Analysis of Selected Seasonality Effects in Markets of Futures Contracts with the Following Underlying Instruments: Crude Oil, Brent Oil, Heating Oil, Gas Oil, Natural Gas, Feeder Cattle, Live Cattle, Lean Hogs and Lumber

Abstract

The commodity market has become one of the main popular segments of the financial markets among individual and institutional investors in recent years, as an alternative possibility of investments. Like to the equity market, the problem of anomalies in the commodities market is becoming an interesting phenomenon, particularly in the segment of the agricultural and energy markets.

This paper tests the hypothesis of daily, monthly, the day-of-the-week, the weekend effect, the first and the second half of monthly effects on the market of futures contracts of: crude oil, Brent oil, heating oil, gas oil, natural gas, feeder cattle, live cattle, lean hogs and lumber. Calculations presented in this paper indicate the existence of monthly effect in: January (heating oil, natural gas and lumber), February (gas oil), August (heating oil), September (heating oil, natural gas and lumber), October (natural gas), November (crude oil, Brent oil and lumber) and December (natural gas and feeder cattle), as well as the day-of-the-week effect: on Mondays (feeder cattle, live cattle, lean hogs), on Tuesdays (heating oil), on Wednesdays (heating oil, natural gas, live cattle, lean hogs and lumber), on Thursdays (crude oil, feeder cattle, live cattle) and Fridays (Brent oil, heating oil). The calendar anomalies were also detected for different days of each month on various commodity markets.
The weekend effect was not registered, but seasonal effects regarding equality of the daily average rates of return in the first and in the second half of each month were detected on the lean hogs market.

**Key words:** market efficiency, commodity market, seasonality effects

## 1. Introduction

The theory of Efficient Market Hypothesis (EMH) was introduced by Fama, and quickly became a cornerstone of financial economics for many decades. The problem of the financial markets efficiency, especially of equity markets, has been discussed in a number of scientific works, which has led to a sizable set of publications examining this subject.

Capital market anomalies are called deviations from the prediction of efficient market theory manifested in predictable non-zero risk-adjusted returns. The latter provides more-than-fair or less-than-fair return for its risk. This information permits an investor to open a long or short positon and gain an additional rate of return. Discussion of the most common anomalies in the capital markets can be found, among others, in Keim and Ziemba or Latif et al.

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

A) Day-of-the-week effect – different distributions of expected rates of return can be observed for different days of the week.

B) Monthly effect – achieving by a portfolio replicating a specified stock index, different returns in each month. The most popular monthly effect is called “January
effect”, i.e. the tendency to observe a higher average rate of return of stock market indices in the first month of the year\(^6\).

C) Other seasonal effects – in the financial literature, the following calendar effects can be found: the weekend effect, the holiday effects, the within-the-month effect (positive rates of return only occur in the first half of the month) and the turn-of-the-month effect\(^7\).

The commodity market is one of the segments of the financial market, characterized by high heterogeneity of assets compared to the stock or bond markets\(^8\). It is often perceived as a separate asset class, which in turn leads to a 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 a possibility of constructing a more diversified investment portfolio compared to a portfolio solely consisting of shares or bonds. Another factor in favor of investing in the commodity market is an ability to protect the investment portfolio from the negative effects of inflation and attractiveness when there is a threat of currency devaluation or an outbreak of armed conflict.

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 three different segments of the commodity market: energy market (crude oil, Brent oil, heating oil, gas oil and natural gas), meats (feeder cattle, live cattle, lean hogs) and softs (lumber).

The prices of crude oil, Brent oil, heating oil, gas oil and natural gas futures contracts, quoted on the New York Mercantile Exchange are expressed in US dollars and one contract unit is equal to: 1000 US barrels, 1000 US barrels, 42 000 gallons, 42 000 gallons and 10 000 MMBtu, respectively. The prices of live cattle, feeder cattle, lean hogs and lumber futures are quoted on Chicago Mercantile Exchange in US dollars and the contract unit is defined as 40 000, 50 000, 40 000 pounds and 110 000 broad foot, respectively.

The 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 a month.

\(^7\) C. Dzhabarov, W. Ziemba, *Do Seasonal Anomalies Still Work?*, Longer working paper 2009, UBC.

2. 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. It is worth noting that the number of scientific papers dedicated to commodity market efficiency is lower than those related to the stock market. Numerous research has examined the price efficiency of agricultural markets. However, many of the studies differ with respect to the analyzed commodity, the covered time period and implemented method of analysis, and the type of data employed in the research.

The tests of price market efficiency in a semi-strong form were performed by Canarella and Pollard, Just and Rausser, Rausser and Carter and regarded, among others, market of soybean oil and soybean meal. Giles and Goss as well as Just and Rausser proved that the live cattle and lean hogs markets were not efficient in a semi strong form. The same conclusion was reached by Gordon, analyzing daily data on the markets of live cattle, lean hogs and rough rice in the USA. Kaur and Rao, after tests of the weak form of market efficiency, with the use of autocorrelation analysis,

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found that markets of soya oil and lean hogs were not efficient\textsuperscript{17}. McKenzie and Holt with the use of the co-integration and error correction model with GQARCH-in-mean process, for the data of the period 1966–1995, found that cattle, hogs and corn futures markets were characterized by short-run inefficiencies and pricing biases\textsuperscript{18}. Qingfeng studied the relations between hog, corn and soybean meal futures prices using the Perron unit root test and autoregressive multivariate co-integration models and concluded that inefficiency existed in these three commodity futures markets\textsuperscript{19}. Sahoo and Kumar examined the efficiency of seven commodity markets and came to a conclusion that the five of the analyzed markets were efficient, among which there were: soya oil and crude oil\textsuperscript{20}.

Gulen discovered that the futures prices of light sweet crude oil listed on NYMEX, are an unbiased predictor of the spot price\textsuperscript{21}. In turn, Lokare found an evidence of co-integration in both spot and futures prices, indicating the operational efficiency of crude oil in India\textsuperscript{22}. Panas based on leptokurtic monthly price changes, rejected the null hypothesis that oil prices on the Rotterdam and Italian were efficient\textsuperscript{23}. Herbert and Kreil\textsuperscript{24}, analyzing the US spot and futures natural gas prices found these market to be inefficient but Tabak and Cajueiro\textsuperscript{25}, using the rescaled range analysis, proved that the efficiency of Brent and WTI crude oil markets are becoming more efficient in time. To the same conclusion came Wang and Liu based on the detrended fluctuation analysis approach\textsuperscript{26}. Alvarez et al., adapting the detrended fluctuation analysis


proved that the crude oil market was efficient in the long-run but inefficient in the short-term\textsuperscript{27}.

Empirical tests of market efficiency for forest commodity futures markets are limited. Dechard\textsuperscript{28} used the conventional three-stage approach to test the forward rate unbiasedness hypothesis with the standard unit root method and then applying Johansen’s Maximum Likelihood approach in the co-integration analysis between spot and futures prices of lumber. The results provide evidence that the spot and futures market prices for U.S. softwood lumber follow a stationary long-run equilibrium. He and Holt\textsuperscript{29} studied the efficiency of forest commodity futures market. Taking an alternative empirical test of market efficiency that allowed a non-linear and time-varying risk premium, with the use of weekly spot and futures prices (June 1997 – October 2001), the authors concluded that there is no long-run equilibrium in these markets. The empirical test results revealed that the lumber market is neither efficient nor unbiased in both the long-term and short-term. Haasan and Hofmann-MacDonald adapting Johansen’s cointegration test for bimonthly lumber future prices in the period of May 1999 – July 2009, showed that the analyzed market did not behave in a rational way\textsuperscript{30}.

In summary, there has been no consensus about the efficiency of agricultural commodities. One of the reasons for the heterogeneous results are the different test setups and another – a single-market perspective\textsuperscript{31}.

3. 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, characterized by normal distributions. On the basis of two independent populations of rate of returns, whose sizes are equal \( n_1 \) and \( n_2 \), respectively, the hypotheses \( H_0 \) and \( H_1 \) should be tested with the use of statistics \( z_{32} \):

\begin{align*}
\text{3. Data and Methods} & \\
\text{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, characterized by normal distributions. On the basis of two independent populations of rate of returns, whose sizes are equal } n_1 \text{ and } n_2, \text{ respectively, the hypotheses } H_0 \text{ and } H_1 \text{ should be tested with the use of statistics } z_{32}. \\
\end{align*}
\[
z = \frac{\bar{r}_1 - \bar{r}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}
\]  

(1)

where:

\(\bar{r}_1\) – average rate of return in the first population,
\(\bar{r}_2\) – 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 return in the first population,
\(S_2^2\) – variance of rates of return in the second population.

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 Formula 1 to calculate the \(z\) statistics, but the number of degrees should be modified according to the following formula\(^3\):  

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

(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:

a) For the analysis of the daily rates of return, if \(\bar{r}_1\) is the daily average rate of return in month \(X\) (the first population), then \(\bar{r}_2\) is the daily average rate of return in all other months, except month \(X\) (the second population).

b) For the analysis of the daily rates of return for individual days of the week, if \( r_1 \) is the daily average rate of return on day \( Y \) (the first population), then \( r_2 \) is the daily average rate of return on all other days, except day \( Y \) (the second population).

c) For the analysis of the rates of return for individual days of a month, if \( r_1 \) is the daily average rate of return on day \( Y \) (the first population), then \( r_2 \) is the daily average rate of return on all other days, except day \( Y \) (the second population).

d) For the analysis within-the-month effect, if \( r_1 \) is the average rate of return in the first half of the analyzed months (days from the 1st to the 15th – the first population), then \( r_2 \) is the average rate of return in the second half (days from 16th to the end of the analyzed month – the second population).

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

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

If the p-value is less than or equal to 0.05; then hypothesis \( H_0 \) is rejected in favor of 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-Snedecor statistics) for equality of variances of two population rates of return,

where \( F = \frac{S_1^2}{S_j^2} \), on the condition that \( S_1^2 > S_j^2 \) and that \( i, j = 1, 2; \) and the degrees of freedom are equal:

\( n_i \) – for variance in the numerator of \( F \),
\( n_j \) – 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:

\[
_{0}F H: S_1^2 = S_2^2
\]  

(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 concerning 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 explains the reason for applying p-value in the following part of the paper.
4. Results Analysis

4.1. The Analysis of the Day-of-the-week Effect

One-session average rates of return for each day of the week on the market are included in table 1. In the same table the results of testing statistical hypotheses for the daily rates of return for different days of the week during the analyzed period are presented.

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

a) Crude oil: Mondays (-0.1026%) and Fridays (-0.1163%),
b) Brent oil: Mondays (-0.0867%) and Fridays (-0.1628%),
c) Heating oil: Mondays (-0.0098%), Thursdays (-0.0194%) and Fridays (-0.0064%),
d) Gas oil: Mondays (-0.0446%) and Fridays (-0.0708%),
e) Natural gas: Wednesdays (-0.2664%) and Fridays (-0.1274%),
f) Feeder cattle: Mondays (-0.0650%) and Tuesdays (-0.133%),
g) Live cattle: Mondays (-0.0665%), Tuesdays (-0.0067%) and Fridays (-0.0251%),
h) Lean hogs: Mondays (-0.1053%) and Fridays (-0.0865%),
i) Lumber: Tuesdays (-0.0297%), Wednesdays (-0.1950%) and Fridays (-0.0444%).

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

The results of testing the 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) Crude oil, Brent oil, heating oil – Mondays, Wednesdays, Thursdays and Fridays,
   b) Gas oil – Mondays, Wednesdays and Fridays,
   c) Natural gas – Mondays, Thursdays and Fridays,
   d) Feeder cattle – Mondays, Tuesdays, Wednesdays and Thursdays,
   e) Live cattle – Mondays, Tuesdays, Wednesdays, Thursdays and Fridays,
   f) Lean hogs – Wednesdays and Fridays,
   g) Lumber – Mondays, Wednesdays and Fridays,

2. The null hypothesis regarding equality of two average rates of return was rejected for the following days (p-value shown in parentheses):
   a) Crude oil – Thursdays (0.0350). The p-value higher than 0.05 and lower than 0.1 was registered for Mondays (0.0737) and Fridays (0.0683).
b) Brent oil – Fridays (0.0049). The p-value for Wednesdays sessions was equal 0.0500.
c) Heating oil – Tuesdays (0.0139), Wednesdays (0.0082) and Fridays (0.0009).
d) Natural gas – Wednesdays (0.0136). The p-value for Mondays was equal 0.0602.
e) Feeder cattle – Mondays (0.0016) and Thursdays (0.0241).
f) Live cattle – Mondays (0.0012), Wednesdays (0.0320) and Thursdays (0.0020).
g) Lean hogs – Mondays (0.0177) and Wednesdays (0.0031). The p-value for Fridays rates of return amounted to 0.0708.
h) Lumber – Wednesdays (0.0054) and Fridays (0.0302).
i) Gas oil – the p-value for Wednesdays rates of return was equal to 0.0748.
In all other cases, there was no reason to reject the null hypothesis in favor of the alternative hypothesis.

4.2. The Analysis of the Daily Rates of Return in Different Months

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

The average daily rates of return were positive in the following cases:

a) Crude oil – in 5 months: March, April, July, August and September,
b) Brent oil – in 6 months: March, April, May, July, August and September,
c) Heating oil – in 7 months: from March to September,
d) Gas oil – in 6 months: February, March, April, June, July and August,
e) Natural gas – in 5 months: March, April, May, September and October,
f) Feeder cattle – in 7 months: January, March, April, June, July, September and November,
g) Live cattle – in 6 months: January, February, July, September, October and November,
h) Lean hogs – in 5 months: January, March, April, September and November,
i) Lumber – in 5 months: January, March, May, August and November.

The results obtained while 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) Crude oil – for all months except: February, October and November,
   b) Brent oil – for all months except: February and October,
   c) Heating oil – for all months except: November and December,
   d) Gas oil – for all months except: February and October,
e) Natural gas – for all months except: August and November,
f) Feeder cattle – for all months except: February, April, June, July and December,
g) Live cattle – for all months except: March,
h) Lean hogs – for all months except: June, August and November,
i) Lumber – for all months except: March and November.

2. The null hypothesis regarding equality of daily rates of return in two populations was rejected regarding the following cases (p-value shown in parentheses):
   a) Crude oil: November (0.0380). The p-value higher than 0.05 and lower than 0.1 was registered in April (0.878) and October (0.0827).
   b) Brent oil – November (0.0397). The p-value higher than 0.05 and lower than 0.1 was observed in April (0.629), August (0.0895) and October (0.0749).
   c) Heating oil: January (0.0368), August (0.0088) and September (0.0426). The p-value calculated for February mounted to 0.0632.
   d) Gas oil: February (0.0464). The p-value for June and August daily average rates of return was equal 0.0837 and 0.0805, respectively.
   e) Natural gas: January (0.0382), September (0.0033), October (0.0236) and December (0.0358).
   f) Feeder cattle: December (0.0339).
   g) Lumber: January (0.484), September (0.0001) and November (0.0050).
   h) The p-value for live cattle was equal to 0.0976 and 0.0820 in February and July, respectively. The p-value higher than 0.05 and lower than 0.1 was calculated for lean hogs in April (0.0784) and September (0.0696).

In all other analyzed cases there was no reason to reject the null hypothesis regarding equality of daily average rates of return in two populations. These facts indicate that the month effect on the analyzed markets was detected (for $\alpha = 0.05$).

4.3. The Analysis of the Average Daily Rates of Return in Different Days of the Month

The positive average daily rates of return, calculated for each day of the analyzed months were observed on the market of:
   a) Crude oil – in 15 out of 31 cases (i.e. in 49.39% cases). The highest and the lowest daily average rates of return were equal: max = 0.0338% (for the 1st day of the month) and min = -0.7016% (for the 17th day of the month).
   b) Brent oil – in 15 out of 31 cases (i.e. in 49.39% cases). The max = 0.3394% (1st) and min = -0.6962% (17th).
c) Heating oil – in 14 out of 31 cases (i.e. in 45.16% cases). The max = 0.3348% (7th) and min = −0.5947% (8th).

d) Gas oil – in 17 out of 31 cases (i.e. in 54.84% cases). The max = 0.5810% (30th) and min = −0.4767% (3rd).

e) Natural gas – in 14 out of 31 cases (i.e. in 45.16% cases). The max = 0.9881% (15th) and min = −0.7265% (27th).

f) Feeder cattle – in 14 out of 31 cases (i.e. in 45.16% cases). The max = 0.4451% (5th) and min = −0.3111% (30th).

g) Live cattle – in 17 out of 31 cases (i.e. in 54.84% cases). The max = 0.3722% (5th) and min = −0.2813% (21st).

h) Lean hogs – in 18 out of 31 cases (i.e. in 58.06% cases). The max = 0.5987% (12th) and min = −0.5378% (29th).

i) Lumber – in 15 out of 31 cases (i.e. in 48.39% cases). The max = 0.4286% (17th) and min = −0.5767% (23rd).

The results obtained while testing the null hypothesis allow formulating the following conclusions:

1. For all days of each 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) Crude oil – for all days of each month except: 2nd, 3rd, 4th, 6th, 7th, 8th, 10th, 13th, 21st, 27th, 30th,

   b) Brent oil – for all days of each month except: 2nd, 3rd, 4th, 6th, 7th, 8th, 10th, 13th, 14th, 18th, 21st, 27th, 30th, 31st,

   c) Heating oil – for all days of each month except: 2nd, 10th, 12th, 13th, 14th, 16th, 17th, 18th, 21st, 22nd, 24th, 26th, 30th, 31st,

   d) Gas oil – for the following days of each month: 4th, 5th, 11th, 13th, 18th, 23rd, 25th, 26th, 28th, 29th, 30th,

   e) Natural gas – for all days of each month except: 1st, 2nd, 5th, 6th, 7th, 16th, 21st, 28th, 30th, 31st.

   f) Feeder cattle – for the following days of each month: 11th, 12th, 13th, 14th, 18th, 21st, 25th, 29th,

   g) Live cattle – for all days of each month except: 1st, 4th, 20th, 26th, 27th, 30th, 31st.

   h) Lean hogs – for the following days of each month: 1st, 2nd, 3rd, 6th, 7th, 8th, 15th, 16th, 18th, 20th, 25th.

2. The null hypothesis regarding equality of the daily average rates of return in two populations was rejected in favor of the alternative hypothesis for the following days of the month:
a) Crude oil – 8\textsuperscript{th} (0.0430) and 26\textsuperscript{th} (0.0424),
b) Brent oil – 8\textsuperscript{th} (0.0412) and 26\textsuperscript{th} (0.0434),
c) Heating oil – 8\textsuperscript{th} (0.0387); the p-value calculated for the average rate of return on the 3\textsuperscript{rd}, 27\textsuperscript{th} and 29\textsuperscript{th} day amounted to 0.0777, 0.0863 and 0.0974 respectively,
d) Gas oil – 9\textsuperscript{th} (0.0440), 28\textsuperscript{th} (0.0482) and 30\textsuperscript{th} (0.0341),
e) Natural gas – 15\textsuperscript{th} (0.0008); the p-value for the average rate of return on the 4\textsuperscript{th} day was equal to 0.0805,
f) Feeder cattle – 5\textsuperscript{th} (0.0101) and 9\textsuperscript{th} (0.0444); the p-value higher than 0.05 and lower than 0.1 was observed for 15\textsuperscript{th} (0.0851) day,
g) Live cattle – 5\textsuperscript{th} (0.0285) and 6\textsuperscript{th} (0.0475); the p-value lower than 0.1 and greater than 0.05 was recorded for the following days: 7\textsuperscript{th} (0.0511) and 19\textsuperscript{th} (0.0560),
h) Lean hogs – 12\textsuperscript{th} (0.0117); the p-value lower than 0.1 was also computed for the following days: 4\textsuperscript{th} (0.868) and 28\textsuperscript{th} (0.0529),
i) Lumber – 17\textsuperscript{th} (0.0447) and 23\textsuperscript{rd} (0.0139).

4.4. The Analysis of the Average Daily Rates of Return in the First and the Second Half of Each Month

the 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 presented in table 2. The average daily rate of return in the first and the second half of the month was higher than zero on the market of gas oil (0.0595% – in the first half and 0.0723% – in the second). In cases of all other commodities, the daily average rate of return was negative in one of the two analyzed halves of the month. The null hypothesis, regarding equality of variances of daily rates of return in two populations, was rejected in the case of the analyzed commodities. There was no reason to reject the null hypothesis referring to the equality of average rates of return in two populations in the case of all analyzed commodities except lean hogs, for which the p-value was equal to 0.0088. 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 each month (for \( \alpha = 0.05 \)) for all the analyzed commodities except lean hogs.
Table 2. The Average Daily Rates of Return and Results of Testing the Null Hypothesis for the Average Daily Rates of Return for the First and Second Half of the Month

<table>
<thead>
<tr>
<th>Crude oil</th>
<th>Bent oil</th>
<th>Heating oil</th>
<th>Gas oil</th>
<th>Natural gas</th>
<th>Feeder cattle</th>
<th>Live cattle</th>
<th>Lean hogs</th>
<th>Lumber</th>
</tr>
</thead>
<tbody>
<tr>
<td>average rate of return in the first half of the month</td>
<td>-0.0148%</td>
<td>-0.0152%</td>
<td>-0.0407%</td>
<td>0.0595%</td>
<td>-0.1205%</td>
<td>0.0506%</td>
<td>0.0589%</td>
<td>0.1393%</td>
</tr>
<tr>
<td>average rate of return in the second half of the month</td>
<td>-0.0824%</td>
<td>-0.0822%</td>
<td>-0.0275%</td>
<td>0.0723%</td>
<td>0.0167%</td>
<td>-0.0577%</td>
<td>-0.0207%</td>
<td>-0.1099%</td>
</tr>
<tr>
<td>p-value</td>
<td>0.5271</td>
<td>0.5310</td>
<td>0.8743</td>
<td>0.9005</td>
<td>0.3774</td>
<td>0.0947</td>
<td>0.2304</td>
<td>0.0088</td>
</tr>
<tr>
<td>test of the null hypothesis</td>
<td>TRUE</td>
<td>TRUE</td>
<td>TRUE</td>
<td>TRUE</td>
<td>TRUE</td>
<td>TRUE</td>
<td>TRUE</td>
<td>FALSE</td>
</tr>
</tbody>
</table>

Source: the author's own calculations.

4.5. The Analysis of the Weekend Effect

The analysis of the average overnight rates of return (Monday open price vs Friday closing price), as well as the result of testing the null hypothesis, are shown in table 3.

Table 3. The Average Intraday Rates of Return on the Market of the Analyzed Commodities and the Results of Testing the Null Hypothesis for the Weekend Effect

<table>
<thead>
<tr>
<th>Crude oil</th>
<th>Bent oil</th>
<th>Heating oil</th>
<th>Gas oil</th>
<th>Natural gas</th>
<th>Feeder cattle</th>
<th>Live cattle</th>
<th>Lean hogs</th>
<th>Lumber</th>
</tr>
</thead>
<tbody>
<tr>
<td>average overnight rate of return (Monday open price – Friday closing price)</td>
<td>-0.0431%</td>
<td>-0.0132%</td>
<td>0.0158%</td>
<td>0.1339%</td>
<td>-0.0464%</td>
<td>0.0124%</td>
<td>0.0116%</td>
<td>-0.0102%</td>
</tr>
<tr>
<td>p-value</td>
<td>0.2225</td>
<td>0.4538</td>
<td>0.7411</td>
<td>0.3502</td>
<td>0.3913</td>
<td>0.8380</td>
<td>0.7126</td>
<td>0.3640</td>
</tr>
<tr>
<td>test of the null hypothesis</td>
<td>TRUE</td>
<td>TRUE</td>
<td>TRUE</td>
<td>TRUE</td>
<td>TRUE</td>
<td>TRUE</td>
<td>TRUE</td>
<td>TRUE</td>
</tr>
</tbody>
</table>

Source: the author's own calculations.
5. Conclusion

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 on 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 a stock level or marginal unit cost. It is also important to note that, despite the physical diversity, this asset class is often characterized by a high degree of price correlation.

The aim of this article was to examine the prevalence of selected seasonality effects on three different segments of the commodity market: energy market (crude oil, Brent oil, heating oil, gas oil and natural gas), meats (feeder cattle, live cattle, lean hogs) and softs (lumber). The analysis of the effects of seasonality included an examination of daily returns over various days of the week, average daily rates of return on different days of the month, and average daily rates of return in the first and the second half of the month, and the existence of the weekend effect. The main limitation of this research is the assumption of normal distribution of return rates of the analyzed commodities along with the use of the price data gained from Bloomberg data source.

The calculations presented in this paper indicate the existence of the monthly effect in: January (heating oil, natural gas and lumber), February (gas oil), August (heating oil), September (heating oil, natural gas and lumber), October (natural gas), November (crude oil, Brent oil and lumber) and December (natural gas and feeder cattle), as well as the day-of-the-week effect: on Mondays (feeder cattle, live cattle, lean hogs), on Tuesdays (heating oil), on Wednesdays (heating oil, natural gas, live cattle, lean hogs and lumber), on Thursdays (crude oil, feeder cattle, live cattle) and Fridays (Brent oil, heating oil). The calendar anomalies were also detected for different days of each month on various commodity markets: on the 5\textsuperscript{th} (feeder cattle, live cattle), on the 6\textsuperscript{th} (live cattle), on the 8\textsuperscript{th} (crude oil, Brent oil and heating oil), on 9\textsuperscript{th} (gas oil, feeder cattle), on the 12\textsuperscript{th} (lean hogs), on 15\textsuperscript{th} (natural gas), on 17\textsuperscript{th} (lumber), on 23\textsuperscript{rd} (lumber), on 26\textsuperscript{th} (crude oil and Brent oil), on 28\textsuperscript{th} (gas oil) and on 30\textsuperscript{th} (gas oil). The weekend effect was not registered, but seasonal effects regarding equality of the daily average rates of return in the first and in the second half of each month was detected on the lean hogs market.
The obtained results partially confirm the outcomes received by Ovavarin and Meade. According to the authors, higher (the lowest) daily average rate of return characterized Mondays (Wednesdays) sessions. In the analyzed period, the average daily rates of return were the highest in Monday sessions on the market of natural gas, whilst were the lowest on the same day of the week on the market of feeder cattle, live cattle and lean hogs. In Wednesday sessions, the highest daily average rate of return was recorded for Brent oil, heating oil and gas oil, but it was the lowest for soybean oil.

Further research on the occurrence of calendar anomalies in the agricultural market should include the following assets: oat, wheat and corn.

References


