IMPACT OF THE MOON PHASES ON PRICES OF 110 EQUITY INDICES AND COMMODITIES

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ABSTRACT: *The influence of the moon on human behavior has been featured in many, not only scientific publications. This paper tests the hypothesis that the one-session rates of return of 107 stock indices and commodities, calculated for full moon and new moon phases (considering moon phases falling on Saturdays and Sundays – Regime 1, or ignoring them – Regime 2), are statistically different form zero (at the significance level of 95%). Calculations presented in this paper indicate that the one-session average rates of return for the sessions, when the moon was in new phase, are statistically different from zero. For Regime 1, the null hypothesis was rejected for 15 and 39 indices and commodities when the moon was in the full and noon phase (α=5%), respectively, and for Regime 2, the number of null hypothesis rejection was equal to 26 (full moon) and 45 (new moon) – for α=5%. In case of testing equality of average rates of return in two populations, the number of null hypothesis rejection was equal in the Regime 1: 5 and 21 (for full and new moon, respectively), whilst in the Regime 2, it mounted to 5 and 17. In case of testing the null hypothesis regarding equality of one-session average rates of return, computed for each day of the week, the result permit to reject in the Regime 1: 46 and 34 cases, and in the Regime 2: 39 and 54 cases (full and new moon, respectively). Calculations of one-session average rates of return, regarding moon phases falling in a specific month, displayed that they are statistically different from zero - in the Regime 1: in 131 and 70 cases and in the Regime 2: in 120 and 80 cases (for full and new moon, respectively).*

KEYWORDS: Market Efficiency, Calendar Effects, Market Anomalies, Moon Influence.

INTRODUCTION

Introduction to the problem - moon influence on investors decisions

In the scientific literature, there has been widespread belief that moon cycles affect human behavior (Dichev & Janes, 2003). Huston and Passerello (1971) proved that human beings exhibit more depressive behavior during the full moon. According to Wilkinson (1997) moon phases influences human anxiety and depression. In line with academic research, moon phases affect also economic behavior of people (Lo & Repin, 2001; Loewenstein, 2000) and investors' financial decisions (Dichev & Janes, 2003). In line with contemporary surveys "…a large part of the population, about 50%, believes that strange behavior peak around the full moon" (Kelly et al., 1996) and one may use "…stock prices as a powerful aggregators of regular and recurring human behavior" (Dichev & Janes, 2001). The daily stock index data analyzed over decades and in many countries "..allows researchers to examine lunar cycle hypothesis on countless decisions of hundreds of millions of individuals" (Dichev & Janes, 2001). In the scientific literature a statement can be found that the behavioral biases can impact investors decisions,

thereby may influence stock and indices rates of return (Hirshleifer, 2001; Kahneman & Riepe, 1998).

Relation between mood and stock returns was examined by Sauders (1993) and also by Hirshleifer and Shumway (2003), who proved that sunny weather was associated with an upbeat mood of investors and found the strong correlation between stock rates of return and sunshine. The Authors found that stock returns tended to be higher on sunny days. Sunshine was lined to tipping (Rind, 1996) and lack of sunshine to depression (Eagles, 1994). Taking into consideration seasonal time-variation of risk premia in stock returns, Kamstra et al. (2001), referring to yearly daylight fluctuations, introduced the Seasonal Affective Disorder (SAD) and found statistical significance relationship between stock returns and SAD. According to the Authors, the lack of sunlight induced investors depression, what increased their risk aversion and affected stock valuation. Keef and Roush (2007) based on 26 international stock exchanges proved the relation between the sunshine effect, per capita GDP and latitude. They found no effect in the stock exchanges situated near the equator and a big influence on northern exchanges.

The main purpose of this paper is to verify the influence of the moon on the registered rates of return – for this purpose it is necessary to test the null hypothesis that the one-session average rate of return calculated for the session, which falls during particular phase of the moon (full moon or new moon), is statistically different from zero. The second aim of this paper is to verify the null hypothesis that the difference of one-session average rate of return calculated for the session, which falls during particular phase of the moon (full or new), and the one-session average rate of return, calculated for all sessions, which not fall during particular moon phase, is equal zero. Test for equality of two one-session average rates of return will be applied also in case considering specific moon phase (full or new moon) falls on a specific day of the week and in the specific month of the year.

This is the first research regarding moon influence on rates of return on such big data of stock indices and commodities.

LITERATURE REVIEW

Crack (1999) proved that near new moon and full moon, stock markets volatility was higher and stock markets return were lower than during other periods. To the same conclusion came Gao (2009), analyzing rates of returns for two major stock markets of China during the period of 16 years. Dichev and Janes (2003) proved that returns during 15 days round new moon dates are about double the returns in the 15 days round full moon dates for nearly all major stock indices of 24 analyzed, in the period of 30 years. In turn, Yuan et al. (2006) calculated relationship between lunar phases and stock market returns of 48 countries and found that rates of return were lower during the full moon than in the days around a new moon. The return difference was around 3% to 5% between new moon and full moon and was not due to changes in stock market volatility or trading volumes. The lunar effect could not be explained by announcements of macroeconomics factors or major global shocks, and was independent of calendar anomalies Zacks (2011, p. 55). Brahman et al. (2011), based on empirical study on seven stock markets in the period 1999-2009, confirmed previous research of Yuan et al. (2006). According to Sivakumar and Sathyyanarayanan (2009) impact of lunar cycles on returns of the Bombay Stock Exchange index over the period of 17 years, was quite limited. Rotton and Kelly

(1985) cite a working paper of Rotton and Rosenberg (1984), who investigated relation between lunar phases and closing prices of Dow Jones Industrial Average, and found no relation after correcting Dow Jones Industrial Average prices for first autocorrelations (Yuan et al., 2001).

Liu (2009) examined average daily returns, the correlation between consecutive daily returns, and the GARCH (Generalized Auto-Regressive Conditional Heteroskedasticity) volatility for 12 stock exchanges, including G-7 markets and 5 emerging markets in Asia, indicated the existence of the lunar impact on daily stock returns although different schemes were presented on each of the analyzed markets. Lempori (2009) investigating influence of eclipses on the rates or return on the US and Asian stock markets, in the period of 1928-2008, proved existence of below-average stock returns and trading volume declining during these events.

According to research conducted by Herbst (2007) the relationship between moon phases and market returns were varied and not consistent - moon cycles were not reliable in the process of predicting stock price returns and price volatility. Analyzing two periods of panic on the New York Stock Exchange in 1929 and 1987, and extending its study on all the panic examples from 1857 through 1987 on different markers, Carolan (1992) introduced spiral calendar, measuring distance between two important price extremes, not in hours or days but in Lunar Month Units.

The existence of a lunar cycle on precious metal returns was measured by Lucey (2008). According to the findings, the influence appeared to be the strongest in the silver than gold market, with very little evidence for a platinum market.

METHOD

The research is divided into four parts and two regimes. In the first part, the following null hypothesis will be tested: the one-session average rate of return for the session, which falls during particular phase of the moon, is statistically equal zero. Appropriate statistical tests will be conducted for two confidence levels of 95% (α=5%) and 99% (α=1%). In case of rejection the null hypothesis, alternative hypothesis will be adopted, which was formulated in the following way: one-session average rate of return for the session, which falls during particular phase of the moon, is statistically different from zero. The hypothesis will be tested for two moon phases: full moon and new moon. If a particular phase of the moon falls on Saturday or Sunday, then the one-session rate of return was calculated for Friday and Monday sessions, respectively (Regime 1). In the Regime 2, the moon phases falling on Saturday or Sundays were ignored in the process of computing rate of return and null hypothesis testing. It means that only one-session returns, when the moon was in one of two analyzed phases (falling on Mondays, Tuesdays, Wednesdays, Thursdays and Fridays session), were taken into account. Adoption of such a distinction between Regime 1 and Regime 2 means that in case of Regime 1 it will be about twice the rates of return falling on Fridays (Fridays rates of return were calculated when the moon phase falls on Fridays or Saturdays) and Mondays (Mondays rates of return were computed when the moon phase falls on Sundays or Mondays) than rates of return calculated for moon phases falling on the other working days (Tuesday, Wednesday and Thrursday). On the other hand, when the analyzed phases of the moon falls on a holiday, the one-session rate of return will be calculated for the last session preceding the holiday in the Regime 1 and ignored in the Regime 2.

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The calculation were proceeded for following 74 world stock indices and 33 commodities – in the parenthesis are indicated the first month and year considered in the process of rates of return calculation.

World stock indices:

AEX (01.1992), All Ordinaries (11.1989), AMEX (01.1995), ATHEX (01.1992), BEL 20 (01.1992), BET (01.1992), BOVESPA (01.1970), BUMIX (01.1992), BUX (01.1992), CAC 40 (01.1992), CDAX (04.2004), CRB (01.1994), DAX (01.1992), DJ Composite (01.1981), DJ Eurostoxx (08.2002), DJIA (01.1970), DJTA (01.1970), DJUA (01.1995), EOE (01.1995), FTSE-100 (01.1992), FTSE-250 (01.1992), FTSMIB (01.1998), HANG SENG (01.1970), HEX (01.1995), IBEX (01.1992), ICEX (01.1993), IPC (11.1991), IPSA (01.1987), JCI (04.1983), KLCI (01.1977), KOSPI (02.1980), MDAX (03.1996), MERVAL (05.1988), MEX (08.1989), MICEX (10.1997), MSCI AC World (07.2003), MSCI World (07.2007), mWIG40 (01.1998), NASDAQ (05.1971), NIKKEI (01.1970), NZX50 (01.2001), OMX Riga (01.2000), OMX Stockholm (01.2000), OMX Talin (01.2000), OMX Vilnius (01.2001), OSE (01.1992), PSEI (01.1986), PSI 20 (01.1993), PX (09.1993), RTS (11.1995), RUSSEL (11.2001), SAS (07.1995), SASLCT (01.2003), SDAX (03.1999), SENSEX (04.1979), SET (07.1987), SMI (01.1992), SOFIX (11.2011), SP 500 (01.1970), SPTSX (01.1977), SPTSX Composite (03.1961), SSE B-Share (01.2000), SSE Composite (01.1991), Straits Times (11.2011), sWIG80 (01.1995), TAIEX (01.1995), TECDAX (09.1999), TOPIX (11.2001), TSE 300 (08.1989), UK 100 (01.1992), UX (11.1997), WIG (01.1992), WIG20 (04.1994) and XU 100 (01.1992).

Commodities (metals) – quoted on the London Metal Exchange: Aluminum (01.1992), aluminum Aloy NASAAC (01.2005), cobalt (05.2010), copper (01.1992), gold (01.1992), lead (01.1992), molybdenum (01.2003), nickel (01.1992), palladium (01.1992), platinum (01.1992), silver (01.1992), tin (01.1992) and zinc (01.1992).

Commodities (data form Reuters and London moon phases) - first data considered in the process of rates of return calculation was January 1992: Brent oil, canola, cocoa, coffee, corn, cotton, crude oil, gas oil, gasoline, heating oil, lumber, natural gas, orange juice, rough rice, soybean, soybean meal, soybean oil, sugar, wheat, wheat KCBT.

For both stock indices and commodities last session taken into account in the process of calculating rates of return was 30.06.2015.

The adapted methodology in the second, third and fourth part can be divided into:

1. Testing the null hypothesis regarding equality of variances of rates of return in two populations,

2. Testing the null hypothesis regarding equality of averages rates of return in two populations.

Testing the null hypothesis regarding equality of variances of rates of return in two populations

The null and alternative hypothesis can be formulated as follows:

$$_0^F H: S_1^2 = S_2^2$$

$$_1^F H: S_1^2 \neq S_2^2 \tag{1}$$

where:

S_1^2 - variance of rates of return in the first population,

S_2^2 - variance of rates of return in the second population.

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 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 α=0,05) is lower than F-statistics, e.g. the ratio F-test to F-statistics is lower than 1, there is no reason to reject the null hypothesis.

Testing the null hypothesis regarding equality of average rates of returns in two populations

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, 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 (Osinska 2006, p. 43-44):

$$z = \frac{\overline{r_1} - \overline{r_2}}{\sqrt{\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right)}} \tag{2}$$

where:

$\overline{r_1}$ –average rate of return in the first population,

$\overline{r_2}$ –average rate of return in the second population,

The Formula 2 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: $df(1) = n_1 + n_2 - 2$.

When the populations variances are unequal, the number of degrees should be modified according to the following formula [Defusco et al., 2001, p. 335]:

$$df(2) = \frac{\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right)^2}{\frac{\left(S_1^2/n_1\right)^2}{n_1} + \frac{\left(S_2^2/n_2\right)^2}{n_2}} \qquad (3)$$

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:

$$H_0 : E(r_1) = E(r_2)$$

$$H_1 : E(r_1) \neq E(r_2) \qquad (4)$$

In particular:

1. 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).

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).

In all analyzed 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).

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 explains the reason of applying p-value in the following part of the paper. If the p-value (p-value(1) or p-value(2)) is less than or equal to 0,05; then the hypothesis H_0 is rejected in favor of the hypothesis H_1. Otherwise, there is no reason to reject hypothesis H_0. In the part 3 of the article, the p-value listed in the tables are equal to p-value(1) or p-value(2) depending on the result of testing the null hypothesis, concerning the equality of variance in the two populations of rates of returns.

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 populations. Assuming, the if the first population is composed of the rates of return calculated during the session, when the moon was in one of the two analyzed phases, then the second population determine the one-session rates of return for all remaining sessions.

In the third part, the test for equality of two one-session average rates of return will be applied in case when specific moon phase (full or new moon) falls on a specific day of the week. And so, if the first population is composed of the rates of return calculated during the session, when the full moon coincided on Monday, then the second population determines the one-session

rates of return for all remaining sessions during the week, e.g. on Tuesday, Wednesday, Thursday and Friday session. Similar calculations will be carried out taking into account the returns of the session, when the full moon falls on: Tuesdays, Wednesdays, Thursdays and Fridays, and then for the second moon phase.

In the fourth part of the paper the test for equality of two one-session average rates of return, calculated in a specific moon phase (full or new moon), falling on a specific month, will be exploited in the process of hypothesis testing. For example, if the first population are the rates of return calculated during the session, when the full moon was observed in January, then the second population determine the rates of return registered for all remaining sessions (session from February to December). Similar calculations will be carried out for all other months of the year, and then for the second moon phase.

RESULTS

Analysis of the average rates of return

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

1. In the Regime 1 for $\alpha= 5\%$, when the moon was in the full phase, the null hypothesis was rejected in the favor of the alternative hypothesis in case of the following 15 stock indices and commodities (in parenthesis the one-session average rates of return and standard error, respectively): BOVESPA (0,3594%; 0,1784%), DJIA (0,1068%; 0,0468%), DJ Composite (0,1435%; 0,0517%), DJTA (0,1223%; 0,0474%), ICEX (0,1495%; 0,0509%), IPSA (0,1186%; 0,0520%), PX (0,1948%; 0,0983%), SASLCT (0,1723%; 1,0002%), SP 500 (0,1156%; 0,0471%), SPTSX (0,1299%; 0,4580%), SPTSX Composite (0,1635%; 1,1453%), sWIG80 (0,2258%; 0,0878%), TSE 300 (0,1708%; 0,0631%), feeder cattle (0,1852%; 0,9493%), molybdenum (0,1723%; 0,0806%).

2. In the Regime 1 for $\alpha= 1\%$, when the moon was in the full phase, the null hypothesis was rejected in the favor of the alternative hypothesis in case of the following 7 stock indices and commodities: DJIA, DJ Composite, ICEX, SPTSX, sWIG80, TSE 300, feeder cattle.

3. In the Regime 1 for $\alpha= 5\%$, when the moon was in the new phase, the null hypothesis was rejected in the favor of the alternative hypothesis in case of the following 39 stock indices and commodities: AEX (0,2525%; 0,0867%), BEL 20 (0,1751%; 0,0713%), BOVESPA (0,6431%; 0,1647%), CAC40 (0,3043%; 0,0806%), CDAX (0,3239%; 0,1221%), DAX (0,3379%; 0,0940%), DJ Composite (0,1119%; 0,0553%), DJ Euro-stoxx (0,3579%; 1,7458%), DJIA (0,1068%; 0,0468%), EOE (0,2619%; 0,0982%), FTSE 250 (0,1782%; 0,0573%), HEX (0,4090%; 0,1184%), IBEX (0,2562%; 0,0871%), IPC (0,1828%; 0,0777%), IPSA (0,1298%; 0,0520%), MDAX (0,2321%: 0,0754%), MERVAL (0,6540%; 0,2254%), MICEX (0,5603%; 0,2135%), MSCI World (0,1814%; 1,1167%), OMX Stockholm (0,2605%: 0,0840%), OMX Vilnius (0,1789%; 0,9613%), OSE (0,1132%; 0,0741%), RTS (0,5298%; 0,1646%), RUSSEL (0,2411%; 0,1205%), SDAX (0,2241%; 0,0642%), SENSEX (0,1496%; 0,0748%), SMI (0,2529%; 0,0676%), SPTSX Composite (0,1422%; 1,0480%), SSE B-shares

(0,2808%; 0,1432%), Straits Times (0,1710%; 0,0610%), sWIG80 (0,1979%; 0,0988%), TECDAX (0,3207%; 0,1403%), TOPIX (0,1996%; 0,0887%), UK 100 (0,2358%; 0,0670%), XU 100 (0,3037%; 0,1413%), WIG (0,3170%; 0,1164%), WIG20 (0,2309%; 1,7475%), cotton (0,2252%; 1,8267%), tin (0,2916%; 0,1190%),

4. In the Regime 1 for α= 1%, when the moon was in the new phase, the null hypothesis was rejected in the favor of the alternative hypothesis in case of the following 20 stock indices and commodities: AEX, BOVESPA, CAC40, CDAX, DAX, DJ Eurostoxx, EOE, FTSE 250, HEX, IBEX, MDAX, MICEX, MERVAL, OMX Stockholm, RTS, SDAX, SMI, Straits Times, UK 100, WIG.

5. In the Regime 2 for α= 5%, when the moon was in the full phase, the null hypothesis was rejected in the favor of the alternative hypothesis in the of the following 26 stock indices and commodities (in parenthesis the one-session average rate of return and standard error, respectively): AMEX (0,1180%; 0,0703%), BOVESPA (0,4864%; 0,2308%), DAX (0,1458%; 0,0712%), DJIA (0,1250%; 0,0471%), DJ Composite (0,1865%; 0,0523%), DJTA (0,1233%; 0,0561%), DJUA (0,1800%; 0,0821%), Hang Seng (0,1405%; 0,0764%), ICEX (0,1437%; 0,0524%), IPSA (0,1034%; 0,0516%), KLCI (0,1176%; 0,0528%), NASDAQ (0,1714%; 0,0572%), MERVAL (0,5443%; 0,2001%), PSEI (0,1719%; 0,0825%), SASLCT (0,1863%; 0,8647%), SP 500 (0,1308%; 0,0472%), SPTSX (0,1876%; 0,0487%), SPTSX Composite (0,2330%; 1,0437%), Straits Times (0,1471%; 0,0704%), sWIG80 (0,1632%; 0,0812%), TSE 300 (0,2602%; 0,0674%), cobalt (-0,4949%; 0,1886%), feeder cattle (0,1580%; 0,7810%), lumber (-0,2675; 1,8023%), molybdenum (0,1863%; 0,0824%) and wheat (-0,2187%; 1,6312%).

6. In the Regime 2 for α= 1%, when the moon was in the full phase, the null hypothesis was rejected in the favor of the alternative hypothesis in case of the following 16 stock indices and commodities: DJIA, DJ Composite, DJTA, DJUA, IBEX, ICEX, KLCI, NASDAQ, MERVAL, SASLCT, SP 500, SPTSX, SPTSX Composite, cobalt, feeder cattle and molybdenum.

7. In the Regime 2 for α= 5%, when the moon was in the new phase, the null hypothesis was rejected in the favor of the alternative hypothesis in case of the following 45 stock indices and commodities: AEX (0,2871%; 0,0874%), BEL 20 (0,1915%; 0,0704%), BOVESPA (0,6144%; 0,1745%), CAC (0,3398%; 0,0825%), CDAX (0,3324%; 0,1354%), DAX (0,4042%; 0,0957%), DJ Eurostoxx (0,3496%; 1,6250%), DJIA (0,0836%; 0,0502%), DJUA (0,1512%; 0,0901%), EOE (0,3009%; 0,0990%), FTSMIB (0,2840%; 0,1007%), FTSE 250 (0,1648%; 0,0616%), HEX (0,4531%; 0,1167%), IBEX (0,2783%; 0,0827%), IPC (0,1885%; 0,0817%), IPSA (0,1669%; 0,0545%), KLCI (0,1299%; 0,0651%), MDAX (0,2135%; 0,0776%), MICEX (0,6001%; 0,2400%), MERVAL (0,3964%; 0,2066%), OMX Stockholm (0,2803%, 0,0848%), OMX Vilnius (0,2396%; 0,9020%); OSE (0,1829%; 0,8020%), RTS (0,5412%; 0,1590%), RUSSEL (0,2465%; 0,1364%), SDAX (0,1886%; 0,0673%), SECOM (0,2038%; 0,1173%), SET (0,2074%; 0,0984%), SMI (0,3110%; 0,0642%), SSE B-shares (0,2711%; 0,1327%), Straits Times (0,1976%; 0,0632%), TECDAX (0,2554%; 0,1501%), TOPIX (0,2338%; 0,0907%), UK 100 (0,2711%; 0,0675%), XU

100 (0,3129%; 0,1396%), WIG (0,3061%; 0,1243%), WIG20 (0,2076%; 1,5197%), aluminum Aloy NASAAC (0,4569%; 0,1585%), Brent oil (-0,2234%; 1,7538%), cobalt (1,1315%; 0,03639%), copper (0,2726%; 0,1149%), cotton (0,3096%; 1,6248%), feeder cattle (0,1202%; 0,7453%), live cattle (0,1309%; 0,8724%) and tin (0,3418%; 0,1330%).

8. In the Regime 2 for α= 1%, when the moon was in the new phase, the null hypothesis was rejected in the favor of the alternative hypothesis in case of the following 33 stock indices and commodities: AEX, BEL 20, BOVESPA, CAC, CDAX, DAX, DJ Euro-stoxx, EOE, FTSMIB, FTSE 250, HEX, IBEX, IPC, IPSA, MDAX, MICEX, OMX Stockholm, OMX Vilnius, OSE, RTS, SDAX, SMI, Straits Times, TOPIX, UK 100, XU 100, WIG, aluminum Aloy NASAAC, cobalt, copper, cotton, feeder cattle and tin.

Test for equality of two one-session average rates of return

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

Regime 1

1. The null hypothesis regarding equality of variances of daily average rates of return in two populations, when the moon was in the full phase, was rejected (for α=5%) in the following 48 cases: AEX, All Ordinaries, BEL 20, BET, BOVESPA, CDAX, DJIA, EOE, FTSE 100, HANG SENG, ICEX, IPSA, KLCI, NIKKEI, MDAX, MICEX, MSCI AC World, MSCI World, mWIG40, OMX Stockholm, SAS, SMI, SOFIX, SP 500, SPTSX, SSE Composite, Straits Times, TAIEX, TOPIX, TSE 300, UK 100, UX, WIG20, aluminum, Brent oil, cobalt, coffee, corn, cotton, feeder cattle, gold, lean hogs, orange juice, platinum, rough rice, soybean, sugar, wheat.

2. The null hypothesis regarding equality of variances of daily average rates of return in two populations, when the moon was in the new phase, was rejected (for α=5%) in the following 57 cases: AEX, AMEX, BOVESPA, BUX, CAC 40, CDAX, DAX, DJ Eu-rostoxx, EOE, FTSE 100, NASDAQ, DJ Composite, DJTA, DJUA, HANG SENG, ICEX, IPC, IPSA, JCI, KLCI, MICEX, MERVAL, NZX 50, OMX Talin, PSEI, PX, SAS, SSE Composite, SOFIX, Straits Times, SPTSX, sWIG80, TOPIX, UK 100, UX, aluminum, Brent oil, cobalt, cocoa, coffee, copper, feeder cattle, gasoline, gold, lead, live cattle, lumber, orange juice, palladium, platinum, rough rice, silver, soybean, soybean meal, sugar, tin, wheat.

3. The null hypothesis regarding equality of two average rates of return was rejected for the following indices and commodities (p-value shown in parenthesis):

   a) For full moon sessions – in the following 5 cases: ICEX (0,0235), SPTSX (0,0408), TSE 300 (0,0249), wheat (0,0393), wheat KCBT (0,0307). The p-value higher than 0,05 and lower than 0,1 was registered in the following cases: DJ Composite (0,0570), NIKKEI (0,0572), SENSEX (0,0890), SPTSX Composite (0,0665), sWIG80 (0,0575), feeder cattle (0,0579), gas oil (0,0807).

   b) For new moon sessions – in the following 21 cases: AEX (0,0110), BEL 20 (0,0250), CAC 40 (0,0006), CDAX (0,0210), DAX (0,0013), DJ Eurostoxx

(0,0126), EOE (0,0142), FTSE 250 (0,0236), HEX (0,0004), IBEX (0,0038), MDAX (0,0128), MICEX (0,0374), OMX Stockholm (0,0046), RTS (0,0076), SDAX (0,0032), SMI (0,0011), Straits Times (0,0491), TECDAX (0,0261), UK 100 (0,0020), aluminum Aloy NASAAC (0,0213) and tin (0,0236). The p-value higher than 0,05 and lower than 0,1 was registered for: FTSMIB (0,0620), MSCI World (0,0837), OMX Vilnus (0,0887), WIG20 (0,0807).

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

Regime 2

1. The null hypothesis regarding equality of variances of daily average rates of return in two populations, when the moon was in the full phase, was rejected (for α=5%) in the following 48 cases: AEX, BEL 20, BET, BOVESPA, BUX, CDAX, CRB, DJUA, EOE, FTSE 100, ICEX, IPSA, KLCI, MSCI AC World, MSCI World, NIKKEI, OMX Stockholm, OMX Vilnius, PX, SAS, SMI, SOFIX, SPTSX, SPTSX Composite, SSE Composite, TAIEX, TECDAX, TOPIX, TSE 300, UK 100, WIG20, aluminum, Brent oil, cobalt, cocoa, coffee, corn, copper, cotton, feeder cattle, gold, lead, live cattle, platinum, rough rice, soybean, sugar and zinc.

2. The null hypothesis regarding equality of variances of daily average rates of return in two populations, when the moon was in the new phase, was rejected (for α=5%) in the following 56 cases: AEX, AMEX, BOVESPA, BUMIX, CAC40, CDAX, DAX, DJ Composite, DJ Eurostoxx, DJIA, DJTA, DJUA, EOE, FTSE 100, FTSE 250, HANG SENG, ICEX, JCI, KLCI, MEX, MICEX, MERVAL, MSCI World, NASDAQ, NZX 50, PSEI, PX, SAS, SET, SP 500, SSE Composite, SOFIX, SPTSX, TOPIX, TSE 300, UK 100, UX, WIG, XU 100, Brent oil, coffee, copper, gasoline, gold, lead, lean hogs, live cattle, lumber, nickel, orange juice, rough rice, silver, soybean, soybean meal, sugar, wheat KCBT.

3. The null hypothesis regarding equality of two average rates of return was rejected for the following indices and commodities (p-value shown in parenthesis):

   a) For full moon sessions – in the following 5 cases: DJ Composite (0,0173), SPTSX (0,0076), SPTSX Composite (0,0208), TSE 300 (0,0033), feeder cattle (0,0417). The p-value higher than 0,05 and lower than 0,1 was registered in the following cases: DJIA (0,0945), ICEX (0, 0745), NASDAQ (0,0651), SENSEX (0,0868) and SP 500 (0,0812), gas oil (0,0983), lumber (0,0602).

   b) For new moon sessions - in the following 17 cases: AEX (0,0149), BEL 20 (0,0467), CAC 40 (0,0015), DAX (0,0011), EOE (0,0189), FTSMIB (0,0214), HEX (0,0004), IBEX (0,0041), OMX Stockholm (0,0070), OMX Vilnius (0,0484), RTS (0,0139), SDAX (0,0438), SMI (0,0003), UK 100 (0,0026), aluminum Aloy NASAAC (0,0139), cobalt (0,0339), tin (0,0365). The p-value higher than 0,05 and lower than 0,1 was registered in the following cases: DJ Eurostoxx (0,0699), MDAX (0,0572), MICEX (0,0932), SDAX (0,0677), Straits Time (0,0681), TOPIX (0,0868), Brent oil (0,0807), copper (0,0538), cotton (0,0527).

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

Thus, both in the regime 1 and 2, the number of rejections of the null hypothesis was greater for session occurring during the new than the full moon.

The highest one session average rate of return, when the moon was in full and new phase, in the Regime 1 was registered for the same index: BOVESPA 0,3425% and 0,6043%, respectively. The lowest one session average rate of return in the Regime 1 was observed on the market of cobalt (-0,3109%) – full moon and on the market of lumber (-0,2377%) – new moon. In the Regime 2, the highest one session average rates of return for full moon session was registered for MERVAL (0,5966%) and for new moon session for cobalt (1,1110%). The lowest one session rates of return were calculated for cobalt (-0,3550%) when the moon was in the full phase and for Brent oil (-0,2046%) during new moon sessions - see figure 1 and figure 2.
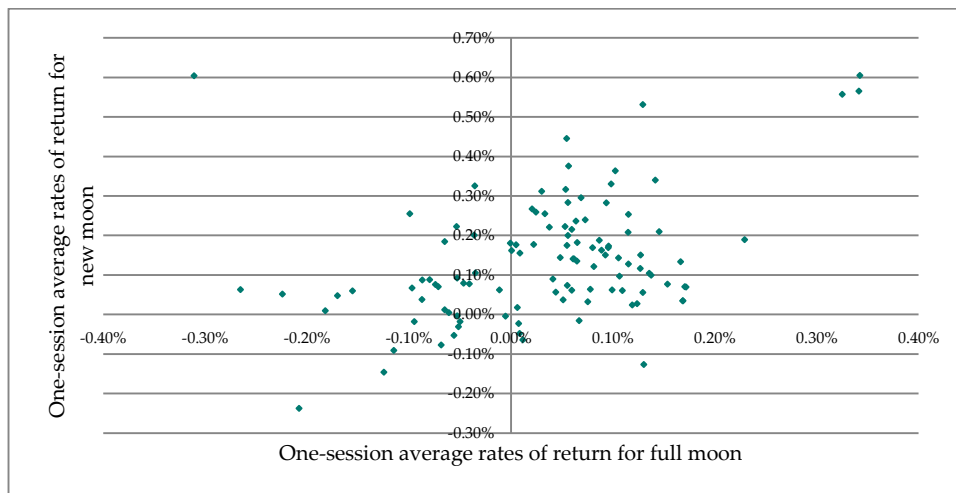
The one session average rate of return calculated for full moon sessions was higher than the one session average rate of return for new moon session in 27 cases in the Regime 1 (in parenthesis are given: the one session average rate of return for full and new moon phase, respectively): All Ordinaries (0,0086%; -0,0485%), DJ Composite (0,1378%; 0,0990%), DJIA (0,1066%; 0,0970%), DJTA (0,1094%; 0,0607%), HANG SENG (0,1191%; 0,0236%); ICEX (0,1536%; 0,0765%), KLCI (0,0514%; 0,0367%); NASDAQ (0,0755%; 0,0317%), NZX 50 (0,0077%; -0,0232%), OMX Talin (0,1270%; 0,1160%); PX (0,1359%; 0,1037%), SASLCT (0,1686%; 0,0343%), SOFIX (0,1239%; 0,0270%), SP 500 (0,0993%; 0,0617%), SPTSX (0,1295%; 0,0555%), SPTSX Composite (0,1666%; 0,1334%), sWIG80 (0,2295%; 0,1892%), TSE 300 (0,1718%; 0,0690%), Brent oil (-0,1246%, 0,0925%), feeder cattle (0,1706%; 0,0697%), heating oil (-0,0684%; -0,0775%), lean hogs (0,1305%, -0,1205%), molybdenum (0,1686%; 0,0343%), lumber (-0,2079%; -0,2377%), orange juice (0,0780%; 0,0637%), soybean meal (0,0119%; -0,0645%), sugar (0,0671%; -0,0163%). In all other cases the one session average rates of return for full session were lower than one session average rate of return for new moon sessions.

In the Regime 2, one session average rate of return for full moon was higher than the one session average rate of return for new moon for the following 41 indices (in parenthesis are given: the one session average rate of return for full and new moon phase, respectively): All Ordinaries (0,0385%; -0,0493%), AMEX (0,1178%; 0,0856%), BET (0,1366%; 0,0762%), CRB (-0,0168%; -0,0540%), DJ Composite (0,1867%; 0,0574%), DJIA (0,1269%; 0,0764%), DJUA (0,1853%; 0,1366%), DJTA (0,1175%; 0,0532%), HANG SENG (0,1612%; 0,0100%), ICEX (0,1473%; 0,0818%), KLCI (0,1241%; 0,0683%), MEX (0,1803%, 0,1741%), MERVAL (0,5689%; 0,3697%), NASDAQ (0,1702%; 0,0152%), NZX 50 (0,0523%; -0,0017%), OMX Riga (0,0205%; 0,0018%), PSEI (0,1557%; 0,0777%), PX (0,1225%; 0,0426%), SASLCT (0,1788%; 0,0011%), SOFIX (0,0257%; 0,0117%), SP 500 (0,01314%; 0,0333%), SPTSX (0,1924%; 0,0413%), SPTSX Composite (0,2405%; 0,0948%), sWIG80 (0,1583%; 0,1379%), TSE 300 (0,2671%; 0,0187%), aluminum (0,0883%; 0,0715%), Brent oil (-0,0376%; -0,2046%), canola (0,0467%; -0,0093%), cocoa (0,1295%; 0,1143%), coffee (0,1259%; 0,0900%), corn (0,0141%; -0,1378%), feeder cattle (0,1477%; 0,1141%), gold (0,0661%; 0,0624%), lean hogs (0,1376%; -0,0694%), heating oil (-0,0174%; -0,0934%), molybdenum (0,1788%; 0,0011%), orange juice (0,1691%; 0,0536%), silver (0,0709%; 0,0195%), soybean

meal (0,0331%; -0,1588%), sugar (0,0074%; -0,1559%) and zinc (0,0793%; -0,1039%).

In the Regime 1 the number of positive and negative one session average rate of return was equal to 76 and 31 – in case of full moon sessions and mounted to 94 and 13 – in case of new moon sessions. In the Regime 2 the number of positive and negative one session average rate of return was equal to 79 and 28 – in case of full moon sessions and mounted to 94 and 13 – in case of new moon sessions.

Figure 1. One-session average rates of return for analyzed indices and commodities – Regime 1.

Source: own calculation

Figure 2. One-session average rates of return for analyzed indices and commodities – Regime 2.
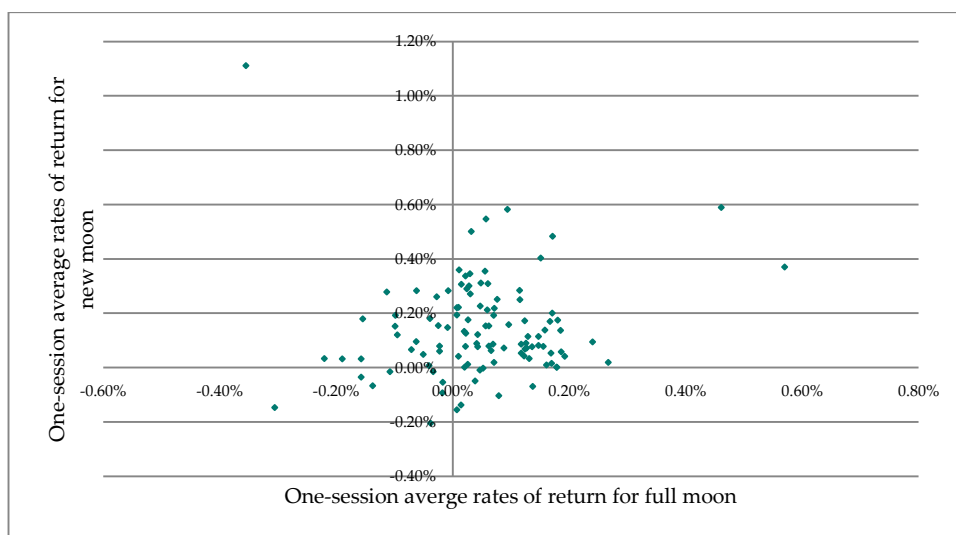
Source: own calculation

Test for equality of two one-session average rates of return, when the analyzed moon phase falls on the specific day of the week

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

Regime 1

In general the null hypothesis regarding equality of two average rates of return was rejected in 46 cases when the moon was in the full phase, and in 34 cases for the new phase. When the full moon falls on a Monday, the null hypothesis was rejected in 20 cases, whilst for Tuesday and Friday in 8 cases – see Table 1. For Thursday session, the number of rejections was the smallest and equal to 4. In turn, per sessions falling during the new moon, the largest number of rejections of the null hypothesis was also registered for the Monday sessions and equal to 10. On the second position ranked Friday session (8), and on the last (like in case when the moon was in the full phase) Thursday sessions (4). In each of the three days of the week, e.g. Monday, Tuesday and Wednesday, the number of registered effects of the moon influence on the reported one-session rates of return, was higher for full than the for the new moon phase. More detailed results of testing the null hypothesis are provided below.

Table 1. The number of the null hypothesis rejection when the analyzed moon phases falls on the specific day of the week

	Monday	Tuesday	Wednesday	Thursday	Friday
p-value <0,05 - full moon	20	8	6	4	8
p-value <0,05 - new moon	10	5	7	4	8

Source: own calculations

The null hypothesis regarding equality of two average rates of return was rejected for the following indices and commodities (p-value shown in parenthesis). In the square bracket are listed stock exchange indices and commodities with the p-value higher than 0,05 and lower than 0,1.

For **full moon** sessions falling on:

a) Mondays: ATHEX (0,0454), BEL 20 (0,0498), OMX Riga (0,0016), OMX Vilnius (0,0452), PSEI (0,0111), SASLCT (0,0398), SPTSX (0,0204), SPTSX Composite (0,0311), Straits Times (0,0104), XU 100 (0,0386), aluminum (0,0201), Brent oil (0,0375), coffee (0,0407), copper (0,0263), crude oil (0,0480), heating oil (0,0444), lead (0,0001), molybdenum (0,0398), nickel (0,0045) and zinc (0,0049), [ICEX (0,0969), KLCI (0,0991), MERVAL (0,0706), MSCI AC World (0,0726), MSCI World (0,0728), SMI (0,0683), sWIG80 (0,0615), TSE 300 (0,0972) and tin (0,0850)]

b) Tuesdays: BOVESPA (0,0377), TSE 300 (0,0360), NZX 50 (0,0277), SPTSX Composite (0,0424), copper (0,0108), corn (0,0422), nickel (0,0070), wheat (0,0419), [SPTSX (0,0615), Straits Times (0,0751), aluminum (0,0632), lumber (0,0565), tin (0,0932), wheat (0,0667) and zinc (0,0657)]

c) Wednesdays: FTSE 250 (0,0386), OMX Riga (0,0047), OSE (0,0429), PSI 20 (0,0239), UK 100 (0,0115), gas oil (0,0411), [SDAX (0,0696), XU 100 (0,0558), crude oil (0,0610), feeder cattle (0,0911), lean hogs (0,0744), soybean meal (0,0986), soybean oil (0,0806) and tin (0,0816)]

d) Thursdays: ICEX (0,0066), aluminum Aloy NASAAC (0,0007), wheat (0,0146) and zinc (0,0210), [AEX (0,0550), BEL 20 (0,0814), EOE (0,0798), aluminum (0,0592), Brent oil (0,0748), lead (0,0849), natural gas (0,0670), nickel (0,0643), tin (0,0740)]

e) Fridays: ICEX (0,0288), MDAX (0,0441), SET (0,0074), sWIG80 (0,0078), TSE 300 (0,0487), crude oil (0,0086), heating oil (0,0447), lumber (0,0051), [BEL 20 (0,0628), OMX Talin (0,0750), PSI 20 (0,0957), SENSEX (0,0872), SOFIX (0,0880), coffee (0,0517), orange juice (0,0666)]

For **new moon** sessions falling on:

a) Mondays: BOVESPA (0,0376), DJIA (0,0397), HANG SENG (0,0346), ICEX (0,0177), IPSA (0,0071), MEX (0,0026), SET (0,0160), aluminum (0,0185), cobalt (0,0346), nickel (0,0460), [BET (0,0556), JCI (0,0661), OMX Riga (0,0755), PSEI (0,0812), SP 500 (0,0721), SPTSX (0,0898), sWIG80 (0,0640), aluminum Aloy NASAAC (0,0962), cocoa (0,0975), and lead (0,0978)]

b) Tuesdays: MEX (0,0143), SAS (0,0168), XU 100 (0,0237), lean hogs (0,0253), natural gas (0,0418), [BUMIX (0,0760), IPSA (0,0503), UK (0,0913), TOPIX (0,0823), tin (0,0689), wheat (0,0851)]

c) Wednesdays: RTS (0,0082), SASLCT (0,0200), aluminum Aloy NASAAC (0,0477), canola (0,0047), corn (0,0188), molybdenum (0,0200) and tin (0,0317) [ICEX (0,0830), OMX Talin (0,0900), OSE (0,0695), SAS (0,0749), orange juice (0,0591)]

d) Thursdays: AMEX (0,0238), orange juice (0,0202), soybean (0,0270), soybean meal (0,0181), [sWIG80 (0,0938), canola (0,0506), lumber (0,0508)]

e) Fridays: All Ordinaries (0,0126), CAC40 (0,0465), DAX (0,0352), HANG SENG (0,0043), OMX Riga (0,0135), PSEI (0,0192), SET (0,0094) and platinum (0,0393), [FTSE 100 (0,0719), JCI (0,0778), MSCI World (0,0809), NZX 50 (0,0933), TECDAX (0,0907), UK 100 (0,0508), orange juice (0,0513)].

The null hypothesis was rejected twice for the following stock market indices and commodities:

a) For the full moon phase: ICEX, TSE 300, OMX Riga, heating oil, nickel, copper, crude oil, wheat and zinc.

b) For the new moon phase: HANG SENG, MEX and SET.

Taking into consideration both moon phases, null hypothesis was rejected three times concerning: ICEX, OMX Riga, SET and nickel.

Regime 2

In general the null hypothesis regarding equality of two average rates of return was rejected in 39 cases when the moon was in the full phase, and in 54 for the new phase – see table 2. When the full moon falls on a Monday, the null hypothesis was rejected in 20 cases, whilst on Tuesday and Friday sessions only in 4 cases. In turn, per session falling during the new moon, the largest number of rejections of the null hypothesis was registered for the Fridays sessions - 24. On the second position ranked Monday sessions (14), and on the last Thursday sessions (4). For two days of the week (Monday and Thursday), the number of registered effects of the moon influence on the reported one-session rates of return was higher for full than the for the new moon phase. More detailed results of testing the null hypothesis are provided below.

Table 2. The cases of rejection the null hypothesis when the analyzed moon phases falls on the specific day of the week

	Monday	Tuesday	Wednesday	Thursday	Friday
p-value <0,05 - full moon	20	4	5	6	4
p-value <0,05 - new moon	14	5	7	4	24

Source: own calculations

The null hypothesis regarding equality of two average rates of return was rejected for the following indices and commodities (p-value shown in parenthesis). In the square bracket are listed stock exchange indices and commodities with the p-value higher than 0,05 and lower than 0,1.

For **full moon** sessions falling on:

a) Mondays: ATHEX (0,0216), BEL 20 (0,0232), IPSA (0,0324), KLCI (0,0099), OMX Riga (0,0033), OMX Vilnius (0,0223), PX (0,0357), SMI (0,0118), SPTSX (0,0103), SPTSX Composite (0,0276), Straits Times (0,0139), TSE 300 (0,0314), XU 100 (0,0160), mWIG40 (0,0228), aluminum (0,0366), aluminum Aloy NASAAC (0,0452), nickel (0,0411), lead (0,0003), soybean oil (0,0421), zinc (0,0245), [AEX (0,0983), BET (0,0773), BOVESPA (0,0999), PSEI (0,0667), SOFIX (0,0766), sWIG80 (0,0605), gasoline (0,0617), platinum (0,0604)].

b) Tuesdays: BOVESPA (0,0467), copper (0,0153), nickel (0,0123), wheat (0,0314), [NZX 50 (0,0747), OSE (0,0650), SPTSX Composite (0,0645), TSE 300 (0,0677), corn (0,0942), tin (0,0967), wheat KCBT (0,0838)].

c) Wednesdays: OMX Riga (0,0104), PSI 20 (0,0296), UK 100 (0,0208), XU 100 (0,0433), gas oil (0,0481) [CRB (0,0990), FTSE 250 (0,0578), IBEX (0,0997), OSE (0,0578), crude oil (0,0581), soybean oil (0,0418), tin (0,0645), wheat KCBT (0,0929)].

d) Thursdays: AEX (0,0444), ICEX (0,0085), aluminum Aloy NASAAC (0,0009), natural gas (0,0451), wheat (0,0133) and zinc (0,0362), [ATHEX (0,0965), BEL 20 (0,0567), CDAX (0,0600), EOE (0,0720), MDAX (0,0547), OMX Stockholm (0,0561), PSI 20 (0,0837), WIG (0,0639), corn (0,0886) and tin (0,0789)].

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e) Fridays: BEL 20 (0,0272), SET (0,0351), crude oil (0,0054), lean hogs (0,0424), [ICEX (0,0503), sWIG80 (0,0525), heating oil (0,0866), lumber (0,0791)].

For **new moon** sessions falling on:

a) Mondays: BOVESPA (0,0018), DJ COMPOSITE (0,0342), DJIA (0,0040), HANG SENG (0,0495), ICEX (0,0438), IPSA (0,0062), MERVAL (0,0106), MEX (0,0014), SP 500 (0,0012), aluminum (0,0192), cobalt (0,0227), cocoa (0,0208), platinum (0,0457), sugar (0,0385), [DJTA (0,0540), NASDAQ (0,0501), NIKKEI (0,0524), SASLCT (0,0849), SEE B-Shares (0,0688), molybdenum (0,0849), aluminum Aloy NASAAC (0,0661) and palladium (0,0563)]

b) Tuesdays: MEX (0,0106), SAS (0,0182), XU 100 (0,0215), lean hogs (0,0133), natural gas (0,0452), [BUX (0,0704), BUMIX (0,0689), IPSA (0,0944), TAIEX (0,0782), TOPIX (0,0975), cocoa (0,0756), lumber (0,0815), tin (0,0720), wheat (0,0835) and zinc (0,0533)]

c) Wednesdays: RTS (0,0082), SASLCT (0,0176), canola (0,0071), corn (0,0083), molybdenum (0,0176), orange juice (0,0496) and tin (0,0276), [ICEX (0,0978), OSE (0,0924), SAS (0,0884), UX (0,0900), Brent oil (0,528)]

d) Thursdays: AMEX (0,0158), rough rice (0,0328), soybean (0,0341), soybean meal (0,0107), [DJIA (0,0807), NZX 50 (0,0984), SPTSX Composite (0,0740), canola (0,0864), lumber (0,0921), wheat KCBT (0,0752)]

e) Fridays: AEX (0,0374), All Ordinaries (0,0194), CAC40 (0,0024), CDAX (0,0456), DAX (0,0118), DJ Eurostoxx (0,0190), EOE (0,0485), FTSMIB (0,0264), HANG SENG (0,0268), IBEX (0,0330), MDAX (0,0131), MISCI AC World (0,0393), MSCI World (0,0274), NZX 50 (0,0362), SDAX (0,0475), SET (0,0143), SMI (0,0200), sWIG80 (0,0345), TECDAX (0,0166), canola (0,0117), corn (0,0225), palladium (0,0196), platinum (0,0100), rough rice (0,0148), [BEL 20 (0,0914), BUMIX (0,0675), MICEX (0,0528), PSEI (0,0636), SOFIX (0,0717), TOPIX (0,0887) and UK 100 (0,0558)]

In analyzed cases, when the p-value was higher than 0,05 therefore there was no reason to reject the null hypothesis. Thus, one-session average rate of return, calculated for each day of the week, when the specific moon phase falls on, was equal to the average one-session rate of return obtained for all other cases (for the confidence level of 95%).

For the moon phase moon falling on the specified day of the week, the null hypothesis was rejected twice for the following stock market indices and commodities:

a) BEL 20, OMX Riga, aluminum Aloy NASAAC, canola, crude oil, nickel, soybean oil, wheat and zinc - for new moon phase

b) HANG SENG, MEX, canola, corn, platinum rough rice – for new moon phase.

Taking into consideration both moon phases, null hypothesis was rejected three times for: XU 100 and two times for: AEX, BEL 20, BOVESPA, HANG SENG, ICEX, IPSA, MEX, OMX

Riga, SET, SMI, aluminum, aluminum Aloy NASAAC, nickel, platinum and zinc.

Test for equality of two average rates of return, when the analyzed moon phase falls during the specific month of year

The results of testing zero hypothesis with the use of average rates of returns for two different populations enable to draw the following conclusions:

Regime 1

In general, the null hypothesis regarding equality of two average rates of return was rejected in 131 cases when the moon was in the full phase, and in 70 for the new phase. Most rejections of the null hypothesis were noted for the month of June (45) and February (21), when the moon was in the full and new phase, respectively. In turn, the least likely effect of the moon influences on the rates of return was performed for the full and new moon phase in April – 2 and 1, respectively. In seven months, the number of occurrences of lunar effect was higher for full than for the new moon phase, in two cased it was equal (February and May), and in three cases - was smaller (see table 3). More detailed results of testing the null hypothesis are provided below.

Table 3. The cases of rejection the null hypothesis when the analyzed moon phases falls on the specific month

	January	February	March	April	May	June	July	August	September	October	November	December
p-value <0,05 - full moon	5	21	15	2	5	45	5	10	6	5	8	4
p-value <0,05 - new moon	6	21	2	1	5	2	8	4	3	3	13	2

Source: own calculations

The null hypothesis regarding equality of two average rates of return was rejected for the following indices and commodities (p-value shown in parenthesis). In the square bracket are listed stock exchange indices and commodities with the p-value higher than 0,05 and lower than 0,1.

For **full moon** sessions falling in:

a) January: AMEX (0,0415), MSCI AC World (0,0025), MSCI World (0,0033), RUSSEL (0,0273), natural gas (0,0132), [CDAX (0,0888), DAX (0,0672), DJ Eurostoxx (0,0759), FTSMIB (0,0946), SPTSX Composite (0,0776), copper (0,0637), lean hogs (0,0932), zinc (0,0511)]

b) February: AEX (0,0388), ATHEX (0,0085), BOVESPA (0,0310), CAC40 (0,0319), CDAX (0,0208), FTSMIB (0,0027), FTSE 250 (0,0025), IBEX (0,0067), MDAX (0,0415), OMX Stockholm (0,0156), OSE (0,0461), PX (0,0437), SDAX (0,0094), SMI (0,0342), TAIEX (0,0048), TECDAX (0,0026), WIG (0,0333), cobalt (0,0389), nickel (0,0298), orange juice (0,0352) and tin (0,0359), [DAX (0,0702), corn (0,0903), EOE (0,0759), MSCI AC World (0,0624), PSEI (0,0938), SET (0,0840), coffee (0,0711),

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gasoline (0,0781)]

c) March: DAX (0,0171), FTSE 250 (0,0227), HEX (0,0045), KOSPI (0,0300), MSCI AC World (0,0191), MSCI World (0,0301), mWIG40 (0,0033), OMX Stockholm (0,0232), SET (0,0181), SMI (0,0192), Straits Times (0,0404), sWIG80 (0,0287), TOPIX (0,0129), feeder cattle (0,0140), wheat (0,0444), [BOVESPA (0,0685), BUMIX (0,0618), MDAX (0,0661), OMX Talin (0,0598), OSE (0,0883), PX (0,0744), wheat KCBT (0,0862)]

d) April: PSEI (0,0240), SSE Composite (0,0153), [palladium (0,0821), Brent oil (0,0879), crude oil (0,0665), natural gas (0,0833)]

e) May: ATHEX (0,0331), FTSE 250 (0,0424), SPTSX (0,0416), aluminum (0,0194), Brent oil (0,0434), [KOSPI (0,0518), TSE 300 (0,0767), XU 100 (0,0715)]

f) June: AEX (0,0155), All Ordinaries (0,0091), AMEX (0,0026), BEL 20 (0,0491), BUMIX (0,0345), BOVESPA (0,0311), BUX (0,0038), CAC 40 (0,0370), CDAX (0,0170), DAX (0,0066), DJ Composite (0,0177), DJ Eurostoxx (0,0251), DJIA (0,0436), DJUA (0,0112), EOE (0,0039), FTSMIB (0,0037), FTSE 250 (0,0001), HEX (0,0009), IPSA (0,0440), KOSPI (0,0062), MDAX (0,0073), MEX (0,0261), MSCI AC World (0,0063), MSCI World (0,0088), mWIG40 (0,0046), OMX Stockholm (0,0018), OSE (0,0244), PX (0,0052), SAS (0,0148), SASLCT (0,0485), SDAX (0,0027), SET (0,0332), SPTSX Composite (0,0238), SSE B-Shares (0,0085), SMI (0,0246), SPTSK (0,0215), TECDAX (0,0001), TSE 300 (0,0088), RUSSEL (0,0131), UK 100 (0,0001), UX (0,0278), WIG (0,0091), WIG20 (0,0209), molybdenum (0,0495), rough rice (0,0024), [PSI 20 (0,0890), SSE COMPOSITE (0,0789), sWIG80 (0,0697)]

g) July: gold (0,0417), feeder cattle (0,0011), orange juice (0,0099), palladium (0,0045), silver (0,0023), [ATHEX (0,0679), BUX (0,0738), OMX Vilnius (0,0729), gasoline (0,0888), platinum (0,0813), soybean meal (0,0977), soybean oil (0,0797)]

h) August: DJ Composite (0,0162), DJIA (0,0222), DJTA (0,0011), SP 500 (0,0199), SPTSX (0,0196), SPTSX Composite (0,0046), Straits Times (0,0254), TSE 300 (0,0217), copper (0,0484), orange juice (0,0054), [BUMIX (0,0848), OMX Vilnius (0,0824), SOFIX (0,0787), lumber (0,0544)]

i) September: CAC40 (0,0285), PSI 20 (0,0347), SASLCT (0,0273), SDAX (0,0417), TECDAX (0,0099) and molybdenum (0,0273), [AEX (0,0969), EOE (0,0653), IBEX (0,0829), IPSA (0,0727), natural gas (0,0772) and platinum (0,0628)]

j) October: DJ Eurostoxx (0,0071), DJUA (0,0431), MSCI AC World (0,0120), MSCI World (0,0096), palladium (0,0041), [CDAX (0,0614), DAX (0,0550), MDAX (0,0682), SASLCT (0,0746), coffee (0,0859), molybdenum (0,0746), nickel (0,0922),]

k) November: AMEX (0,0410), FTSE 100 (0,0324), CRB (0,0447), DJ Composite (0,0225), DJTA (0,0356), SAS (0,0088), cobalt (0,0482), sugar (0,0141), [OMX Talin (0,0955), PSEI (0,0569), TAIEX (0,0533), TOPIX (0,0794), UK 100 (0,0580), lean hogs (0,0511), soybean (0,0826)]

l) December: KOSPI (0,0312), OMX Riga (0,0157), feeder cattle (0,0185), tin (0,0144), [All Ordinaries (0,0866), BET (0,0571), KLCI (0,0654), PSI 20 (0,0743), SDAX (0,0969), cobalt (0,0776), live cattle (0,0818)]

For **new moon** sessions:

a) January: BUMIX (0,0136), DJUA (0,0026), MERVAL (0,0186), NZX 50 (0,0456), PSEI (0,0053), cotton (0,0309), [AMEX (0,0890), mWIG40 (0,0517), OSE (0,0832), PX (0,0601), cocoa (0,0967)]

b) February: AEX (0,0220), BEL 20 (0,0098), BUX (0,0245), CDX (0,0234), DAX (0,0123), DJ Eurostoxx (0,0028), EOE (0,0167), FTSMIB (0,0097), HANG SENG (0,0101), IBEX (0,0002), KLCI (0,0466), KOSPI (0,0006), MDAX (0,0188), MSCI AC World (0,0027), MSCI World (0,0013), OMX Stockholm (0,0089), OSE (0,0337), PSEI (0,0494), SMI (0,0038), TAIEX (0,0007), UK 100 (0,0107), [AMEX (0,0706), CAC40 (0,0540), IPC (0,0875), OMX Vilnius (0,0842), SAS (0,0656), TECDAX (0,0723), cobalt (0,0516) and nickel (0,0851)]

c) March: JCI (0,0215), corn (0,0076), [CDAX (0,0995), PSI 20 (0,0921), gasoline (0,0830), live cattle (0,0952), wheat (0,0556)]

d) April: NZX 50 (0,0317), [IPSA (0,0960), MICEX (0,0769), gasoline (0,0674)]

e) May: KLCI (0,0212), NIKKEI (0,0369), TOPIX (0,0402), aluminum (0,0489) and cobalt (0,0294).

f) June: cobalt (0,0392) and nickel (0,0461), [HANG SENG (0,0878), JCI (0,0668), RTS (0,0981), SSE Composite (0,0771)]

g) July: EOE (0,0378), IPSA (0,0209), JCI (0,0113), mWIG40 (0,0061), PSEI (0,0369), SET (0,0437), SMI (0,0188), soybean oil (0,0148), [AMEX (0,0575), ATHEX (0,0888), BEL 20 (0,0824), DJUA (0,0742), MEX (0,0666), MICEX (0,0660), OMX Vilnius (0,0757), RUSSEL (0,0812), UX (0,0957), Brent oil (0,0707), gasoline (0,0905)]

h) August: ICEX (0,0027), SAS (0,0222), cotton (0,0220), gasoline (0,0405) [IPC (0,0538), PSEI (0,0774), gold (0,0547), rough rice (0,0636), soybean (0,0862)]

i) September: PSEI (0,0313), corn (0,0133), rough rice (0,0442), [ATHEX (0,0822), ICEX (0,0613), MEX (0,0602), SSE B-Shares (0,0650), canola (0,0921)]

j) October: NZX 50 (0,0387), cotton (0,0027), sugar (0,0026), [AMEX (0,0977), ICEX (0,0996), MICEX (0,0789), PSI 20 (0,0603), SSE Composite (0,0733), soybean (0,0934), soybean oil (0,0650), silver (0,0980)]

k) November: AEX (0,0105), CAC 40 (0,0102), DJTA (0,0015), EOE (0,0155), FTSMIB (0,0245), IBEX (0,0222), IPC (0,0129), SSE Composite (0,0338), TECDAX (0,0143), UX 100 (0,0164), lean hogs (0,0320), lumber (0,0405) and palladium (0,0496) [CDAX (0,0686), DAX (0,0574), DJ Composite (0,0777), DJIA (0,0938), FTSE 250 (0,0650), HEX (0,0544), NASDAQ (0,0888), OMX Vilnius (0,0903), OSE (0,0538), SMI

(0,0611), WIG20 (0,0506), cobalt (0,0640), live cattle (0,0924)]

l) December: OSE (0,0112) and copper (0,0466), [KOSPI (0,0855), SPTSX Composite (0,0726), TSE 300 (0,0798), gasoline (0,0915), soybean oil (0,0963)]

In all these cases, when the p-value was higher than 0,05; and therefore there was no reason to reject the null hypothesis.

For full moon phase falling on the specified month, the null hypothesis was rejected four times in case of FTSE 250 and three times for 9 stock indices: AMEX, CAC 40, DJ Composite, KOSPI, OMX Stockholm, SDAX, SMI, SPTSX, TECDAX - in this group there is therefore a noticeable lack of commodities. When the moon was in the new phase, the null hypothesis was rejected four times for PSEI index and three times for: EOE and NZX 50. Considering both moon phases, the null hypothesis was rejected 5 times in case of two indices: PSEI and SMI.

Regime 2

In general, the null hypothesis regarding equality of two average rates of return was rejected in 120 cases when the moon was in the full phase, and in 80 cases for the new phase. Most rejections of the null hypothesis were registered for the month of February: 26, when the moon was both in the phase of full and new moon. In turn, the least likely effect of the moon influence on the rate of return was performed for the full moon phase in the month of May (0), and for the new moon – in March and May (0). In seven months, the number of occurrences of lunar effect was higher for full than for the new moon phase, in two cases it was equal (February and October) and in three – smaller – see table 4. More detailed results of testing the null hypothesis are provided below.

Table 4. The cases of rejection the null hypothesis when the analyzed moon phases falls on the specific month

	January	February	March	April	May	June	July	August	September	October	November	December
p-value <0,05 - full moon	3	26	13	5	0	19	9	15	5	8	9	8
p-value <0,05 - new moon	7	26	2	7	2	4	8	3	3	8	6	4

Source: own calculations

The null hypothesis regarding equality of two average rates of return was rejected for the following indices and commodities (p-value shown in parenthesis). In the square bracket are listed stock exchange indices and commodities with the p-value higher than 0,05 and lower than 0,1.

For **full moon** sessions falling in:

a) January: MSCI AC World (0,0215), MSCI World (0,0315), zinc (0,0271), [IPSA (0,0903)].

b) February: AEX (0,0001), ATHEX (0,0272), BOVESPA (0,0191), CAC 40 (0,0001), CDAX (0,0083), DAX (0,0069), EOE (0,0004), FTSE (0,0378), FTSMIB (0,0019),

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FTSE 250 (0,0037), IBEX (0,0017), MDAX (0,0084), MICEX (0,0278), OMX Stockholm (0,0438), OSE (0,0318), PX (0,0442), RTS (0,0180), SDAX (0,0080), SMI (0,0042), TEC DAX (0,0091), TAIEX (0,0054), UK 100 (0,0292), WIG (0,0355), cobalt (0,0160), gas oil (0,0199) and tin (0,0293), [HEX (0,0828), MSCI AC World (0,0697), PSEI (0,0840), Straits Times (0,0806), cocoa (0,0560), natural gas (0,0719), nickel (0,0641)].

c) March: All Ordinaries (0,0285), DJ Eurostoxx (0,0329), HEX (0,0281), KLCI (0,0265), KOSPI (0,0148), mWIG40 (0,0163), NZX 50 (0,0153), SET (0,0081), Straits Times (0,0054), TOPIX (0,0058), corn (0,0379), feeder cattle (0,0194), wheat (0,0485), [DAX (0,0529), MSCI AC World (0,0512), MSCI World (0,0704), OMX Stockholm (0,0926), RUSSEL (0,0878), SMI (0,0520), silver (0,0791), wheat KCBT (0,0755)].

d) April: PSEI (0,0295), SSE Composite (0,0315), Brent oil (0,0412), soybean (0,0237), soybean oil (0,0499), [Straits Times (0,0834), TAIEX (0,0583), WIG (0,0748), crude oil (0,0560) and palladium (0,0826)].

e) May: [AMEX (0,0737), KOSPI (0,0626), OSE (0,0792), SPTSX (0,0722), TSE 300 (0,0942), Brent oil (0,0553), coffee (0,0968) and gold (0,0724)]

f) June: All Ordinaries (0,0176), AMEX (0,0296), DJ Composite (0,0345), DJUA (0,0201), FTSE 250 (0,0047), KOSPI (0,0088), mWIG40 (0,0346), SASLCT (0,0390), SET (0,0348), SPTSX (0,0106), SPTSX Composite (0,0304), SSE B-shares (0,0282), TECDAX (0,0001), TSE 300 (0,0054), UK 100 (0,0011), UX (0,0216), WIG (0,0450), molybdenum (0,0390), rough rice (0,0392), [ATHEX (0,0895), BOVESPA (0,0886), BUX (0,0508), DAX (0,0694), DJIA (0,0585), FTSMIB (0,0682), HEX (0,0571), HANG SENG (0,0959), IPSA (0,0626), JCI (0,0573), MEX (0,0556), NZX 50 (0,0847), SAS (0,0870), SDAX (0,0882), SSE Composite (0,0995), RUSSEL (0,0721), wheat KCBT (0,0755)]

g) July: KLCI (0,0123), SAS (0,0461), cobalt (0,0174), gasoline (0,0365), feeder cattle (0,0065), live cattle (0,0150), orange juice (0,0188), palladium (0,0142) and silver (0,0126), [ATHEX (0,0842), BUX (0,0871), gold (0,0644), wheat KCBT (0,0898)].

h) August: BUMIX (0,0010), DJ Composite (0,0059), DJIA (0,0075), DJTA (0,0007), MERVAL (0,0292), MEX (0,0116), NASDAQ (0,0390), SASLCT (0,0175), SOFIX (0,0473), SP 500 (0,0071), SPTSX (0,0230), SPTSX Composite (0,0084), TSE 300 (0,0226), molybdenum (0,0175), orange juice (0,0090) [BOVESPA (0,0556), MSCI AC World (0,0625), MSCI World (0,0670), Straits Times (0,0657), RUSSEL (0,0618), copper (0,0869), gas oil (0,0972)]

i) September: OMX Riga (0,0413), PSI 20 (0,0173), SASLCT (0,0121), gas oil (0,0093) and molybdenum (0,0121), [CAC40 (0,0717), DJ Eurostoxx (0,0843), IBEX (0,0978), IPSA (0,0569), SDAX (0,0650), canola (0,0939) and platinum (0,0795)].

j) October: BUX (0,0424), DJ Eurostoxx (0,0168), DJUA (0,0172), MSCI AC World (0,0171), MSCI World (0,0124), SASLCT (0,0621), cobalt (0,0005) and palladium (0,0120), [DAX (0,0691), molybdenum (0,0621), sugar (0,0668)].

k) November: AMEX (0,0427), CAC 40 (0,0351), DJ Composite (0,0215), DJIA (0,0379), DJTA (0,0087), FTSE 100 (0,0438), SAS (0,0049), UK 100 (0,0111), lean hogs (0,0303), [AEX (0,0866), CRB (0,0807), DAX (0,0825), EOE (0,0614), OSE (0,0727), SP 500 (0,0518), TOPIX (0,0810) and cobalt (0,0951)]

l) December: All Ordinaries (0,0050), FTSE 100 (0,0414), KLCI (0,0055), KOSPI (0,0113), NIKKEI (0,0001), NZX 50 (0,0062), TAIEX (0,0048), orange juice (0,0071) [HANG SENG (0,0548), MICEX (0,0622), OMX Riga (0,0644), Strait Times (0,0596), coffee (0,0682), lumber (0,0720)]

For **new moon** sessions:

a) January: BUMIX (0,0088), DJUA (0,0061), MERVAL (0,0121), PSEI (0,0256), PX (0,0480), SSE Composite (0,0100), canola (0,0137) [mWIG40 (0,9738), NZX 50 (0,0788), SMI (0,0836), SSE B-shares (0,0943), cotton (0,0817), sugar (0,0650)].

b) February: AEX (0,0080), BEL 20 (0,0063), BUX (0,0096), CAC40 (0,0082), CDAX (0,0103), DAX (0,0053), DJ Eurostoxx (0,0181), EOE (0,0077), FTSMIB (0,0016), HEX (0,0378), HANG SENG (0,0260), IBEX (0,0006), KLCI (0,0131), KOSPI (0,0013), MDAX (0,0275), MSCI AC World (0,0032), MSCI World (0,0017), OMX Stockholm (0,0193), OMX Vilnius (0,0902), PSEI (0,0232), SAS (0,0024), SMI (0,0082), TECDAX (0,0083), TAIEX (0,0328), UK 100 (0,0464) and cobalt (0,0053), [BUMIX (0,0555), Nikkei (0,0532), OSE (0,0655), SASLCT (0,0781), SSE COMPO-SITE (0,0552), WIG20 (0,0812) and molybdenum (0,0781)].

c) March: cocoa (0,0350), corn (0,0477), [AEX (0,0775), CAC40 (0,0893), DAX (0,0983), EOE (0,0620), crude oil (0,0711), gasoline (0,0794), wheat (0,0613)]

d) April: NZX 50 (0,0001), cobalt (0,0001), canola (0,0092), gasoline (0,0178), heating oil (0,0342), nickel (0,0159), orange juice (0,0082) [DJ Composite (0,0934), SPTSX (0,0849), nickel (0,0536), lumber (0,0746), wheat KCBT (0,0978)]

e) May: BUMIX (0,0108), DJIA (0,0435), [BUX (0,0836), DJ COMPOSITE (0,0925), Nikkei (0,0509), SP 500 (0,0791), RTS (0,0857), SSE B-shares (0,0751), XU 100 (0,0751), TOPIX (0,0527), aluminum (0,0940) and tin (0,0735)]

f) June: OMX Vilnius (0,0245), SOFIX (0,0183), sWIG80 (0,0363) and cobalt (0,0001), [HANG SENG (0,0969), IPC (0,0527), TOPIX (0,0597), lean hogs (0,0743) and nickel (0,0917)

g) July: MEX (0,0079), IPSA (0,0108), JCI (0,0119), mWIG40 (0,0040), SET (0,0016), SMI (0,0440), gasoline (0,0226), soybean oil (0,0227), [DJUA (0,0698), EOE (0,0713), PSEI (0,0687), SPTSX (0,0652), UX (0,0612), Brent oil (0,0698) and gold (0,0878)]

h) August: ICEX (0,0006), cotton (0,0125), gasoline (0,0362), [IPC (0,0803), PSEI (0,0807), PX (0,0965), SAS (0,0555) and TECDAX (0,0716)]

i) September: MEX (0,0452), corn (0,0223), cotton (0,0089), [ICEX (0,0555), KLCI (0,0558), PSEI (0,0594), gold (0,0883) and lean hogs (0,0996)]

j) October: HEX (0,0359), IPSA (0,0285), MERVAL (0,0471), NZX 50 (9,9224), PSI 20 (0,0187), SOFIX (0,0332), molybdenum (0,0259), sugar (0,0093) [mWIG40 (0,0801), SSE Composite (0,0972), WIG20 (0,0291)]

k) November: DJTA (0,0342), IPC (0,0227), TECDAC (0,0326), XU 100 (0,0341), cobalt (0,0001), lean hogs (0,0220), [CAC40 (0,0669), FTSE 250 (0,0787), IBEX (0,0519), OMX Vilnius (0,0915), SSE Composite (0,0688), Straits Times (0,0780), UK 100 (0,0670) and palladium (0,0831)]

l) December: BUX (0,0289), TSE 300 (0,0306), JCI (0,0276), OSE (0,0192), [BET (0,0706), SAS (0,0865) and cooper 0,0606)]

In analyzed cases, when the p-value was higher than 0,05 therefore there was no reason to reject the null hypothesis. Thus, one-session average rate of return, calculated for each month, when the specific moon phase falls on, was equal to the average one-session rate of return obtained for all other cases (for the confidence level of 95%).

For full phase of the moon falling in the specified month, the null hypothesis was rejected three times in case of the following indices and commodities: All Ordinaries, DJ Composite, FTSE 100, KLCI, KOSPI, SASLCT, UK 100, cobalt, molybdenum, orange juice. When the moon was in the new phase, the null hypothesis was rejected five times for cobalt and three times for: corn, cotton, gasoline. Considering both moon phases, the null hypothesis was rejected 8 times in case of cobalt and 4 times for the following indices: KLCI, KOSPI, NZX 50, TECDAX, UK 100, gasoline, orange juice.

The change of the approach of returns calculation from the Regime 1 to Regime 2, influenced results of statistical hypotheses testing. The different result were obtained for the following indices and commodities:

1. In case of analysis of the average rates of return (in parenthesis the α value): AMEX (5%); DAX (5%), DJTA (1%), HANG SENG (5%), KLCI (5% and 1%), MERVAL (5% and 1%), MSCI World (5%), Nasdaq (5% and 1%), PSEI (5%), PX (5%), SPTSX Composite (5%, 1%), SASLCT (1%), Straits Times (5%), sWIG80 (1%), Brent oil (5%), cobalt (5% and 1%), cotton (1%), feeder cattle (5% and 1%), live cattle (5%), lumber (5%), molybdenum (1%) and wheat (5%), .

2. In case of analysis the difference between average rates of return in two populations:

    a) Full moons: DJ Composite, ICEX, SPTSX Composite, wheat, wheat KCBT.

    b) New moons: CDAX, FTSMIB, FTSE 250, MDAX, OMX Vilnius, Straits Times, TECDAX, cobalt, soybean meal, wheat.

3. In case of analyzing rates of return in the different days of the week (in parenthesis name of the day of the week): AEX (Thursday), BEL 20 (Friday), DJ Eurostoxx (Fridays), FTSE 250 (Wednesday), ICEX (Friday), IPSA (Monday), KLCI (Monday), MDAX (Fridays), MSCI AC World (Friday), MSCI World (Friday), mWIG40 (Monday), NZX 50 (Tuesday), OSE (Wednesday), PSEI (Monday), PX (Monday), SASLCT (Monday), SMI (Monday), SPTSX Composite (Tuesday), sWIG80 (Friday), TSE 300

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(Monday, Tuesday and Fridays), XU 100 (Wednesday), Brent Oil (Monday), canola (Friday), cocoa (Monday), coffee (Monday), copper (Monday), corn (Tuesday and Friday), crude oil (Monday, Wednesday), heating oil (Monday and Friday), lean hogs (Friday), lumber (Friday), molybdenum (Monday), natural gas (Thursday) aluminum Aloy NASAAC (Monday), soybean (Monday and Wednesday), soybean meal (Monday and Wednesday), sugar (Monday), rough rice (Friday). The difference in results of null hypothesis testing was the highest for Mondays (17- full moon and 8-new moon)) and Fridays (8-full moon and 20-new moon), which is in line with expectations. For other days of the week the results were equal to: 4 (Tuesday), 6 (Wednesday) and 2 (Thursday) for full moon, and equal to 0 (Tuesday and Thursday) and 1 (Wednesday) – for new moon sessions – see table 5.

Table 5. The number of indices and commodities for which there was observed the difference in the process of null hypothesis testing (for the different days of the week)

	Monday	Tuesday	Wednesday	Thursday	Fridays
Full moon	17	4	6	2	8
New moon	8	0	1	0	20

Source: own calculations

4. In case of analyzing average rates of return in different months (in parenthesis the number of the month for which the difference was observed, e. g. 1 is equal January, 2 – February, etc…):

   a) Full moon: AEX (6), All Ordinaries (3, 12), AMEX (1), ATHEX (5), BEL 20 (6), BOVESPA (6), BUMIX (6, 8), BUX (6, 10), CAC 40 (6, 9, 11), CDAX (6), CRB (11), DAX (2, 3, 6), DJ Eurostoxx (3, 6), DJIA (6, 11), EOE (2, 6), FTSE 100 (2, 12), FTSE 250 (3, 5), FTSMIB (6), HEX (6), IPSA (6), KLC (3, 7, 12), MDAX (6), MEX (8, 6), MICEX (2), MSCI AC World (3, 6) MSCI World (3, 6), NASDAQ (8), NZX 50 (3, 12), OMX Riga (12), OMX Stockholm (3, 6, 9), OSE (6), PX (6), RTS (2), RUSSEL (1, 6), SAS (6, 7), SASLCT (8), SDAX (6, 9), SOFIX (8), SMI (3, 6), SPTSX (5), Straits Times (8), sWIG80 (3), TAIEX (12), TECDAX (9), UK 100 (2, 11), WIG20 (6), aluminum (6), Brent oil (4, 5), cobalt (7, 10, 11), copper (8), corn (3), feeder cattle (12), gas oil (2, 9), gasoline (7), gold (7), lean hogs (11), live cattle (7), molybdenum (8), nickel (2), orange juice (2, 12), soybean (4), soybean meal (4), soybean oil (4), sugar (11), tin (2) and zinc (1).

   b) New moon: AEX (11), BUX (12), BUMIX (5), CAC 40 (2, 11), DJIA (5), EOE (7, 11), FTSMIB (11), HEX (2, 10), IBEX (11), IPSA (10), JCI (3, 12), KLCI (5), MERVAL (10), MEX (7, 9), NIKKEI (5), NZX 50 (1), OSE (2), OMX Vilnius (6), PSEI (7, 9), PSI 20 (10), PX (1), SAS (2, 8), SSE Composite (1, 11), SOFIX (6, 10), sWIG80 (6), TECDAX (2), TSE 300 (12), TOPIX (5), UK 100 (11), XU 100 (11), WIG20 (10), aluminum (5), canola (1, 4), cobalt (2, 4, 5, 10, 11), cocoa (3),

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copper (12), cotton (1), corn (12), gasoline (4, 7), heating oil (4), live cattle (4), lumber (11), natural gas (1), nickel (4, 6), orange juice (4, 12), rough rice (9), and palladium (11).

The highest number of differences in case of the full moon was observed for June session (26), and the lowest for October (2). In case of new moon session, the highest value was noticed in November (11) and the lowest in August (1) – see table 6.

Table 6. The number of indices and commodities for which there was observed the difference in the process of null hypothesis testing (for the different month).

	January	February	March	April	May	June	July	August	September	October	November	December
Full moon	4	9	12	4	5	26	6	9	5	2	11	10
New moon	2	6	2	7	7	4	4	1	3	7	11	6

Source: own calculations

DISCUSSION

The relationship between the moon phases and rates of return on sizeable group of world stock exchanges has already been raised in the scientific papers. This paper is one of the first dedicated to the study of the statistical significance of the rates of return on such a big sample of stock indices and commodities, calculated for two moon phases and testing the hypothesis that the one-session rates of return of 107 stock indices and commodities, computed for full moon and new moon phases, are statistically different form zero (at the significance level of 95%). Calculations presented in this paper indicate that the one-session average rates of return for the sessions, when the moon was in new phase, are statistically different from zero. For Regime 1, the null hypothesis was rejected 15 and 39 indices and commodities when the moon was in the full and noon phase ($\alpha=5\%$), respectively, and for Regime 2, the number of null hypothesis rejection was equal to 26 (full moon) and 45 (new moon) – for $\alpha=5\%$. In case of testing equality of average rates of return in two populations, the number of null hypothesis rejection was equal in the Regime 1: 5 and 21 (for full and new moon, respectively), whilst in the Regime 2, it mounted to 5 and 17. In case of testing the null hypothesis regarding equality of one-session average rates of return, computed for each day of the week, the result permit to reject in the Regime 1: 46 and 34 cases (full and new moon), and in the Regime 2: 39 and 54 cases. Calculations of one-session average rates of return, regarding moon phases falling in a specific month, displayed that they are statistically different from zero - in the Regime 1: in 131 and 70 cases (for full and new moon, respectively) and in the Regime 2: in 120 and 80 cases (for full and new moon, respectively). The number of null hypothesis rejection, generally was bigger for the new than full moon sessions.

In the Regime 1 the number of positive and negative one session average rate of return was equal to 76 and 31 – in case of full moon sessions and mounted to 94 and 13 – in case of new moon sessions. In the Regime 2 the number of positive and negative one session average rate

of return was equal to 79 and 28 – in case of full moon sessions and mounted to 94 and 13 – in case of new moon sessions. The obtained results regarding average rates of return during full and new moon session confirm the observations of other researchers: Dichev and Jones (2003), Yuan et al. (2006) and Brahman et al. (2011).

The main limitation of this research is the assumption of normal distribution of return rates of analyzed indices and commodities along with the use of price data gained from Bloomberg data source as well as the unequal intervals of observations for different equity indices and commodities.

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).

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