.05; otherwise the p-value(2) will be used – that's why in the following part of this paper, designation p-value will be applied.

#### 3. Analysis of results

#### 3.1. The analysis of the day-of-the-week effect

One-session average rates of return for each day of the week on the market of all analysed futures are shown in the Table 1. In the same table, there are presented the results of testing statistical hypotheses for the daily rates of returns for different days of the week.

The negative one-session average rates of return were observed for the following days of the week:

- a) barley: Mondays (-0.0223%) and Tuesdays (-0.0819%),
- b) canola: Wednesdays (-0.0115%), Thursdays (-0.0840%) and Fridays (-0.0206%),
- c) soybean oil: Mondays (-0.0098%), Tuesdays (-0.0194%) and Fridays (-0.0064%),
- d) soybean meal: Thursdays (-0.0494%) and Fridays (-0.0109%),
- e) rough rice: Mondays (-0.1137%), Tuesdays (-0.0340%) and Fridays (-0.279%).

In all other cases the positive one-session average rates of return were calculated.

The results of testing null hypothesis permit to draw the following conclusions:

- 1. For all days of the week, the null hypothesis regarding equality of variances of daily average rates of return in two populations was rejected (for  $\alpha = 0.05$ ) in the following cases:
  - a) barley Mondays, Wednesdays, Thursdays and Fridays,
  - b) canola Mondays, Tuesdays, Wednesdays and Fridays,
  - c) soybean oil Mondays, Tuesdays, Wednesdays and Fridays,
  - d) soybean meal Mondays, Tuesdays and Fridays,
  - e) rough rice Tuesdays, Wednesdays and Thursdays.
- 2. The null hypothesis regarding equality of two average rates of return was rejected for the following days (p-value shown in parenthesis):
  - a) canola Tuesdays (0.0471),
  - b) rough rice Thursdays (0.0225).

In all other cases there was no reason to reject the null hypothesis in the favour of the alternative hypothesis.

Information regarding number and frequency of positive and negative rates of return, computed for each day of the week, are included in Table 2.

The frequency of one-session positive average rate of return was equal or higher than 50% in the following days of the week:

- a) barley Wednesdays (52.01%) and Thursdays (50.63%),
- b) canola Mondays (51.91%), Tuesdays (53.55%), Thursdays (50.84%) and Fridays (50.49%),
- c) soybean oil Tuesdays (51.01%),
- d) soybean meal Mondays (51.67%), Tuesdays (50.29%) and Fridays (52.64%),
- e) rough rice Thursdays (50.00%).

The frequency of one-session negative average rate of return was equal or higher than 50% in the following days of the week:

- a) barley Mondays (50.24%), Tuesdays (50.36%) and Fridays (52.35%),
- b) canola Wednesdays (50.41%),
- c) soybean oil Mondays (52.22%), Wednesdays (51.53%), Thursdays (51.13%), Fridays (53.37%),
- d) soybean meal Wednesdays (50.06%) and Thursdays (50.84%),
- e) rough rice Mondays (49.60%), Tuesdays (51.33%), Wednesdays (50.83%), Thursdays (50.00%) and Fridays (54.22%).

Table 1. The 1	results of	testing t	he null	hypotl	hesis fo	r the da	y-of-the	e week	rates of	return							
						Mont	hs							Da	iys of the wee	k	
	January	February	March	April	May	June	July	August	September	October	November	December	Monday	Tuesday	Wednesday	Thursday	Friday
								barley						·			
one-session average rate of return	-0.1538%	0.0284%	-0.0195%	0.1867%	-0.0064%	-0.0819%	0.0485%	-0.0500%	0.1319%	0.1227%	0.0997%	-0.2494%	-0.0223%	-0.0819%	0.0689%	0.0134%	0.0216%
z-statistics	-0.8476	0.2646	-0.1387	1.4095	-0.0752	-0.8935	0.3440	-0.4090	0.6549	1.0307	0.8694	-1.1843	-0.3164	-0.9118	1.0157	0.1260	0.2360
p-value	0.3977	0.7915	0.8897	0.1588	0.9401	0.3723	0.7309	0.6830	0.5135	0.3039	0.3857	0.2378	0.7517	0.3620	0.3101	0.8998	0.8135
Test of the null hypothesis	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
								canola									
one-session average rate of return	0.0139%	0.0492%	0.0527%	0.0278%	0.0006%	0.0557%	-0.0593%	0.0065%	-0.2371%	0.1125%	0.0266%	-0.0549%	0.0563%	0.0702%	-0.0115%	-0.0840%	-0.0206%
z-statistics	0.1963	0.7114	0.6553	0.4097	-0.0039	0.8325	-0.6324	0.0730	-3.3046	1.6116	0.3963	-0.9456	1.2841	1.7317	-0.3171	-1.9862	-0.4416
p-value	0.8445	0.4773	0.5126	0.6822	0.9969	0.4052	0.5275	0.9418	0.0010	0.1071	0.6921	0.3449	0.1994	0.0836	0.7512	0.0471	0.6589
Test of the null hypothesis	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE
								soybean oil									
one-session average rate of return	-0.0771%	0.2336%	-0.0270%	0.1222%	-0.0933%	-0.0126%	-0.0951%	-0.0014%	-0.1650%	0.0351%	0.0663%	-0.0159%	-0.0098%	0.0194%	-0.0382%	0.0186%	-0.0064%
z-statistics	-0.9547	2.7983	-0.2979	1.7140	-1.2048	-0.1258	-1.1191	0.0226	-1.9643	0.4576	0.8731	-0.1809	-0.1397	0.4977	-0.7650	0.4675	-0.0599
p-value	0.3398	0.0052	0.7658	0.0873	0.2284	0.8999	0.2632	0.9820	0.0496	0.6474	0.3827	0.8565	0.8889	0.6188	0.4444	0.6401	0.9522
Test of the null hypothesis	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
							8	oybean mea	ղ								
one-session average rate of return	-0.0305%	0.0952%	0.0307%	0.1136%	0.0349%	-0.0034%	-0.2416%	0.0437%	-0.2629%	0.2125%	-0.0481%	0.1007%	0.0541%	0.0353%	0.0064%	-0.0494%	-0.0109%
z-statistics	-0.4175	1.0749	0.2807	1.3320	0.3414	-0.0821	-1.9700	0.3557	-2.9226	2.2610	-0.6010	1.2335	0.8701	0.5619	-0.0037	-1.0027	-0.2577
p-value	0.6765	0.2830	0.7790	0.1835	0.7330	0.9346	0.0496	0.7223	0.0035	0.0238	0.5479	0.2180	0.3844	0.5743	0.9970	0.3161	0.7967
Test of the null hypothesis	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
								rough rice									
one-session average rate of return	-0.1090%	0.0254%	0.0464%	0.1223%	-0.0940%	-0.1866%	0.0982%	-0.0323%	0.0136%	-0.0721%	0.0783%	-0.0141%	-0.1137%	-0.0340%	0.0069%	0.1025%	-0.0279%
z-statistics	-1.1893	0.4106	0.6793	1.5922	-0.9710	-1.4901	1.0266	-0.2250	0.3103	-0.8182	1.1120	-0.0335	-1.7949	-0.3867	0.3782	2.2843	-0.3022
p-value	0.2350	0.6814	0.4970	0.1121	0.3316	0.1370	0.3053	0.8220	0.7565	0.4136	0.2668	0.9733	0.0727	0.6990	0.7054	0.0225	0.7625
Test of the null hypothesis	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE

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Source: own calculations.

	ı	1	I														
							Months							Dé	ays of the wee	k	
	January	February	March	April	May	June	July	August	September	October	November	December	Monday	Tuesday	Wednesday	Thursday	Friday
								barley									
Percentage of positive rates of return	46.99%	43.93%	54.59%	59.46%	56.00%	51.85%	47.80%	44.08%	46.98%	45.96%	54.78%	51.40%	49.76%	49.64%	52.01%	50.63%	47.65%
Percentage of negative rates of return	53.01%	56.07%	45.41%	40.54%	44.00%	48.15%	52.20%	55.92%	53.02%	54.04%	45.22%	48.60%	50.24%	50.36%	47.99%	49.37%	52.35%
								canola									
Percentage of positive rates of return	47.65%	52.96%	55.53%	55.75%	51.60%	48.74%	52.24%	48.65%	45.27%	54.11%	52.55%	49.70%	51.91%	53.55%	49.59%	50.84%	50.49%
Percentage of negative rates of return	52.35%	47.04%	44.47%	44.25%	48.40%	51.26%	47.76%	51.35%	54.73%	45.89%	47.45%	50.30%	48.09%	46.45%	50.41%	49.16%	49.51%
							ŝoŝ	bean oil									
Percentage of positive rates of return	48.20%	53.61%	49.19%	49.57%	50.29%	45.96%	48.19%	46.00%	43.45%	48.53%	52.19%	47.99%	47.78%	51.01%	48.47%	48.87%	46.63%
Percentage of negative rates of return	51.80%	46.39%	50.81%	50.43%	49.71%	54.04%	51.81%	54.00%	56.55%	51.47%	47.81%	52.01%	52.22%	48.99%	51.53%	51.13%	53.37%
							soyb	ean meal									
Percentage of positive rates of return	48.24%	51.08%	51.65%	50.00%	49.72%	50.56%	50.00%	51.73%	44.78%	57.60%	51.92%	50.57%	51.67%	50.29%	49.94%	49.16%	52.64%
Percentage of negative rates of return	51.76%	48.92%	48.35%	50.00%	50.28%	49.44%	50.00%	48.27%	55.22%	42.40%	48.08%	49.43%	48.33%	49.71%	50.06%	50.84%	47.36%
							ro	ugh rice									
Percentage of positive rates of return	48.77%	46.98%	52.50%	50.59%	48.26%	42.33%	50.46%	47.65%	50.30%	48.35%	51.05%	46.43%	49.60%	48.67%	49.17%	50.00%	45.78%
Percentage of negative rates of return	51.23%	53.02%	47.50%	49.41%	51.74%	57.67%	49.54%	52.35%	49.70%	51.65%	48.95%	53.57%	50.40%	51.33%	50.83%	50.00%	54.22%

Table 2. The number and percentage of positive and negative daily rates of returns

Source: own calculations.

## **3.2.** The analysis of the one-session average rates of return in different months

The analysis of the one-session average rates of return, calculated for each of the analysed months, as well as the result of testing the null hypothesis, are shown in Table 1.

The average daily rate of returns were positive:

- a) barley in 6 months: February (0.0284%), April (0.1867%), July (0.0485%), September (0.1319%), October (1227%) and November (0.0997%),
- b) canola in 9 months: January (0,0139%), February (0.0492%), March (0.0527%), April (0.0278%), May (0.0006%), June (0.0557%), August (0.0065%), October (0.1125%) and November (0.0266%),
- c) soybean oil in 4 months: February (0.2336%), April (0.1222%), October (0.0351%), November (0.0663%),
- d) soybean meal in 6 months: February (0.0952%), March (0.0307%), May (0.1136%), August (0.0437%), October (0.2125%) and December (0.1007%),
- e) rough rice in 6 month: February (0.0254%), March (0.0464%), April (0.1223%), July (0.0982%), September (0.0136%) and November (0.0783%). The results obtained during testing the null hypothesis permit to formulate

the following conclusions:

- 1. For all months the null hypothesis regarding equality of variances of daily average rates of return in two populations was rejected (for  $\alpha = 0.05$ ) in the following cases:
  - a) barley for all months except: March, April and July,
  - b) canola for all months except: June, September and October,
  - c) soybean oil April, August, October and December,
  - d) soybean meal for all months except: September, October and November,
  - e) rough rice for all months except: February, March, May and August.
- 2. The null hypothesis regarding equality of variances of daily rates of return in two populations was rejected for the following cases (p-value shown in parenthesis):
  - a) canola: September (0.0010),
  - b) soybean oil: February (0.0052) and September (0.0496),
  - c) soybean meal: July (0.0496), September (0.0035) and October (0.0238).

This fact indicates that the month effect on the analysed markets was detected (for  $\alpha = 0.05$ ).

In all other analysed cases there was no reason to reject the null hypothesis regarding equality of daily average rates of return in two populations.

Information regarding number and frequency of positive and negative rates of return, computed for each day of the week, are included in Table 2.

The frequency of one-session positive average rate of return was higher than 50% in the following cases:

- a) barley in 6 months: March (54.59%), April (59.46%), May (56.00%), June (51.85%), November (54.78%) and December (51.40%).
- b) canola in 7 months: February (52.96%), March (55.53%), April (55.75%), May (51.60%), July (52.24%), October (54.11%) and November (52.55%),
- c) soybean oil in 3 months: February (53.61%), May (50.29%) and November (52.19%).
- d) soybean meal in 9 months: February (51.08%), March (51.65%), April (50.00%), June (50.56%), July (50.00%), August (51.73%), October (57.60%), November (51.92%) and December (50.57%).
- e) rough rice in 5 months: March (52.50%), April (50.59%), July (50.46%), September (50.30%) and November (50.05%).

The frequency of one-session negative average rate of return was equal or higher than 50% in the following cases:

- a) barley in 6 months: January (53.01%), February (56.07%), July (52.20%), August (55.92%), September (53.02%) and October (54.04%),
- b) canola in 5 months: January (52.35%), June (51.26%), August (51.35%), September (54.73%) and December (50.30%),
- c) soybean oil in 9 months: January (51.80%), March (50.81%), April (50.43%), June (54.04%), July (51.81%), August (54.00%), September (56.55%), October (51.47%) and December (52.01%),
- d) soybean meal in 5 months: January (51.76%), April (50.00%), May (50.28%), July (50.00%), September (55.22%),
- e) rough rice in 7 months: January (51.23%), February (53.02%), May (51.74%), June (57.67%), August (52.35%), October (51.65%) and December (53.57%).

# **3.3.** The analysis of the one-session average rates of return in different days of the month

The positive daily average rates of return, calculated for each day of the analysed months were observed on the market of:

- a) barley in 12 out of all 31 days of month, e.g. in. 38.71% cases,
- b) canola in 15 out of 31 days of month, e.g. in 48.39% cases,
- c) soybean oil in 15 out of 31 days of month, e.g. in 48.39% cases,
- d) soybean meal in 14 out of 31 days of month, e.g. in 45.16% cases,
- e) rough rice in 14 out of 31 days of month, e.g. in 45.16% cases.

The highest one-session positive and negative average rates of return were registered in the following days:

- a) barley: max = 0.06718% (21<sup>st</sup>), min = -0.3234 (4<sup>th</sup>),
- b) canola: max = 0.2294% (17<sup>th</sup>), min = -0.2485% (12<sup>th</sup>),
- c) soybean oil: max = 0.2602% (9<sup>th</sup>), min = -0.2176% (12<sup>th</sup>),
- d) soybean meal: max = 0.4428% (9<sup>th</sup>), min = -0.3379% (15<sup>th</sup>),
- e) rough rice: max = 0.3834% (5<sup>th</sup>), min = -0.3012% (14<sup>th</sup>).

The results obtained during testing the null hypothesis allow to formulate the following conclusions:

- 1. For all days of the month, the null hypothesis regarding equality of variances of daily average rates of return in two populations was rejected (for  $\alpha = 0.05$ ) in the following cases:
  - a) barley for all days of the month except: 9<sup>th</sup>, 20<sup>th</sup>, 22<sup>th</sup> and 23<sup>rd</sup>.,
  - b) canola for the following days: 3th,  $5^{\text{th}}$ -10<sup>th</sup>, 13<sup>th</sup>, 18<sup>th</sup>, 20<sup>th</sup>, 21<sup>st</sup>, 23<sup>rd</sup> and 26<sup>th</sup>,
  - c) soybean oil for the following days: 2<sup>nd</sup>, 3<sup>rd</sup>, 7<sup>th</sup>, 8<sup>th</sup>, 12<sup>th</sup>, 13<sup>th</sup>, 15<sup>th</sup>, 16<sup>th</sup>, 26<sup>th</sup>, 29<sup>th</sup>-31<sup>st</sup>,
  - d) soybean meal for the following days: 2<sup>nd</sup>, 4<sup>th</sup>, 5<sup>th</sup>, 7<sup>th</sup>, 8<sup>th</sup>, 10<sup>th</sup>, 12<sup>th</sup>, 13<sup>th</sup>, 20<sup>th</sup>, 22<sup>nd</sup>, 24<sup>th</sup> and 25<sup>th</sup>,
  - e) rough rice for the following days: 2<sup>nd</sup>, 8<sup>th</sup>, 10<sup>th</sup>, 13<sup>th</sup>-17<sup>th</sup>, 19<sup>th</sup>, 26<sup>th</sup>-28<sup>th</sup> and 30<sup>th</sup>.
- 2. The null hypothesis regarding equality of the daily average rates of return in two populations, was rejected in favour of the alternative hypothesis for the following days of the month (p-value shown in parenthesis):
  - a) barley  $-4^{\text{th}}$  (0.0354),  $7^{\text{th}}$  (0.0460) and  $13^{\text{th}}$  (0.0436). The p-value calculated for the average rate of return of the  $6^{\text{th}}$  day of the month was equal 0.0750,
  - b) canola 12<sup>th</sup> (0.0469). The p-value calculated for the average rate of return of the 17<sup>th</sup>, 28<sup>th</sup>, and 30<sup>th</sup> day of the month was equal 0.0582; 0.0929 and 0.0990 respectively,
  - c) soybean oil  $-9^{\text{th}}$  (0.0224). The p-value calculated for the average rate of return of the 13<sup>th</sup> day of the month mounted to 0.0747,
  - d) soybean meal 9<sup>th</sup> (0.0019) and 15<sup>th</sup> (0.0328). The p-value calculated for the average rate of return of the 11<sup>th</sup> and 13<sup>th</sup> day of the month was equal 0.0922 and 0.0747, respectively,
  - e) rough rice  $-5^{\text{th}}$  (0.0047),  $9^{\text{th}}$  (0.0464),  $14^{\text{th}}$  (0.0250) and  $16^{\text{th}}$  (0.0253).



Figure 1. Percentage of positive average daily rates of returns for each of analysed days of a month and each commodity

Source: own calculations.

The frequency of positive average daily returns (see Figure 1), equal or higher than 50% was observed on the market of:

- a) barley in 14 days of each month, and was the highest on the 21<sup>st</sup> day of each month (70.59%) and the lowest on the 24<sup>th</sup> day (42.42%),
- b) canola in 17 days of each month, and was the highest on the 24<sup>th</sup> day of each month (59.26%) and the lowest on the 28<sup>th</sup> day (43.38%).
- c) soybean oil in 11 days of each month, and was the highest on the 1<sup>st</sup> day of each month (58.73%) and the lowest on the 26<sup>th</sup> day (39.85%),
- d) soybean meal in 17 days of each month, and was the highest on the 9<sup>th</sup> day of each month (59.86%) and the lowest on the 10<sup>th</sup> day (40.29%),
- e) rough rice in 10 days of each month, and was the highest on the 5<sup>th</sup> day of each month (55.80%) and the lowest on the 28<sup>th</sup> day (42.22%).

# **3.4.** The analysis of the one-session average rates of return in the first and the second half of the month

Analysis of the average daily rates of return, calculated for the first and the second half of each month, as well as the result of testing the null hypothesis, are shown in the Table 3. The average daily rate of return in the first and the second half of each month was higher than zero for on the market of barley (0.0065%), soybean oil (0.0234%) and rice (0.0187%). The null hypothesis, regarding equality of variances of daily rates of return in two populations, was rejected in the case of barley, canola and rice. There was no reason to reject the null hypothesis referring to the equality of average rates of return in two populations. It means that the daily average rates of return in the first half do not differ from the

daily average rates of return in the second half of a month (for  $\alpha = 0.05$ ). The p-value calculated in the process of testing the null hypothesis was higher than the critical value (0.05) and its lowest value, equal 0.5619 was registered in the case of soybean meal.

	Barley	Canola	Soybean Oil	Soybean meal	Rice
Average rate of return in the first half of the month	-0.0065%	-0.0084%	-0.0060%	0.0234%	0.0187%
Average rate of return in the second half of the month	0.0076%	0.0097%	-0.0005%	-0.0099%	-0.0411%
T-statistic	-0.1640	-0.4179	-0.1159	0.5801	1.1103
p-value	0.8698	0.6761	0.9077	0.5619	0.6761
Test of the null hypothesis	TRUE	TRUE	TRUE	TRUE	TRUE

**Table 3.** The average daily rates of return on the market of barley futures and results of testing the null hypothesis for the average daily rates of return for the first and second half of a month

Source: own calculations.

The frequency of positive daily average returns in the first half of the month was higher than 50% in the case of Canola (50.56%) and Soybean meal (50.32%). For other three commodities the frequency of negative daily average rate of return in the first half was higher than 50%: barley (51.05%), Soybean oil (51.71%) and rice (50.50%). In the second half of each month, the frequency of positive daily rates of return was higher than 50% for: barley (50.72%), canola (51.23%) and soybean meal (50.41%), while for two other remaining commodities mounted to 48.10% (soybean oil) and 47.03% (rice).

#### Conclusions

In recent years, there has been observed an increased interest in the commodity market, including agricultural commodities, from both institutional and individual investors. Investment strategies implemented in the commodity market by its participants, heavily resemble those of the stock and currency markets. However it should be mentioned that particular characteristics are assigned to the agricultural commodity market such as stock level or marginal unit cost.

The aim of this study was to determine the prevalence of selected effects of seasonality on the market of barley, canola, soybean oil, soybean meal and rough rice futures. Analysis of the effects of seasonality included an examination of daily returns over various days of the week, daily average rates of return in different days of the month and daily average rates of return in the first and the second half of the month. The main limitation of this research is the assumption of normal distribution of return rates of analysed commodities as well as the use of price data gained from Bloomberg data source. Calculations presented in this paper indicate the existence of monthly effect: in September (canola), February and September (soybean oil) and July, September and October (soybean meal) as well as the day-of-the-week effect: on Tuesdays (canola) and on Thursdays (rough rice). The seasonal effects were also observed in the case of testing the statistical hypothesis for daily averaged rates of returns for different days of the month: 4<sup>th</sup> (barley), 12<sup>th</sup> (canola), 9<sup>th</sup> (soybean oil and soybean meal) and 5<sup>th</sup> (rough rice). The seasonal effects were no registered for the daily average rates of return in the first and in the second half of the month.

The results obtained in this paper, in the case of average daily returns in some part confirm but in the other deny outcomes received by Ovararin and Meade [2010]. According to the Authors the higher (lowest) daily average rate of return characterised Mondays (Wednesdays) sessions. In the analysed period the average daily rates of return was the highest on Monday session on the market of soybean meal, while was the lowest on the same day of the week on the market of rough rice. On Wednesday session, the highest daily average rate of return was recorded for barley, but on the same session it was the lowest for lumber.

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