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## Should Investors in Commodity Markets Be Superstitious (Based on the Example of 29 Commodities)?

**Abstract:** The issue of efficiency of financial markets has always fascinated scientists. It is significant from the point of view of assessing portfolio management effectiveness and behavioural finance. In the first part of this paper, the hypothesis of the unfortunate dates effect was tested upon 29 commodity prices in relation to the following four approaches: close-close, overnight, open-open, and open-close. The rates of return were calculated for the sessions falling on the 13<sup>th</sup> and 4<sup>th</sup> day of the month, Friday the 13<sup>th</sup> and Tuesday the 13<sup>th</sup>. The study proved the occurrence of seasonal effects on the so-called unlucky dates.

**Keywords:** market efficiency, calendar anomalies, unfortunate dates effect

**JEL:** G10, G12, G15

# 1. Introduction

The efficient market hypothesis (EMH), introduced by Fama in 1970 (Fama, 1970: 383–417), belongs to the most important paradigms of the traditional financial theories. According to this hypothesis, efficient markets are markets where “there are large numbers of rational profit maximizers actively competing with each trying to predict future market values of individual securities and where important current information is almost freely available to all participants” (Latif et al., 2011: 3). The presence of calendar anomalies in financial markets has been extensively examined for the last three decades. The most common ones are the day-of-the-week effect, monthly effect, weekend effect, holiday effects, within-the-month effect, and turn-of-the month effect, which have all been analysed by various researchers (Aggarwal, Rivoli, 1989: 541–550; Agrawal, Tandon, 1994: 83–106, Barone, 1990: 493–510, Boudreaux, 1995: 15–20; Gu, 2003: 395–404; Kato, Schwarz, Ziemba, 1990: 12–25; Schwert, 2002: 1–15; Smirlock, Starks, 1986: 197–210; Sutheebanjard, Premchaiswadi, 2010: 210–2023).

Another issue is the behaviour of investors during the days considered by them to be unlucky. In Western Europe, every 13<sup>th</sup> day of the month, especially the 13<sup>th</sup> day of the month when falling on a Friday, is believed to be unlucky. In turn, in Spanish-speaking countries (e.g.: Spain, Uruguay, Argentina, Chile, Peru, Venezuela and Colombia), it is assumed that the date bringing bad luck is Tuesday the 13<sup>th</sup>, which is expressed in the following Spanish proverb: *trece martes ni te cases, ni te embarques* (on Tuesday the 13<sup>th</sup>, don’t get married and don’t travel). On the other hand, in China, an unlucky date is every fourth day of the month. Many Chinese people believe the number 4 to be unlucky whilst considering the number 8 to be a lucky one (Agarwal et al., 2014: 1–20). In some Chinese dialects, the number 8 is pronounced like the word “prosperity”, while the number 4 is similar to the word “death”. Apparently the Chinese vary in their definition of which numbers are lucky. Shum et al. (Shum, Sun, Ye, 2014: 109–117) defined both 6 and 8 as lucky, while Hirshleifer Ming and Huai et al. (2012: 1–22) considered 6, 8 and 9 to be lucky.

Statistically significant differences between daily average rates of return registered on the stock market on the days considered by investors as unlucky dates and daily average rates of return calculated for the other days of the month can be called “the unfortunate dates effect”. The number of studies on “the unfortunate dates effect” in the scientific literature is rather low. Previous research focused on the calculation of rates of return only for the following scheme: Friday the 13<sup>th</sup> close-other Fridays’ close. The author is not aware of any papers analysing Friday the 13<sup>th</sup> effect with the use of rates of return different than the close-close scheme. This article attempts to fill this gap as well as expand research to encompass Tuesday the 13<sup>th</sup> and the sessions falling on the 4<sup>th</sup> day of the month.

The aim of this paper is to examine the prevalence of the unfortunate dates effect of 29 commodities listed on the Chicago Mercantile Exchange. The paper is divided into six parts. In the first four parts, analysis of the unfortunate dates effect will apply

to the returns calculated on the basis of the following prices: (1) last session close – previous session close (close-close), (2) last session open – previous session close (overnight), (3) last session open – previous session open (open-open), and (4) last session close – last session open (open-close). All these calculations will be carried out for the following two populations: (1) the 13<sup>th</sup> day of the month rates of return vs rates of return for all other sessions, (2) Friday the 13<sup>th</sup> rates of return vs rates of return for all other sessions, (3) Tuesday the 13<sup>th</sup> rates of return vs rates of return for all other sessions and (4) the 4<sup>th</sup> day of the month rates of return vs rates of return for all other sessions. In the fifth part of the paper, one-session rates of return for Friday the 13<sup>th</sup> session will be compared with one-session rates of return for all other Fridays. In turn, in the second part of the fifth part of the paper, a similar analysis for rates of return for Tuesday the 13<sup>th</sup> and all other Tuesdays will be conducted.

An analysis of the occurrence of calendar anomalies on particular days of the month (the 13<sup>th</sup>, the 13<sup>th</sup> and Friday, the 13<sup>th</sup> and Tuesday, and on the 4<sup>th</sup> day) should reveal a potential impact of investors based in the following regions: Europe, Latin America, and China.

## 2. Literature review

The belief in the ill-fortune that supposedly accompanies the 13<sup>th</sup> as well as the date of Friday the 13<sup>th</sup> is widespread across the Western world and has ancient and somewhat uncertain origins (Boyle et al., 2004: 1–23). Both the number 13 and Friday are characterised by long and separate histories associated with “bad luck”. It is believed that these two were combined in order to create an unfortunate date at the beginning of the 20<sup>th</sup> century (Chaundler, 1970: 45–66). In the literature, there are a lot of explanations for these two lines of superstitions: Christ was crucified on Friday and the number of people seated at the table for the Last Supper was 13. Even in advanced countries, people are prone to superstitions such as daily newspapers publishing horoscopes to guide their readers. Nowadays many buildings skip the thirteenth floor, streets lack the number 13<sup>th</sup> and hospitals decline to label their operating theatres with that number (Boyle et al., 2004: 1–23; “USA Today”, 2007: 24; Kramer, Block, 2008: 783–793). Fudenberg and Levine (2006: 630–651) theorise that superstitious beliefs can persist if the probability of being exposed as untrue is sufficiently low. If there is always any chance of a bad outcome when following superstition and some chance of a good outcome when not following superstition, a person might not realise that the belief is untrue, and, persists in the superstition (Agarwal et al., 2014: 1–20). Psychology and anthropology researchers suggest that people rely on superstition as a way to cope with misfortune and uncertainty, and to rationalise a complex world (Tsang, 2004: 932–945; Lepori, 2009: 1–52; Zhang, Risen, Hosey, 2014: 1171–1184).

Scanlon et al. found that the number of traffic accidents in the UK was higher on Friday the 13<sup>th</sup>, in spite of the smaller number of cars on the roads (Scanlon et al., 1993: 1584–1587). Kolb and Rodriguez (1987: 1385–1387), in one of the first studies linking superstition with the stock market, proved that average Friday the 13<sup>th</sup> rates of return were significantly lower than average rates of return for all other Fridays, but the later papers of Dyl and Maberly (1988: 1286–1295), Agrawal and Tandon (1994: 83–106), Coutts (1999: 35–37) and Lucey (2000: 294–301) conceded the reverse pattern: average returns on Fridays the 13<sup>th</sup> were higher than those on regular Fridays. Dyl and Maberly proved that in five out of the six analysed periods, Friday the 13<sup>th</sup> rates of return turned out to be positive and higher compared to other Fridays and the only period when Friday the 13<sup>th</sup> rates of return were in red compared to other Fridays rates of return fell during the 1970s (Dyl, Maberly, 1988: 1286–1295).

Fortin et al. investigated the effect of superstition on the prices of single-family homes in Great Vancouver, Canada (Fortin, Hill, Huang, 2013: 1–29). In neighbourhoods with relatively more Chinese residents and in repeated transactions, the sales prices of houses with street address numbers ending in “4” were 2.2% lower, while those ending in “8” were 2.5% higher than prices of other houses. According to Agarwal et al., on a per square meter basis, units with numbers ending in “4” were discounted by 1.1%, units on floors with numbers ending in “4” were discounted by 0.5%, while units with numbers ending in “8” commanded a 0.9% premium (Agarwal et al., 2014: 1–20). Ng, Chong and Du, studying the auction prices between 1997 and 2009, proved that the prices of licence numbers including the lucky number 8 were systematically higher, while the prices of licence numbers with the unlucky number “4” were lower (Ng, Chong, Du, 2010: 293–309). Besides, the premium for “8” could also be interpreted as conspicuous spending to signal wealth or status (Feltovich, Harbaugh, To, 2002).

Analysing daily returns of the NZSE40 index, the value-weighted capital index of the 40 largest securities by market capitalisation at the New Zealand Stock Exchange, in the period 1.01.1967–30.11.2001, Boyle et al. certified that average rates of return for Fridays the 13<sup>th</sup> were not statistically different from rates of return for regular Fridays (Boyle et al., 2014: 1–23). The name of “the Friday the Thirteenth effect”, introduced by Kolb and Rodriguez (1987: 1385–1387), has been regularly used by different researchers (Chamberlain, Cheung, Kwan, 1991: 111–117; Coutts, 1999: 35–37; Patel, 2009: 55–58; Botha, 2013: 247–253; Auer, Rottmann, 2013: 1–27). Coutts examining the Friday the 13<sup>th</sup> effect in the UK with the use of FTSE index over the period of 59 years proved that in most cases rates of return registered for Friday the 13<sup>th</sup> were positive and higher compared to other Fridays rates of return but statistical significance was not observed (Coutts, 1999: 35–37). Patel, analysing the period of 58 years for the NASDAQ and S&P 500 index, discovered that in four out of the seven periods rates of return for Friday the 13<sup>th</sup> were positive and higher than rates of return calculated for other Fridays (Patel, 2009: 55–59).

Hirshleifer et al. found that superstition affected the pricing of initial public offerings in China in the period of 1991–2005 (Hirshleifer, Ming, Huai, 2012: 1–22). At the Shanghai and Shenzhen stock exchanges, listed companies are identified by a numerical code, which is the equivalent of the US ticker. Consistent with superstition, newly listed equities with lucky listing codes (that included at least one lucky digit and no unlucky digit) initially traded at a premium dissipated within three years. Botha analysed the Friday the 13<sup>th</sup> effect for samples from stock exchanges in Kenya, Morocco, Nigeria, South Africa and Tunisia (Botha, 2013: 247–253). Auer and Rottmann proved that the Friday the 13<sup>th</sup> effect was not registered for the Stock Exchange in the Philippines (Auer, Rottmann, 2013: 1–27). Kalayaan found that the mean returns for Friday the 13<sup>th</sup> were lower than those of other Fridays or other days and that the Friday the 13<sup>th</sup> effect was evident during the period of June 1992 to May 2015 for the PSEI index (Kalayaan, 2016: 84–96).

### 3. Data and methods

The research is divided into six parts. The calculations were performed for 29 commodities (in brackets the date of the first session included in the analysis, quotation from the Reuters Service): Brent oil (30.03.1983), canola (1.09.1998), cocoa (1.07.1959), coffee (17.08.1973), copper (1.07.1959), corn (15.02.1968), cotton (1.07.1959), feeder cattle (6.09.1973), gas oil (1.09.1998), gasoline (1.09.1998), gold (2.06.1969), heating oil (6.03.1979), lean hogs (25.06.1969), live cattle (5.01.1970), lumber (1.09.1998), natural gas (3.09.1990), orange juice (1.02.1967), palladium (5.01.1997), platinum (1.03.1968), rough rice (1.09.1998), silver (13.06.1963), soybean (1.07.1957), soybean meal (1.09.1998), soybean oil (1.09.1998), sugar (5.02.2010), wheat (1.07.1959), wheat KCBT (1.09.1998), wheat spring (1.09.1998) and WTI (30.03.1983).

The last session considered in the process of calculating rates of return was on 30.09.2017.

The verification of the statistical hypothesis was done with the use of  $z$  statistics (Defusco et al., 2001: 335) and the Kruskal-Wallis test (Vargha, Delaney, 1998: 170–192).

The paper consists of five empirical parts:

In the first part, the test for equality of two average rates of return will be exemplified for rates of return in two samples. Assuming that if the first population is composed of rates of return calculated for the session on the 13<sup>th</sup> day of the month, then the other population determines rates of return for all remaining sessions.

In the second part, the test for equality of two one-session average rates of return will be exemplified for rates of return in two samples. Assuming that if the first population is composed of rates of return calculated for the session falling on Friday the 13<sup>th</sup> day of the month, then the other population determines rates of return for all remaining sessions.

In the third part, the test for equality of two average rates of return will be exemplified for rates of return in two samples. Assuming that if the first population is composed of rates of return calculated for the session falling on Tuesday the 13<sup>th</sup> day of the month, then the other population determines rates of return for all remaining sessions.

In the fourth part, the test for equality of two average rates of return will be exemplified for rates of return in two samples. Assuming that if the first population is composed of rates of return calculated for the session falling on the 4<sup>th</sup> day of the month, then the other population determines rates of return for all remaining sessions.

In the fifth part, the test for equality of two average rates of return will be exemplified for rates of return in two samples. Assuming that if the first population is composed of rates of return calculated for the sessions falling on Friday the 13<sup>th</sup>, then the other population determines rates of return for all remaining Fridays. In the second part of the fifth part, the test for equality of two average rates of return will be computed under the assumption that the first group of data consists of rates of return for sessions falling on Tuesday the 13<sup>th</sup> and the other group is composed of rates of return for all remaining Tuesdays. In this part, only close-close rates of return will be calculated.

## 4. Analysis of results

### 4.1. The analysis of the calendar effect – the 13<sup>th</sup> day of the month

The results of testing the null hypothesis with the use of average rates of return for two different populations permit to draw the following conclusions:

#### Close-close rates of return

The null hypothesis regarding equality of two average rates of return was rejected for the following 2 commodities (*p*-value shown in parenthesis): corn (0.0381) and soybean meal (0.0430). In all the other cases, there was no reason to reject the null hypothesis in favour of the alternative hypothesis.

The null hypothesis regarding the Kruskal-Wallis test was rejected for the following 3 commodities: copper (0.0165), lean hogs (0.0403) and soybean meal (0.0456).

The highest percentage of positive rates of return equal to 57.33% was registered for soybean meal and the lowest one equal to 45.63% for gas oil. The highest one – the session average rate of return equal to 0.2941% – was registered for soybean meal and the lowest – equal to -0.2171% – for gas oil. Positive one-session average rates of return were observed for 21 commodities (72.41%) and negative for 8 commodities (27.59%) – see Table 1.

Table 1. The highest and lowest percentage of positive rates of return, the highest and lowest one-session average returns, the number of positive and negative one-session average returns

	13 <sup>th</sup> day of the month				13 <sup>th</sup> day of the month falling on Friday				13 <sup>th</sup> day of the month falling on Tuesday				4 <sup>th</sup> day of the month			
	C-C	OV	O-O	O-C	C-C	OV	O-O	O-C	C-C	OV	O-O	O-C	C-C	OV	O-O	O-C
The highest percentage of positive rates of return (%)	57.33 (soybean meal)	57.85 (lean hogs)	57.47 (lean hogs)	58.74 (canola)	64.29 (Brent oil)	68.97 (soybean meal)	66.67 (gasoline)	62.07 (gas oil)	66.67 (soybean oil)	82.46 (feeder cattle)	63.63 (sugar)	72.72 (sugar)	58.45 (natural gas)	56.47 (lean hogs)	57.14 (rough rice)	57.97 (natural gas)
The lowest percentage of positive rates of return (%)	45.63 (gas oil)	32.84 (wheat Spring)	40 (soybean oil)	45.89 (rough rice)	37.93 (lumber)	40.47 (silver)	30.00 (soybean oil)	40.24 (copper)	29.63 (gas oil)	38.97 (canola)	21.42 (wheat Spring)	33.33 (lumber)	41.50 (gasoline)	44.38 (corn)	44.29 (soybean oil)	42.88 (lumber)
The highest one-session average rate of return (%)	0.2941 (soybean meal)	0.1632 (lean hogs)	0.3893 (sugar)	0.3883 (soybean meal)	0.7509 (lean hogs)	0.4646 (lean hogs)	0.8812 (gasoline)	0.4864 (rough rice)	0.6798 (natural gas)	0.5993 (natural gas)	0.5969 (natural gas)	0.3442 (soybean oil)	0.4369 (natural gas)	0.1833 (lumber)	0.2967 (gas oil)	0.4335 (natural gas)
The lowest one-session average rate of return (%)	-0.2171 (gas oil)	-0.1170 (gas oil)	-0.03580 (gas oil)	-0.0973 (sugar)	-0.3516 (lumber)	-0.3662 (wheat)	-0.6209 (canola)	-0.2265 (lumber)	-0.6449 (gas oil)	-0.5255 (gas oil)	-0.9682 (gasoline)	-0.4653 (lumber)	-0.4227 (sugar)	-0.3580 (gas oil)	-0.2480 (natural gas)	-0.2362 (sugar)
Number of positive one-session average rates of return	21 (72.41%)	14 (48.28%)	14 (48.28%)	23 (79.31%)	18 (67.02%)	13 (44.83%)	17 (58.62%)	19 (65.52%)	19 (65.52%)	13 (48.83%)	8 (27.59%)	20 (68.97%)	16 (55.17%)	14 (48.28%)	17 (58.62%)	14 (48.28%)
Number of negative one-session average rates of return	8 (27.59%)	15 (51.72%)	15 (51.72%)	6 (21.03%)	11 (37.93%)	16 (55.17%)	12 (41.38%)	10 (34.48%)	10 (34.48%)	16 (55.17%)	11 (72.41%)	9 (31.03%)	13 (30.77%)	15 (51.72%)	12 (41.38%)	15 (51.72%)

Source: own calculation



### Overnight rates of return

The null hypothesis regarding equality of two average rates of return was rejected for the following 3 commodities: gold (0.0102), live cattle (0.0014) and rough rice (0.0055).

There was no reason to reject the null hypothesis for the Kruskal-Wallis test in favour of the alternative hypothesis.

### Open-open rates of return

The null hypothesis regarding equality of two average rates of return was rejected for the following 5 commodities: canola (0.0291), gas oil (0.0460), gold (0.0075), heating oil (0.0317), and live cattle (0.0273).

There was no reason to reject the null hypothesis for the Kruskal-Wallis test in favour of the alternative hypothesis.

### Open-close rates of return

The null hypothesis regarding:

- 1) equality of two average rates of return was rejected for soybean (0.0419) and soybean meal (0.0124),
- 2) the null hypothesis regarding the Kruskal-Wallis test was rejected for copper (0.0263).

## 4.2. The analysis of the calendar effect – the 13<sup>th</sup> day of the month falling on Friday

The results of testing the null hypothesis with the use of average rates of return for two different populations permit to draw the following conclusions:

### Close-close rates of return

The null hypothesis regarding:

- 1) equality of two average rates of return was rejected for lean hogs (0.0114) and soybean meal (0.0264),
- 2) the null hypothesis regarding the Kruskal-Wallis test was rejected for corn (0.0435).

### Overnight rates of return

The null hypothesis regarding:

- 1) equality of two average rates of return was rejected for lean hogs (0.0114),
- 2) the null hypothesis regarding the Kruskal-Wallis test was rejected for the following 3 commodities: Brent oil (0.0157), lean hogs (0.0099) and live cattle (0.0272).



### Open-open rates of return

The null hypothesis regarding:

- 1) equality of two average rates of return was rejected for the following 3 commodities: gasoline (0.0453), heating oil (0.0486) and lean hogs (0.0478),
- 2) the null hypothesis regarding the Kruskal-Wallis test was rejected for the following 3 commodities: canola (0.0341), gas oil (0.0139) and lean hogs (0.0148).

### Open-close rates of return

The null hypothesis regarding:

- 1) equality of two average rates of return was rejected for lean hogs (0.0295),
- 2) the null hypothesis regarding the Kruskal-Wallis test was rejected for soy-bean meal (0.0169).

## 4.3. The analysis of the calendar effect – the 13<sup>th</sup> day of the month falling on Tuesday

The results of testing the null hypothesis with the use of average rates of return for two different populations permit to draw the following conclusions:

### Close-close rates of return

The null hypothesis regarding:

- 1) equality of two average rates of return was rejected for: corn (0.0381) and soy-bean oil (0.0385),
- 2) the null hypothesis regarding the Kruskal-Wallis test was rejected for soy-bean oil (0.0478).

### Overnight rates of return

The null hypothesis regarding:

- 1) equality of two average rates of return was rejected for silver (0.0440),
- 2) the null hypothesis regarding the Kruskal-Wallis test was rejected for coffee (0.0402) and silver (0.0425).

### Open-open rates of return

The null hypothesis regarding:

- 1) equality of two average rates of return was rejected for the following 4 commodities: gasoline (0.0118), gold (0.0276), wheat Spring (0.0225), and WTI (0.0338),

- 2) the null hypothesis regarding the Kruskal-Wallis test was rejected for the following 5 commodities: Brent oil (0.0053), gasoline (0.0339), silver (0.0147), wheat Spring (0.0099), and WTI (0.0358).

#### Open-close rates of return

There was no reason to reject the null hypothesis regarding equality of two average rates of return in favour of the alternative hypothesis.

The null hypothesis regarding the Kruskal-Wallis test was rejected for WTI (0.0480).

### 4.4. The analysis of the calendar effect – the 4<sup>th</sup> day of the month

The results of testing the null hypothesis with the use of average rates of return for two different populations permit to draw the following conclusions:

#### Close-close rates of return

The null hypothesis regarding:

- 1) equality of two average rates of return was rejected for cotton (0.0319),
- 2) the null hypothesis regarding the Kruskal-Wallis test was rejected for the following 4 commodities: Brent oil (0.0053), cotton (0.0339), gasoline (0.0162) and natural gas (0.0220).

#### Overnight rates of return (14)

The null hypothesis regarding:

- 1) equality of two average rates of return was rejected for rough rice (0.0055),
- 2) the null hypothesis regarding the Kruskal-Wallis test was rejected for cotton (0.0120) and rough rice (0.0463).

#### Open-open rates of return (15)

The null hypothesis regarding:

- 1) equality of two average rates of return was rejected for soybean meal (0.0383),
- 2) the null hypothesis regarding the Kruskal-Wallis test was rejected for soybean meal (0.0403).

#### Open-close rates of return (16)

The null hypothesis regarding:

- 1) equality of two average rates of return was rejected for natural gas (0.0298),
- 2) the null hypothesis regarding the Kruskal-Wallis test was rejected for gasoline (0.0483) and natural gas (0.0189).

#### 4.5. The analysis of the calendar effect – the 13<sup>th</sup> day of the month falling on Friday (Tuesday) vs other Fridays (Tuesday) with the use of close-close rates of return

##### Friday the 13<sup>th</sup> vs other Fridays

The null hypothesis regarding:

- 1) equality of two average rates of return was rejected for the following 3 commodities: lean hogs (0.0340), rough rice (0.0461) and soybean meal (0.0417),
- 2) the null hypothesis regarding the Kruskal-Wallis test was rejected for copper (0.0210) and soybean meal (0.0375).

Percentage of positive returns calculated for sessions falling on Friday the 13<sup>th</sup> was higher than 50% in 18 cases: Brent oil, canola, coffee, corn, cotton, feeder cattle, gas oil, gasoline, heating oil, lean hogs, orange juice, rough rice soybean, soybean meal, soybean oil, wheat KCBT, wheat Spring, and WTI. The highest percentage was observed for WIT (64.29%) and the lowest one for lumber (37.93%). The highest one-session average rate of return equal to 0.7509% was registered for lean hogs and the lowest – equal to –0.3516% – for lumber. Positive one-session average rates of return were observed for 18 commodities (62.07%) and negative for 11 (37.93%) – see Table 2.

Table 2. Percentage of positive rates of return, one-session average rates of return for sessions falling on Friday the 13<sup>th</sup> and for other sessions falling on Friday

Commodity	Percentage of positive rates of return Friday the 13 <sup>th</sup>	One-session average rate of return Friday the 13 <sup>th</sup> (%)	One-session average rate of return for all other Fridays (%)
Brentoil	64.29	0.3209	0.1324
Canola	53.33	-0.0044	-0.0013
Cocoa	47.37	0.0283	0.0671
Coffee	54.17	0.2027	0.0804
Copper	41.05	-0.2954	0.0595
Corn	51.81	0.0299	-0.0032
Cotton	51.69	-0.0144	0.0103
Feeder cattle	50.68	0.0672	0.0315
Gasoil	55.17	0.2709	0.2060
Gasoline	55.17	0.0210	0.2197
Gold	43.42	-0.1189	0.0118
Heating oil	63.49	0.3503	0.1686
Lean hogs	59.49	0.7509	0.0907
Live cattle	48.10	0.1514	0.0589
Lumber	37.93	-0.3516	0.3755
Natural gas	50.00	-0.0839	-0.1376

Commodity	Percentage of positive rates of return Friday the 13 <sup>th</sup>	One-session average rate of return Friday the 13 <sup>th</sup> (%)	One-session average rate of return for all other Fridays (%)
Orange juice	58.54	0.3513	0.0570
Palladium	45.45	-0.0841	0.0503
Platinum	46.34	-0.0290	0.0224
Roughrice	63.33	<b>0.3728</b>	0.0025
Silver	43.02	-0.2166	0.0891
Soybean	53.68	0.0694	0.0226
Soybeanmeal	62.07	<b>0.5167</b>	-0.0055
Soybeanoil	51.72	0.0847	-0.0267
Sugar	45.45	0.0313	0.0143
Wheat	46.88	-0.2541	-0.0430
Wheat KCBT	55.56	0.0971	0.0718
Wheat Spring	55.17	-0.1028	0.0957
WTI	64.29	0.3755	0.0917

In bold: commodities for which the difference between average rates of return in two populations of rates of return was statistically significant regarding equality of two average rates of return

Source: own calculation

One-session average rates of return for Friday the 13<sup>th</sup> were positive in the case of 18 commodities: Brent oil, cocoa, coffee, corn, feeder cattle, gas oil, gasoline, heating oil, lean hogs, live cattle, orange juice, rough rice, soybean, soybean meal, soybean oil, sugar, wheat KCBT, and WTI. In three cases, one-session average rates of return for Friday the 13<sup>th</sup> were statistically different than average rates of return for all other Fridays: lean hogs, rough rice and soybean meal. In all the other remaining cases (11), one-session average rates of return for Friday the 13<sup>th</sup> were negative, but for none of them the difference between one-session average rates of return for Friday the 13<sup>th</sup> and one-session average rates of return for all other Fridays was statistically significant.

One-session average rates of return for Friday the 13<sup>th</sup> were higher than one-session average rates of return for all remaining Fridays in 12 cases (Brent oil, coffee, corn, feeder cattle, gas oil, heating oil, lean hogs, live cattle, natural gas, orange juice, rough rice, soybean, soybean meal, soybean oil, sugar, wheat KCBT, and WTI) but only in three cases the difference between average rates of return in the two analysed populations was statistically significant: lean hogs, rough rice and soybean meal.

#### Tuesday the 13<sup>th</sup> vs other Tuesdays

The null hypothesis regarding equality of two average rates of return was rejected for soybean oil (0.0442).

There was no reason to reject the null hypothesis regarding the Kruskal-Wallis test in favour of the alternative hypothesis.

Calculations presented in this paper indicate the presence of the unfortunate days effect – the results are presented in Table 3 and Table 4.

Table 3. Number of the unfortunate day effects (results of the Kruskal-Wallis test in brackets)

Type of rate of return	13 <sup>th</sup> vs all other sessions	Friday 13 <sup>th</sup> vs all other sessions	Tuesday 13 <sup>th</sup> vs all other sessions	4 <sup>th</sup> vs all other sessions	Friday 13 <sup>th</sup> vs Fridays	Tuesday 13 <sup>th</sup> vs Tuesdays
Close-close	2 (3)	2 (1)	2 (1)	1 (4)	3 (2)	1 (0)
Overnight	3 (0)	1 (3)	1 (2)	1 (2)		
Open-open	5 (0)	3 (3)	4 (5)	1 (1)		
Open-close	2 (1)	1 (1)	0 (1)	1 (2)		
Sum	12 (4)	7 (8)	7 (9)	4 (9)		

Source: own calculation

Considering the sum of cases when there was *no reason* to reject the null hypothesis, the effect of unlucky days was most strongly observed for:

- 1) Z statistic: the 13<sup>th</sup> day of the month (12), Friday the 13<sup>th</sup> and Tuesday the 13<sup>th</sup> (both 7) and the 4<sup>th</sup> day of the month (4),
- 2) Kruskal-Wallis test: Tuesday the 13<sup>th</sup> and the 4<sup>th</sup> day of the month (both 9), Friday the 13<sup>th</sup> (8) and the 13<sup>th</sup> day of the month (4).

Thus, in the case of the analysed financial instruments, calendar effects were also observed on the 13<sup>th</sup> and Tuesday as well as on the 4<sup>th</sup> day of the month.

Table 4. Commodities for which the null hypothesis was rejected with the use of statistic z as well as with the Kruskal-Wallis test

Type of rate of return	13 <sup>th</sup> vs all other sessions	Friday 13 <sup>th</sup> vs all other sessions	Tuesday 13 <sup>th</sup> vs all other sessions	4 <sup>th</sup> vs all other sessions	Friday 13 <sup>th</sup> vs Fridays	Tuesday 13 <sup>th</sup> vs Tuesdays
Close-close	Soybean meal		Soybean oil	Cotton	Soybean meal	
Overnight		Lean hogs	Silver	Rough rice		
Open-open		Lean hogs	Gasoline, wheat Spring and WTI	Soybean oil		
Open-close				Natural gas		

Source: own calculation

Taking into account the number of cases when the null hypothesis was rejected with the use of the Kruskal-Wallis test and z statistics, the strongest calendar effect was observed for sessions falling on: Tuesday the 13<sup>th</sup>, the 4<sup>th</sup> day of the month, Friday the 13<sup>th</sup> and the 13<sup>th</sup> day of the month.

## 5. Conclusions

The aim of this study was to determine the prevalence of the calendar effect in the case of the unfortunate dates effect based on the example of 29 commodities. The analysis of the effects of seasonality included an examination of the rates of return calculated for four approaches.

In all these cases, the equality of one-session rates of return for two populations was calculated for:

- 1) sessions falling on the 13<sup>th</sup> day of the month vs all other sessions (first part),
- 2) sessions falling on Friday the 13<sup>th</sup> vs all other sessions (second part),
- 3) sessions falling on Tuesday the 13<sup>th</sup> vs all other sessions (third part),
- 4) sessions falling on the 4<sup>th</sup> day of the month vs all other sessions (fourth part).

In the fifth part, the equality of one-session rates of return for the population of Friday the 13<sup>th</sup> and the population of other Fridays was compared. The following part of the fifth part of the paper consists of the analysis of equality of rates of return for the sessions falling on Tuesday the 13<sup>th</sup> vs rates of return calculated for all remaining Tuesdays.

The main limitation of this research is the price range of data gained from the Reuters data source as well as the unequal intervals of observations for different commodity prices. The outcome may be regarded as a part of the ongoing discussions on the hypothesis of financial markets efficiency which was introduced by Fama (1970: 383–417).

Results obtained in the paper regarding the Friday the 13<sup>th</sup> effect (close-close) for the following commodities: lean hogs, rough rice and soybean meal, are in line with the outcomes reported by Agrawal and Tandon (1994: 83–106), Coutts (1999: 35–37) and Lucey (2000: 294–301). Further research on the occurrence of “unfortunate dates effect” in financial markets should cover the equity and also the FX market.

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### Czy inwestorzy na rynku surowców powinni być przesądni (na przykładzie 29 towarów)?

**Streszczenie:** Problem efektywności rynków finansowych zawsze stanowił przedmiot zainteresowania badaczy. Zagadnienie to jest niezwykle ważne z punktu widzenia oceny efektywności zarządzania portfelem aktywów, a także w ujęciu finansów behawioralnych. W artykule, na przykładzie stóp zwrotu 29 surowców, zweryfikowana została hipoteza dotycząca występowania tzw. dni pechowych. Badaniu poddane zostały stopy zwrotu obliczone w następujących ujęciach: cena zamknięcia – cena zamknięcia, *overnight*, cena otwarcia – cena otwarcia oraz cena otwarcia – cena zamknięcia dla sesji przypadających w następujących dniach: 13. i 4. dzień każdego miesiąca, 13. i piątek oraz 13. i wtorek każdego miesiąca. Badanie potwierdziło występowanie efektów sezonowych w tzw. dni pechowe.

**Słowa kluczowe:** efektywność rynków, anomalie kalendarzowe, efekt pechowych dat

**JEL:** G10, G12, G15

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