

On the Rationality of Investors – Lunar Phases and Equity Returns in Poland

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Abstract: *Purpose* – The paper examines the popular belief that the cycles of the moon affect human moods, which is then reflected in investor behaviour. Hence, the relation between lunar phases and equity returns in Poland was examined.

Design/methodology/approach – New (full) moons were called nine-day windows with the centre in the new (full) moon day. Arithmetic daily index returns and average daily and cumulative returns were calculated for the session days in the new and full moon windows. Then the lunar effect on the market portfolio was observed with additional analysis for size effect, calendar month effect, and half-of-the-month effect. A robustness check tested the results.

Findings – Average returns around full moon dates were substantially lower than returns around new moon dates. For size-related indexes, the results were similar. However, for small companies the differences were somewhat smaller. Average returns both for bear and bull months were positive and quite similar during the new moon phase. Average returns for full moon phases were tangibly negative for bear months and much lower for bull month as compared with results for the new moon phase. Both the lunar and the half of the month effects seemed to be important for returns in Poland.

Originality/value – The study concentrated on the lunar effect for returns on the Warsaw Stock Exchange. The applied methodology is new for studying the relation for Poland.

Keywords: lunar cycles, moon phases, stock market, emerging market

Introduction

The efficient market hypothesis gave priority to fundamental information in shaping market prices and assumed no behavioural factors are important in stock valuing. However, in more recent literature many empirical studies challenged this hypothesis and investor rationality. It has become clear that the dominance of the fully rational investor and the exclusiveness of the traditional finance paradigm will have to make space for behavioural factors (e.g. Kahneman, Riepe, 1998; Loewenstein, 2000; Daniel, Hirshleifer, Teoh, 2002).

Along with the increasing interest in behavioural finance, research studies on how emotional factors affect stock markets started to appear. Seeking information about price movements resulted in many empirical studies that demonstrated the importance of non-financial factors on the decisions of financial markets participants. Many examples can be mentioned here such as those testing the relation of stock returns and weather (Hirshleifer, Shumway,

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2003), the impact of religious experience on financial markets (Al-Ississ, 2010), the importance of market mood for prices (Hirshleifer, Teoh, 2002; Jagric, Markovic-Hribernik, Strasek, Jagric, 2010; Shu, 2010). Other studies document the influence of planetary factors on stock returns, e.g. Saunders (1993) and Hirshleifer and Shumway (2003) reported higher stock returns for sunny days, Kamstra, Kramer, and Levi (2003) found a relation between stock returns and the amount of daylight throughout the year, or Krivelyova and Robotti (2003), who found that geomagnetic storms affect stock returns. Academic interest in time-related regularities has also increased. Although many fundamental economic factors were reported as having a key influence on market price movements, a number of market price anomalies such as the January effect (Thaler, 1987), the day-of-the-week effect (Gibbons, Hess, 1981) and turn-of-the-month effect (Ariel, 1987) have been observed.

Since ancient times the belief that the phases of the moon have an effect on the human mind has been widespread. It is also quite a popular belief across many modern cultures not only those strongly connected with natural cycles such as Indian culture. People used to believe that the moon has a close relation with human thinking and decision making. The centuries of such popular beliefs resulted in research studies appearing, concerning the influence of lunar movements on human behaviour. Empirical studies connected with lunar phases and human decisions started to appear in many areas such as psychology or medicine (e.g. Gutierrez-Garcia, Tusell, 1997 or Thakur, Sharma, 1984).

On the borderline between the attempts to explain price movements on capital markets and the traditional belief of the importance of lunar phases on the life on the earth, there appeared academic studies linking stock returns with lunar movements. The lunar cycle is described by the relative positions of the earth, the moon, and the sun. The new moon is the first phase of the moon when it is not visible from the earth. As the relative position changes, the moon starts to be seen from the earth's surface until it reaches full moon. After the full moon, the moon starts to decrease again, until it reaches new moon and the lunar cycle starts again. The first studies that linked lunar phases with market returns were the empirical works by Dichev, Janes (2003) and Yuan, Zheng and Zhu (2006). The issue was also checked for the Polish capital market (Borowski, 2015, and Borowski, 2016). However, the results for Poland include only a one-day window which means it is possible that the entire market reaction was not included in equity prices. Hence, revised studies for Poland with a developed methodology are justified.

The study was financed by the National Science Centre, Poland as a research project (2015/19/D/HS4/01950). The rest of the paper is structured in the following way. In the next section the existing literature is revised. Then, the research sample and data are described. The next sections are strictly connected with empirical testing for the Warsaw Stock Exchange (WSE) which is the main equity market in Poland. Section 3 discusses the lunar effect on the market portfolio. In section 4 the calendar effect is added to the lunar effects. In section 5 the half-of-the-month effect is discussed along with lunar effects. Section 6 checks the robustness for lunar effects for Poland. The last section states the conclusions.

1. Literature Review

Many research studies have been done on the effect of lunar phases on animal, plant and human behaviour. Some human economic decisions also seem to be influenced by moon cycles. Following this, also stock pricing could be influenced by lunar phases. The pioneering paper in this area was published by Dichev and Janes (2003). It was found on international evidence that returns around new moon were about double the returns around full moon dates. Yuan, Zheng and Zhu (2006) also reported lower stock returns for the days around a full moon than on the days around a new moon. The magnitude of the return difference is 3% to 5% per annum. In addition, the lunar effect was independent of other calendar anomalies such as the January effect, the day-of-week effect, the calendar month effect, or the holiday effect.

Keef and Khaled (2011) confirmed the findings of Yuan et al. (2006) and Dichev and Janes (2003). They also used an international sample. The mean return on new moon days was higher than the mean return on lunar control days. However, the mean return on full moon days did not differ from the mean return on lunar control days.

Brahmana, Zamri and Hooy (2012) showed no effect of the moon on stock market behaviour. They tested the full moon's influence on seven Pacific-Basin stock markets. Using a different international sample, Yousop, Sipon, Yoke (2014) showed that returns on the full moon were slightly lower as compared to the returns on the new moon prior to, and during the financial crisis. However, the results during full moon were different for five countries. The research covered ten emerging countries (Argentina, Brazil, China, Colombia, Czech, India, Jordan, Mexico, Oman, Romania and Malaysia).

Along with international samples, studies for national exchanges appeared. Herbst (2007) found no consistent, predictable lunar influence on returns for either full or new moons. The results were based on the Dow Jones Industrial Average. The author interprets the results as supporting rational investment markets and the Efficient Market Theory. Wang, Lin and Chen (2010) showed that lunar cycle had a significant negative influence on stock returns in Taiwan. Sivakumar and Sathyanarayanan (2009) studied the impact of lunar cycles on the Bombay Stock Exchange. The impact of lunar cycles on Indian stock markets appeared to be quite limited, though, as returns during the full moon – although lower than that of the new moon phase – were not statistically significant.

Brahmana, Hooy, Ahmad (2014) applied an interesting quasi-experimental study with a psychometric test. They found that investor psychology was influenced by the full moon, but no effect was recorded during the new moon phase. During the full moon phase, investors tended to be more aggressive and sought hedonic utility instead of the traditional economics utility, meaning that they appeared to follow market sentiment.

This paper is not the first attempt to test the relation between lunar phases and stock returns for Poland. The first study was by Keef and Khaled (2011) where Poland was one of 62 countries included in the cross-country sample with the research period ending in 2007. The results for Poland were not set apart from the international sample. Research

strictly on Poland was conducted by Borowski (2015 and 2016). Borowski (2015) reported that one-session average rates of return for sessions when the moon was in the new phase were statistically different from zero. Borowski (2016) reported that average daily returns were statistically higher than zero for big and small companies when the moon was in the new phase and for small firms when the moon was in the full phase. It is worth pointing out that the returns during sessions close to moon phases were calculated by Borowski (2015 and 2016), while the other authors concentrated rather on returns calculated during a couple of sessions around the full or new moon. As a result of this, a comparison of the prior results for Poland with those for other markets is rather difficult.

2. Data

The research period covers the years 2000–2016. The source of information about daily quotation of indexes was <https://stoq.pl>. Three indexes were taken into account: the main Warsaw Stock Exchange index, called the WIG, and two additional size-related indexes: one including only the smallest companies (sWIG80) and one connected with the pricing of large firms (WIG20).

Full moons were defined as nine-day periods in the 29.531-day lunar cycle (called a lunar or synodic month), with the middle day being described as full moon. New moons were called nine-day windows with the centre in the new moon day.

Based on the daily index quotation at closing, arithmetic daily index returns were calculated for the session days in the new and full moon windows. Later on, they were averaged into means and medians or cumulated and then averaged. Parametric and non-parametric tests were used to test if the average returns were statistically different from zero.

3. Lunar effect on the market portfolio

The literature regarding lunar effects on human behaviour generally concludes that people usually have a more pessimistic approach during the full moon phase. Following this, higher returns were expected during the new moon window compared to the full moon days. The average returns during both lunar phases (for the main WIG index) are presented in Table 1.

An examination of the results for the WIG revealed that average daily returns around full moon dates were substantially lower than returns around new moon dates. For the nine-day window specification, the mean daily return around full moons was 0.01% compared to 0.09% around new moon (0.03% versus 0.08% for medians). Average daily returns in the new moon window had statistically different distribution than returns during the full moon days. The annualized average difference in mean daily returns equalled 23%. The cumulative return difference between new moon periods and full moon periods was 0.52 percentage points per lunar cycle.

Table 1

Average returns in the full and new moon window

	Full moon		New moon	
Panel A: Daily returns for WIG				
Mean (%)	0.01		0.09	
p-val	0.7937		0.0072	***
Median (%)	0.03		0.08	
p-val	0.3405		0.0032	***
Diff(New-Full) (%)	0.08			
p-val	0.0964	*		
N	1,281		1,319	
Panel B: Cumulative returns for WIG				
Mean (%)	0.06		0.58	
p-val	0.7971		0.0091	***
Median (%)	0.32		0.50	
p-val	0.2728		0.0094	***
Diff(New-Full) (%)	0.52			
p-val	0.0984	*		
N	210		211	

Notes: significance at the 1% (***), and 10% (*) level.

Source: own calculations.

Table 2

Average returns in the full and new moon window – size effect

	Big firms			Small firms		
	Full moon	New moon		Full moon	New moon	
Panel A: Daily returns						
Mean (%)	-0.02	0.09		0.06	0.09	
p-val	0.5656	0.0265	**	0.0467	0.0030	***
Median (%)	-0.01	0.06		0.09	0.11	
p-val	0.7507	0.0527	*	0.0010	0.0001	***
Diff(New-Full) (%)	0.12			0.03		
p-val	0.0506	*		0.4788		
N	1,281	1,319		1,281	1,319	
Panel B: Cumulative returns						
Mean (%)	-0.15	0.57		0.36	0.56	
p-val	0.5736	0.0251	**	0.0864	0.0220	**
Median (%)	0.10	0.61		0.55	0.43	
p-val	0.9314	0.0600	*	0.0500	0.0105	**
Diff(New-Full) (%)	0.72			0.20		
p-val	0.0502	*		0.5403		
N	210	211		210	211	

Notes: significance at the 1% (***), 5% (**) and 10% (*) level.

Source: own calculations.

Additionally, the size effect was checked, with the results for big firms (WIG20) and small firms (sWIG80) presented in Table 2. For an alternative summary of the returns for various size-related indexes, Figure 1 presents a graph of new moon vs. full moon annualized mean daily returns for the WIG, sWIG80 and WIG20.

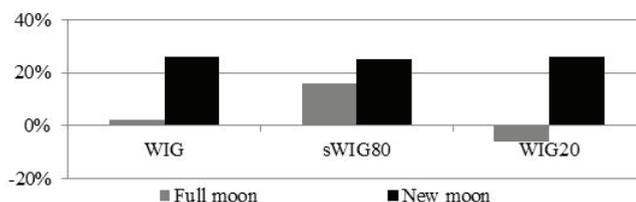


Figure 1. New moon versus full moon annualized mean returns for WSE indexes

Source: own calculations.

For size-related indexes, new moon returns were also substantially higher than full moon returns. However, for small companies the differences were somewhat smaller. In spite of the relatively large difference in returns, none of the t-statistics for the full moon phase was significant at conventional levels. Only the average returns for the new moon windows were statistically significant. The differences in distribution were significant for large companies.

4. Calendar month effect

A large number of previous studies reported the existence of the month effect in equity pricing. Lunar months do not correspond to calendar months. Hence, the importance of the relation between lunar effects and month effects was tested.

Table 3

Average returns in the full and new moon window for bull and bear months

	Bull months		Bear months	
	Full moon	New moon	Full moon	New moon
1	2	3	4	5
Panel A: Daily returns				
Mean (%)	0.07	0.10	-0.05	0.09
p-val	0.2202	0.0393 **	0.3650	0.0813 *
Median (%)	0.06	0.08	-0.02	0.06
p-val	0.0503 *	0.0224 **	0.5582	0.0616 *
N	635	676	646	643

1	2	3	4	5
Panel B: Cumulative returns				
Mean (%)	0.39	0.61	-0.28	0.56
p-val	0.2159	0.0474 **	0.3871	0.0899 *
Median (%)	0.44	0.68	0.21	0.39
p-val	0.0859 *	0.0436 **	0.9087	0.0875 *
N	106	108	104	103

Notes: significance at 5% (**) and 10% (*) level.

Source: own calculations.

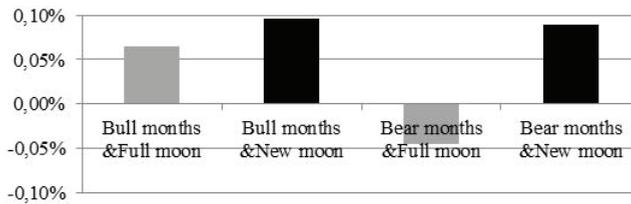


Figure 2. Mean daily returns according to the lunar phase and market conditions

Source: own calculations.

The average returns for the period 2000–2016 made it possible to classify each of the twelve months into bear and bull months with mean daily returns in bull months equal to 0.08% in comparison to -0.01% for bear months. Then, the full and new moon effect was observed in both groups. The results are detailed in Table 3 and illustrated on Figure 2. Average returns for bear as well as bull months were positive and quite similar during the new moon phase with all of the average returns being statistically significant. However, substantial differences were reported between good and bad months for the full moon window: average returns for full moon phases were tangibly negative for bear months and much lower (but positive) for bull months as compared with results for the new moon phase. The good mood of investors during new moon days seemed to overlap the month effects.

5. Half-of-the-month effect

One of the market anomalies is the half-of the month anomaly, that is that average returns in the first half of the month are different than those in the second one. Hence, the relation between returns for the lunar phase and the part of the month is now tested. The results are detailed in Table 4 and illustrated on Figure 3.

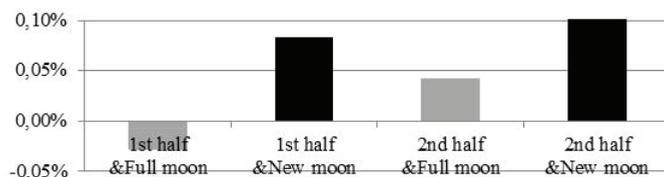
Table 4

Average returns in the full and new moon window for the first and second half of month

	1st half of the month		2nd half of the month	
	Full moon	New moon	Full moon	New moon
Panel A: Daily returns				
Mean (%)	-0.03	0.08	0.04	0.10
p-val	0.6309	0.0750 *	0.3455	0.0441 **
Median (%)	-0.03	0.08	0.07	0.07
p-val	0.9559	0.0378 **	0.1485	0.0348 **
N	590	678	691	641
Panel B: Cumulative returns				
Mean (%)	-0.17	0.52	0.26	0.64
p-val	0.6633	0.0885 *	0.2942	0.0489 **
Median (%)	0.21	0.49	0.41	0.50
p-val	0.9766	0.0616 *	0.0729 *	0.0764 *
N	98	108	112	103

Notes: significance at the 5% (**) and 10% (*) level.

Source: own calculations.

**Figure 3.** Mean daily returns according to the lunar phase and month period

Source: own calculations.

Mean (median) daily returns in the first half of the month for 2000–2016 were equal to 0.01% (0.02%) in comparison to 0.05% (0.06%) for the second half of month. If the lunar effect was included, higher returns for the first part of each month were also observed, but the moon phase effect was also seen. Although the results for the full moon phase were not statistically significant, both the lunar and the half of the month effects seemed to be important for equity returns in Poland.

6. Robustness check

Additional results for various lengths of the moon phase window and for subperiods are presented as a robustness check.

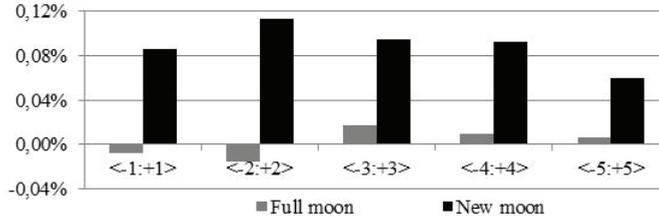


Figure 4. Mean daily returns in different observation windows

Source: own calculations.

Table 5

Average returns in the full and new moon window – robustness check for subperiods

	2000–2007		2008–2016	
	Full moon	New moon	Full moon	New moon
Panel A: Daily returns				
Mean (%)	0.05	0.10	-0.03	0.08
p-val	0.3213	0.0502 *	0.5556	0.0660 *
Median (%)	0.06	0.09	0.00	0.05
p-val	0.1668	0.0284 **	0.9793	0.0529 *
Diff(New-Full) (%)	0.05		0.11	
p-val	0.5003		0.0935 *	
N	607	620	674	699
Panel B: Cumulative returns				
Mean (%)	0.32	0.65	-0.18	0.52
p-val	0.3698	0.0668 *	0.5271	0.0648 *
Median (%)	0.47	0.48	0.22	0.53
p-val	0.2263	0.0634 *	0.7932	0.0666 *
Diff(New-Full) (%)	0.32		0.70	
p-val	0.5199		0.0789 *	
N	99	99	111	112

Notes: significance at the 5% (**) and 10% (*) level.

Source: own calculations.

The results mostly demonstrated the robustness of the conclusions that the lunar effect influences equity returns in Poland.

Conclusions

Many previous studies have indicated the importance of investor sentiment for asset pricing. Simultaneously, lunar phases are mentioned as one of the factors influencing human mood and activities. Prior research evidence suggests that lunar phases may affect investor behaviour and – in consequence – asset prices. As psychology associates the full moon phase with pessimistic thinking, it was expected that market returns would be higher in the periods of the new moon.

To better understand the effect of lunar phase on equity returns, it was examined whether such an effect was related to stock capitalization or other calendar-related market anomalies such as the month effect. Finally, the robustness of the lunar effects was checked for various moon phases window lengths and sample periods.

The results suggest that investors were subject to psychological and behavioural biases when making investment decisions. The findings indicated that equity average returns around full moon dates were substantially lower than returns around new moon dates. For size-related indexes, the results were similar but the differences were somewhat smaller for small companies. Average returns both for bear and bull months were positive and quite similar during the new moon phase. Average returns for full moon phases were tangibly negative for bear months and much lower for bull months as compared with results for the new moon phase. Both the lunar and the half of the month effects seemed to be important for the returns. The robustness check mostly demonstrated that the lunar effect was economically and statistically significant for Poland.

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Z BADAŃ NAD RACJONALNOŚCIĄ INWESTORÓW – FAZY KSIĘŻYCA A STOPY ZWROTU NA GIELDZIE PAPIERÓW WARTOŚCIOWYCH W WARSZAWIE

Streszczenie: *Cel* – Celem badań było zbadanie związku między fazami księżyca a stopami zwrotu realizowanymi na Giełdzie Papierów Wartościowych w Warszawie (GPW). W ostatnich latach, pozaekonomiczne czynniki kształtujące rynkową wartość spółki zyskują na znaczeniu.

Metodologia badania – Okresy nowiu (pełni) określono jako 9-dniowe okna, koncentrujące się wokół dni, w których obserwowano daną fazę księżyca. Na podstawie arytmetycznych stóp zwrotu dla giełdy obliczono przeciętne dzienne i przeciętne skumulowane stopy zwrotu dla okna zdarzenia. Analizę poszerzono o efekt wielkości spółki, efekt miesiąca, efekt połowy miesiąca oraz ocenę odporności wyników.

Wynik – Stopy zwrotu w okresie pełni były znacząco niższe w porównaniu do tych osiągniętych podczas nowiu. Wpływ cyklu księżyca był znaczący – aczkolwiek z różnym natężeniem – również po uwzględnieniu wielkości spółek. Efekt miesiąca oraz połowy miesiąca nakładał się na efekt faz księżyca.

Oryginalność/wartość – Zastosowana metoda badania związku pomiędzy fazami księżyca i stopami zwrotu jest w zakresie badań nad spółkami notowanymi na rynku głównym w Polsce nowa i umożliwia porównanie z wynikami badań otrzymanymi dla innych rynków.

Słowa kluczowe: fazy księżyca, stopy zwrotu, rynek wschodzący

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