

Full Length Research Paper

Does lunar cycle effect exist? Lunar phases and stock return volatilities

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Accepted 11 January, 2018

The idea that lunar cycles may influence human behavior dates back at least to ancient Greece and Rome. Even in modern societies, with their emphasis on science and technology, the legend of moon affecting human behavior is a steadily growing trend. This study thus adopts a behavioral finance perspective to examine the relationship between lunar cycle and investor behavior, and specifically analyzes stock market behavior in Taiwan. The sample data employed in this investigation cover the period of 1998 to 2008, and this study adopts the asymmetric General Autoregressive Conditional Heteroscedasticity (GARCH) model for the analysis and considers the effect of lunar cycle for investor behavior is active or passive on the stock market. Finally, the empirical evidence presented in this study demonstrates how lunar cycle showed the significant and negative influence on stock returns, and stock volatility demonstrates statistically significant and positive influence. The results imply that the moon affects individual mood and thinking, and lead to stock market change.

Key words: Lunar cycle, investor behavior, General Autoregressive Conditional Heteroscedasticity model.

INTRODUCTION

Ancient calendar is a method of calendar organization that is developed daily demand in markets comprising numerous individuals; especially the people of the country depending on the agricultural influence that is more extensive. The lunar cycle influences the universe and the individuals are no exception. By "the lunar cycles" this paper means the time of moon going round the earth in particular is approximately 29.53 days. Lunar phases change begins new moon to shift to full moon, and finally shift to new moon during the period. Numerous ancient calendars are based on moon motion to institute, since lunar cycle naturally influences human behavior more than solar motion. Moreover, significant holidays like Easter and Passover are timed according to lunar cycles. Three types of calendars exist, solar, lunar, and lunisolar. Solar calendars are based on solar motion or tropical year, lunar calendars are based on lunar motion or synodic month, and lunisolar calendars that

integrate the above types of calendars, and moreover have been the favored calendar type used to record Chinese history.

Calendar influences animals, humans and nature during the specific time such as new moon or full moon, with lunar cycles exerting particularly far-reaching effects on outcomes in agriculture and medicine. However, most studies of lunar cycles have focused on stock returns, and few have analyzed the influence of lunar cycles on stock returns and volatility. This study thus investigates returns and volatility relationship and interprets the result by behavioral finance contention. Lunar cycles have long been known to affect human eccentric behavior and the behavior reaches a climax around full moon. Furthermore, for uncertain reasons various stories have shows how the moon affects humans and animals circulated in Western countries. This study thus examines whether lunar phase affects human behavior. By "the behavioral finance" this study means that investor behavior is affected by psychology and then investor behavior affects the finance decision and stock market (Shefrin, 2000; Jacobsen and Marquering, 2008).

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Most of the investor decision is affected by sentiment, which in turn is influenced by weather. Thus, a great deal of the literature at home and abroad discusses the relationship between lunar cycles and the weather, and moreover has demonstrated that investor mood is influenced by various variables, including lunar cycle, weather, (Goldstein, 1972; Cunningham, 1979; Sanders and Brizzolara, 1982; Howarth and Hoffman, 1984; Saunders, 1993; Eagles, 1994; Dichev and Janes, 2003; Yuan et al., 2006) and returns volatility (Andreassen and Kraus, 1990; Clarke and Statman, 1998; Kliger and Levy, 2003; Kang et al., 2010). Previous investigations have demonstrated these variables influence human behavior and then lead to stock returns change, with observed phenomenon such as stock returns are always higher particularly full of sunshine, driven by investor optimism (Saunders, 1993; Hirshleifer and Shumway, 2003), correlations among hours of daylight (Kamstra et al., 2003), geomagnetic storms (Krivelyova and Robotti, 2003) and weather (Goetzmann and Zhu, 2005; Chang et al., 2006; Gerlach, 2007; Yoon and Kang, 2009) and stock returns. With regard to external behavior, evidence shows that abnormal human behavior climaxes around the full moon, with rises in aggression, suicides, and mental instability (Dichev and Janes, 2003; Cao and We, 2005). Just as the full moon brings out werewolves in popular fables, so it is associated with crime; for instance, studies in Florida and the U. K. have identified between crime and the full moon. However, some empirical evidence has failed to identify any relationship between lunar phases and suicide.

The research considers that the lunar phases and suicide are connected and the concept is the most common cognitive biases including selective exposure, selective perception, and self-fulfilling prophecy. For instance, some professionals (medical staff, policemen and social workers) have distorted certain concepts to make people see truth; which main reason is professional prestige (Gutierrez-Garcia and Tusell, 1997). The evidences of Rotton and Kelley (1985) determined how the lunar phase effect is purely fictitious, while Kelly et al. (1996) found the lunar cycle effect to be fragmentary and lack real benefits for present research. Regarding disease, evidence indicates relationship between lunar cycles and both asthma and gout, and for moon and the result shows that morbidity associated with these two diseases peaks around the new and full moons (Mikulecky and Rovensky, 2000). Another study collected 800 patients that suffered urine retention that is a large accumulation of urine in the bladder, which the sufferer is unable to expel the incidence peaks during new moon. Research finds that doctors frequently examine patients during full moons, and moreover the more patients make appointment in advance during these times. From ancient times to the present, mankind has observed close relationships between the moon and human life. Furthermore, considerable empirical evidence exists that the moon is closely linked with human behavior, and presumably that

identifying the links between the moon and human behavior can help avoid negative outcomes occurring at specific times.

METHODOLOGY

This section, first applied the GJR-GARCH model to examine the influence of lunar cycle on stock returns and variation. Additionally, this investigation further subdivides the lunar cycle into new moon and full moon phases to yield more complete results. The sample period ran from February, 1998 to March, 2008. Daily stock index data are provided by the Taiwan Economic Journal (TEJ), and a total sample of 2488 was taken. Besides, dates of new moon and full moon according to Chinese calendar contrast.

During the past 20 years, economists and financial analysis have developed broad classes of conditional heteroskedasticity models for capturing systematic patterns of variance over time. Engle (1982) and Bollerslev (1986) developed the first and most basic of these autoregressive conditional heteroscedasticity (ARCH) and generalized autoregressive conditional heteroscedasticity (GARCH) models, respectively. Subsequently, Hentschel (1995) discussed a unified treatment of various symmetric and asymmetric GARCH models. Owing to the literature on asymmetric volatility in the GARCH model, numerous studies have demonstrated that univariate models can capture the asymmetric volatility effect in asymmetric GARCH (Yeh and Lee, 2000; Friedmann and Sanddorf-Köhle, 2002; Lin and Wang, 2007; Wang and Lin, 2007; Tseng et al., 2008; Wang and Chuang, 2009; Wang and Chuang, 2010). This work employs the GJR-GARCH model (Glosten et al., 1993) to separate stock returns into expected returns and return shocks and determine which of the components of daily Taiwan stock returns play a predominant role in explaining stock returns. Accordingly, the dummies are embedded in the GJR-GARCH (1, 1) to detect the effects of new moon on stock returns and volatilities, as follows:

$$R_t = a_0 + a_1 NM + a_2 FM + \sum_{i=1}^m b_i R_{t-i} + \varepsilon_t \quad (1)$$

$$\varepsilon_t | \Omega_{t-1} \sim t(0, h_t) \quad (2)$$

Where NM denotes the new moon effect, where NM is equals to 1 when it corresponds with the samples are in New Moon period and other equals to 0. Moreover, FM denotes the full moon effect. Where FM is equals to 1 denotes the samples in full moon period and others equals to 0. In equation (2), central t distribution permits stock returns to have thicker tails while retaining symmetry (Harvey and Siddique, 1999; Ang and Chen, 2002; Wang and Lin, 2007). Therefore, this study assumes that TAIEX returns exhibit a non-central t distribution.

$$h_t = \tau_0 + \tau_1 NM + \tau_2 FM + \alpha \varepsilon_{t-1}^2 + \theta S_{t-1} \varepsilon_{t-1}^2 + \beta h_{t-i} \quad (3)$$

The lag of conditional mean returns of GARCH (1, 1) model is chosen by the minimum value of the Akaike Information Criterion (Akaike, 1973) and the Schwarz Bayesian Criterion (Schwarz, 1978). The parameters of the mean and time-varying conditional variance-covariance are jointly determined using the maximum likelihood estimation method.

RESULTS

This section discusses the empirical results for TAIEX

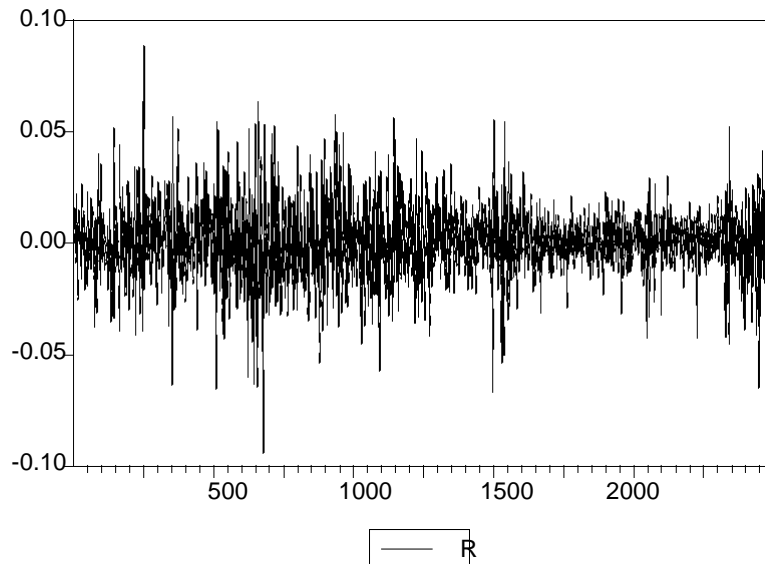


Figure 1. The trend graph of TAIEX.

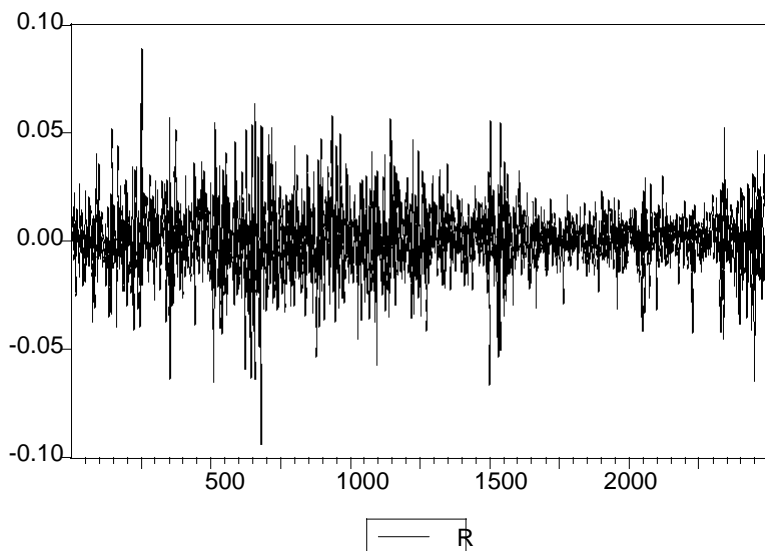


Figure 2. The trend graph of TAIEX.

returns and volatility. First, Figures 1 and 2 shows the trend graphs of Taiwan stock returns and market, respectively. Table 1 then lists basic statistics on TAIEX returns during 1998-2008. At the 5% significance level, skewness of TAIEX returns exhibits a positive-skew while kurtosis shows leptokurtosis. The skewness and kurtosis are highly significant and hence not normal. The Ljung-Box statistics exhibit $Q(6) = 24.7091$ and $Q(12) = 29.6910$, which are statistically significant at the 1% level, displays TAIEX daily returns have significant serial correlation. The Jarque-Bera statistic significantly rejects the assumption of normality. Finally, this study infers that

shape parameters of the distribution of TAIEX returns are not significantly normal.

Next, this study implements the unit root test, which tests whether time series is stationary. Hence, this investigation adopted the ADF and Phillips-Perron to examine whether TAIEX return series conform to steady rules. Table 2 lists the empirical results of the ADF and P-P. The results show that TAIEX returns are stationary at the 5% level. The test outcome of ARCH is listed in Table

3. If there is any heteroscedastic effect (Engle, 1982) and diagnostic test, Sign Bias Test (SBT), Positive Size Bias test (PSBT), Negative Size Bias test (NSBT), and Joint

Table 1. Basic statistics for Taiwan stock market returns.

Statistic	Value
Mean	0.0001
Std. Dev	0.0161
Skewness	0.0033*
Q(6)	24.7091**
Q(12)	29.6910*
Jarque-Bera	616.5959**
Maximum	0.0889
Minimum	-0.0946
Kurtosis	5.4393**
Q ² (6)	356.3074**
Q ² (12)	524.1067**
Sample size	2571

** (*) denotes the statistical significance at 1% (5%) level. Normal test is checked by the Jarque-Bera test, which is based on Jarque and Bera (1980) and is asymptotically chi-square distributed with 2 degree of freedom. Q(6) (Q²(6)) is the Linjung-Box Q statistic for the returns (the squared returns) lagged 6 trading days and its critical value at 5% significant level is 12.5916. Q(12) (Q²(12)) is the Linjung-Box Q statistic for the returns (the squared returns) lagged 12 trading days and its critical value at 5% significant level is 21.0261.

Table 2. The AIC and SBC value of unit root test.

	ADF	PP
None	-33.9201**	-47.8636**
Intercept	-33.9159**	-47.8568**
Intercept and trend	-33.9364**	-47.8726**

Notes: ** denotes statistical significance at 1% level which the critical value is decided on the critical value table of MacKinnon (1991).

Table 3. Asymmetry test of ARCH effect and volatility

Method	ARCH(3)	SBT	NSBT	PSBT	JT
Value	694.3490** (4.5380)	1.2235 (0.1862)	-6.1335** (0.0974)	0.6507 (0.0991)	576.3560** (4.6748)

** (*) denotes the statistical significance at 1% (5%) level. ARCH denotes the Lagrange Multiplier test of Engle (1982) and the criterion is 7.82 at the 5% significant level.

Test (JT) to discover whether the conditional heteroskedasticity has any asymmetric effect (Engle and Ng, 1993). Summarizing the above examination, the volatility of TAIEX returns exhibits conditional heteroscedastical and asymmetry.

Finally, the GJR-GARCH model is listed in Table 4 and reveals that the GJR-GARCH model is significantly negative at the 5% level on TAIEX returns around the new and full moons. The effects may promote a wait and see attitude in investors and negatively impact TAIEX returns. TAIEX volatilities associated with new and full moons exhibit a positive relationship at the 0.05 significance level. The investor have doubts about Taiwanese market

lead to both volatilities are pretty large.

During medieval times, regarding a version of full moon making human lunacy and strange behavior has spread all over for Europe. Taiwan was no exception to this tradition, with the full moon traditionally being associated with negative phenomenon such as crime, suicide and accident. Investor sentiment is instable at present. Thus, if people randomly proceed to invest, stock market uncertainty will make invest environment a high-risk result from significantly stock volatility. Investors are influenced by these superstitious beliefs, and reduce their activity around the time of the full moon, leading to reduced trading activity and consequently returns. Above

Table 4. Coefficient estimation and model test for lunar phase.

Coefficient variable	GJR-GARCH	
	Return	Volatility
New Moon	-0.0431*	5.1919**
Full Moon	-0.0545*	5.2167**
β		4.6922**
α		3.3706**
θ		7.7279**
b_1		0.0524**
b_2		7.9130**
Model diagnosis		
LB-Q(6)		6.2720
LB-Q(12)		13.3310
LB-Q ² (6)		3.2570
LB-Q ² (12)		12.6163

** (*) Denotes statistical significance at 1% and (5%) level and numbers in parentheses are asymptotic standard error. Q(6) and Q²(6) are the Ljung -Box Q statistic for the returns and the squared returns lagged 6 trading days and its critical value at 5% significant level is 12.5916. Q (12) and Q² (12) are the Ljung -Box Q statistic for the returns and the squared returns lagged 12 trading days and its critical value at 5% significant level is 21.0261.

effect conforms to the loss aversion on behavioral finance, and possible reason is that people afraid to bad investment results capital loss. Although, the influence of new moon does not experience directly to people, lunar effects also not to minimize its influence.

It affects the balance of the human body endocrine to lead the brain disorder and judgment drop. Thus, individual non-rationality investment behavior results in stock volatility expanding and investment risk rising. Investors will certainly have the conservative attitude and afraid to proceed to invest rashly which main reason is to avoid misjudge to result the property loss. In words, stock market trade is exceptionally desolate and stock returns take on the situation of down around the new moon.

Conclusion

The sample data employed in this investigation cover the period of 1998 to 2008, and this study adopts the asymmetric GARCH model for the analysis and considers the effect of lunar cycle for investor behavior is active or passive on the stock market. Finally, the empirical evidence presented in this study demonstrates that lunar cycle shows the significant and negative influence on stock returns, and stock volatility demonstrates statistically significant and positive influence. The results imply that the moon affects individual mood and thinking, and lead to stock market change. .

ACKNOWLEDGEMENTS

The authors would like to thank the National Science

Council of the Republic of China, Taiwan for financially supporting this research under Contract No. NSC 99-2410-H-034-028.

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