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Moon phase effect on investor psychology and stock trading performance

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Abstract

Purpose – This article aims to examine how investor moods and aggressiveness differ in their state and influence investor stock market performance associated with the moon phase. The mechanisms and impact of full moon gravity on investor stock trading performance are explored through an experimental approach and econometrics model.

Design/methodology/approach – A time-series quasi-experimental study, using the full moon and new moon time periods, was coupled with a psychometric test of investors' behaviours, administered through an online survey, similar to a pre-post experiment. Confirmation of the results was achieved by using an econometric model, adopted from Dichev and Janes.

Findings – This research found that investor psychology is influenced by the full moon, but no effect was recorded during the new moon phase. Confirmed by the paired *t*-difference test, the small correlation, in addition to the quantitative model, the results show the full moon impacts market behaviour during its orbital phase. Consequently, the authors surmise that the full moon does influence investor cognition and emotion disarray, mood disorders, and aggressiveness, resulting in poor stock trading performance.

Practical implications – The need for an active investment strategy is the major implication of this study. During the full moon phase, investors tend to be more aggressive and moody and seek hedonic utility instead of the traditional economics utility, meaning that they tend to follow the sentiment of the market.

Originality/value – This paper fulfils an identified need to study how the full moon affects investor stock trading performance.

Keywords Environmental economics, Social economy

Paper type Research paper

1. Introduction

The effect of the moon's gravitation on human behaviour has been an issue of fascination for many years. Often called the "Transylvanian effect" (a psychology term to describe the role of moon on human activities), intense debate has surrounded research of its link to human behaviour. In the late 1970s, researchers Campbell and Beets (1978) concluded the Transylvanian effect was a Type 1 error, but this was later refuted by Garzino (1982) who countered that the finding of Campbell and Beet was a Type 2 error. In the end, Campbell (1982) surmised that the study of the moon effect should be stopped because regression of secondary data would not identify an effect of the moon on human behaviour.

However, the effect of full moon on financial markets was pioneered in a study by Dichev and Janes (2003); two decades after Campbell's (1982) paper. By using a moon phase dummy in a regression model, Dichev and Janes (2003) found a significant relationship between the occurrence of the full moon and market returns. However, secondary data was again used to conclude the effects of the moon on investor behaviour, even though this methodology had already been discounted ten years earlier.

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Even though the Transylvanian effect still lacks a solid body of research, social science cannot ignore the role of the moon's gravity on human behaviour because 80 percent of the human body consists of water. The full moon phase produces a "biological tide" inside the human body through its gravity, which corresponds to deviant human behaviour. Note that term "lunatic" literally describes human irrationality which occurs during full moon phase.

Since the 1970s, a number of researchers have linked the moon effect with changes in human behaviour. A social science study conducted by Huston and Passerello (1971) investigated the implications of specific moon phases on human depressive and emotional states. They concluded that the full moon phase affects human behaviour, altering moods to be more depressed or emotionally disturbed. Another early study of the moon effect was Dewey (1971), who noted that more births occur during the waxing phase than the waning phase of the moon, and death rates also increase after the full moon. Other studies also show the effects of moon on generosity (Cunningham, 1979), arson activities, violence (Katzeff, 1981), accidents at work (Nogueira, 1982), anxiety and depression (Wilkinson, 1997), and the quality of life (Barr, 2000). These research findings were empirically using experimental rather than using secondary data. Note that experimental study is much robust than using secondary data because that experimental study captures the real "treatment" of moon phase on human behaviour.

In financial research, the moon effect on stock market behaviour has widely-diversified conclusions. For instance, Sivakumar and Satyanarayan (2009) examined the relationship between the moon's cycle and the Bombay Stock Exchange returns over a period of 17 years, and surmised a significant link with the returns. Gao (2009) also examined the relationship between the moon cycle and market returns of two major Chinese stock markets over 16 years, and concluded that the lunar phases did affect the stock returns. These studies showed that returns were relatively higher during the new moon and relatively lower during the full moon.

On the other hand, conflicting results of an insignificant relationship between moon phases and stock market returns are found in other research. For example, Yuan *et al.* (2006) found that returns were lower during a day with a full moon than on a day with a new moon, with the returns difference between 3 and 5 percent. Moreover, they argued that moon cycles did not affect volatility and trading volumes. Herbst (2007) also found an inconsistent association between the moon phases and market returns, and noted that daily returns' volatility movements did not correspond to the moon phases, nor was the moon cycle a reliable prediction of returns or price volatility. The results of recent research by Brahmana *et al.* (2011), which tested the full moon's influence on seven stock markets (Japan, the UK, the USA, Indonesia, Malaysia, Philippines, and Thailand), are in line with Herbst (2007), with no effect of the moon on stock market behaviour.

Examining the relationship between moon phase and decision-making can be framed by using stimuli-response theory (Dougherty *et al.*, 2005), which addresses irrationality as a result of a response to a trigger in our stimuli system. This research considers the full moon as the trigger, cognition disarray and emotion as the stimulants, and mood disturbance and aggressiveness as the responses. The consequence of these responses is biased decision-making in stock trading (Figure 1).

To examine this relationship, this research is underpinned by four psychology theories, namely, somatic market theory, Ellis' ABC model, Forgas' (1995) affection infusion model (AIM), and cognitive process hypothesis. Ellis' ABC model addresses the

stimulating events that activate irrational behaviour in humans[1], and suggests that the stimulant of full moon gravity changes investors' rationality to hedonic, which affects their decision-making in stock trading. In the somatic marker theory, strong threats from the environment create body reactions that reinforce sustained panic (Tvede, 2002). Hypothetically, it proposes that the full moon influences the cognition process, resulting in biased decision-making. Forgas's (1995) AIM describes how affection infuses into human information processing and creates biased decision-making. The AIM process, from a stimulation event (day with full moon) to the investor decision, is described in four states, which are direct access process, motivational process, heuristic process, and substantive process.

By combining elements of these theories, it is possible to describe how the full moon affects investor decision-making. First, investors are stimulated by the full moon's gravity. Receiving this stimulant, investors experience affection bias, and show moon-induced mood behaviour in their investment decisions. The outcome is that their affected decision-making generates lower stock trading performance. Hence, the hedonic decision-making on stock trading is because of the full moon's gravity, which is line with the conclusions of Debondt and Thaler (1995).

This study not only attempts to explain irrational or hedonic decision-making, but also to expand the research methodology. As literature review failed to uncover existing financial research of the moon effect, the current research is novel in three ways. First, the psychometric questions are adapted to form a questionnaire, and used in a time series quasi-experimental format. Second, unlike previous research, this research is an experimental study, strengthened with an econometrics approach (secondary data) to confirm the results under falsified epistemology. Third, this research directly surveyed investors, which made the data very robust.

Hence the aim of this study is to answer interesting but empirically challenging questions: does the moon phase have an effect on an investor? Does it change the aggressiveness or mood of investors? To answer these questions, this paper is organised as follows: Section 1 is a brief introduction; Section 2 addresses the methodology; experimental research is discussed in Section 3; Section 4 discusses the findings of the quantitative approach; the robustness check is in Sections 5-7 are the results discussion and conclusion, respectively.

1.1 Key terms definition

Before examining the moon effect on investor's irrationality, the terms used in this research are explained. The proxy of irrationality of investor is disarray of cognition and

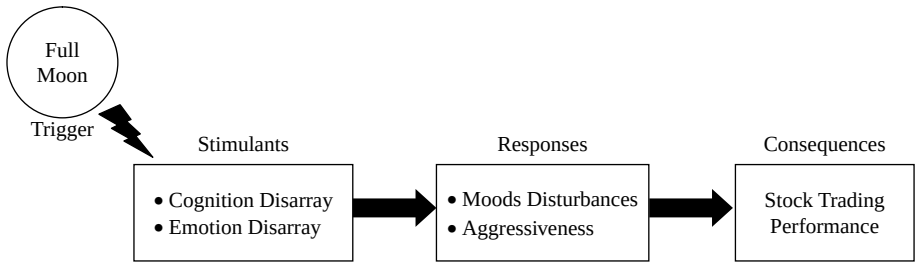


Figure 1.
Stimuli response model

Source: Adopted from Dougherty *et al.* (2005)

disarray of emotion (Tvede, 2002). The disarray of cognition can be defined as the mental behaviour involving a pattern of deviation in judgment that occurs in a particular situation. It occurs as the outcome from a lack of an appropriate mental mechanism, or from the misapplication of a mental mechanism[2]. Allinson and Hayes' (1996) questionnaire of Cognitive Style Index (CSI) was used to measure the disarray of cognition. The other proxy item, the disarray of emotion (known better as emotion), is a complex physiological experience of an individual's state of mind as a result of the interaction between hormones or biochemicals and the environment (Warr, 1987). It is exhibited by physiological arousal, expressive behaviour, and conscious experience, which are associated with personality, disposition, and motivation[3], and in psychology, an individual is considered to behave in certain ways as a result of their emotional disarray. The emotional health scale of Warr (1987) was adopted to measure the emotion.

The investor responses to the irrationality stimulants are aggressiveness and mood disorders[4], which are measured in our research by Buss and Perry's (1992) scale of aggressiveness and the psychometric of the profile of moods state (POMS). Buss and Perry's scale divides aggressiveness into physical aggressiveness, verbal aggressiveness, anger aggressiveness, and hostility aggressiveness[5]. Physical aggressiveness is a measure of the tendency to use physical force when expressing anger or aggression. Verbal aggressiveness is a personality trait that occurs when a person has feelings of disagreement as the person perceives the aggressive inhibitors and dis-inhibitors in a given situation, and is measured by the tendency to be verbally argumentative. Anger aggressiveness is an automatic response to a not-tolerated type of behaviour that can be shown by facial expression, body language, or physiological responses as acts of aggression. It is measured by anger-related arousal and a sense of control. Lastly, hostile aggressiveness refers to a behaviour which is intended to increase social dominance, internal rejection, or denial. It is measured by feelings of resentment, suspicion, and alienation – feelings that seriously undermine both physical and psychological health.

This paper measures mood disturbance by adopting the psychometric of POMS, a psychometric assessment of mood disturbance in six domains: fatigue-inertia, vigour-activity, tension-anxiety, depression-dejection, tension, and confusion-bewilderment[6]. We adopted the psychometric used by Cella *et al.* (1987) with 11 items to mimic the mood disorders precisely[7], instead of the version of POMS used be McNair *et al.* (1989) with 65 items, or Shacham (1983) with 37 items.

2. Methodology

This research utilises two methods, namely, time series quasi experimental and an econometric model. The time series quasi experimental investigates the real behaviour and its psychological role in decision-making during full moon and new moon periods, whereas, the econometric model serves as the robustness assessment to support our hypothesis testing.

2.1 Study 1: time series quasi experimental

The experimental part of the study tests whether the full moon increases investor aggressiveness and mood disorders, which then influence stock trading performance. The time series quasi method employed uses psychometric items in psychology by following previous research in cognition disarray, emotion disarray, moods, and aggressiveness.

Method and scenarios[8]. Because the manipulated variable in this research is the moon phase, two experimental periods (Figure 2) were conducted. The first experiment was conducted on 4 April 2011, during a new moon phase, and the second on the 18 April 2011, during a full moon phase. The initial sample reached 331 investors, but several samples had to be eliminated as they failed to meet two criteria. First, this research sampled only Malaysian nationals. Foreign investors, such as Singaporeans, Indonesians, British, Arabs, Indians, and other nationalities were excluded for the purpose of controlling the rational behaviour perception of investors because the different culture and customs of non-Malaysian investors may influence the heuristic or cognitive process. Second, this research only used the experiment subject (sample) who completed the psychometric test in both periods to avoid bias of the results. If investors completed only one period (full moon or new moon), they were excluded from the sample. The final tally of subjects who voluntarily participated in this study is 202 investors from Bursa Malaysia.

Each subject was given a psychometric questionnaire, which used a four-point scale, and was requested to complete the questionnaire only on the appointed dates. The timeline of the research is outlined in the following sections.

3. Time series quasi experimental result

Before final analysis of the experimental study results, reliability and validity tests were carried out to assess the goodness of the measures. The reliability test, in this study Cronbach's α, shows the consistency with which a measuring instrument measure the concept under analysis. Meanwhile, the validity tests, composite reliability (CR) and an average variance extracted (AVE), tell how well an instrument measures the particular concept (Sekaran and Bougie, 2010).

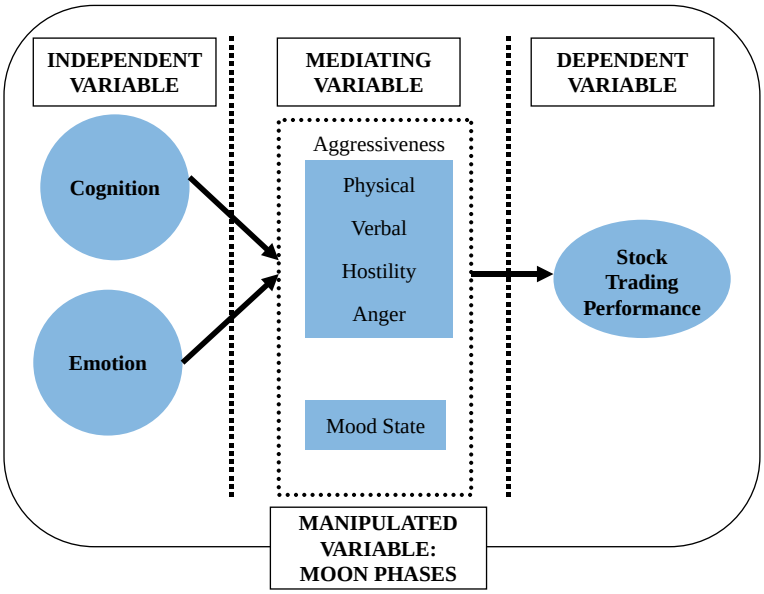


Figure 2.
Research model

3.1 Reliability analysis

The psychometric questionnaire results show a Cronbach's α value that is greater than 0.6. A Cronbach's α value higher than 0.6 is considered acceptable to confirm internal consistency (Nunnally and Berstein, 1994). Next, we conduct validity analysis. The results for both analyses are presented in Table I.

3.2 Validity analysis

The following procedures test convergent validity, the degree to which multiple items that measure the same concept are in agreement. CR and AVE were considered the most relevant tests for this study type, and are recommended by Hair *et al.* (2010). The loadings for all items exceed the required minimum values: 0.5 for the AVE threshold (Barclay *et al.,* 1995), and a 0.7 for the CR (Hair *et al.*, 2010). CR depicts the degree to which the construct indicators indicate the latent variables. Table I shows CR in the "new moon" period ranging from 0.7019 to 0.7639. Meanwhile, the CR in the "full moon" period range from 0.7043 to 0.7721. AVE measures the variance captured by the indicators relative to the measurement error. Table I shows the AVE in the "new moon" period ranging from 0.5185 to 0.6160. In the "full moon" period, the AVE values range from 0.5211 to 0.6310. Therefore, the results show that all variables in this research are valid measures of their respective constructs based on their parameter estimates (Chow and Chan, 2008).

3.3 Discriminant analysis

The discriminant validity of the measures (the degree to which items differentiate among constructs or measure distinct concepts) was calculated by scrutinizing the correlations between the measures of potentially overlapping constructs. Theoretically, the items should load more strongly on their own constructs in the model. The average variance shared between each construct and its measures should also be higher than the variance shared between the construct and other constructs (Compeau *et al.*, 1999). In short, the average variance should be higher than the square of the correlation among items.

	AVE	CR	Cronbach's α
4 April 2011 (new moon)			
Cognition	0.5980	0.7130	0.9436
Emotion	0.5811	0.7220	0.6436
Anger	0.5663	0.7019	0.7347
Verbal	0.6117	0.7558	0.7572
Physical	0.5822	0.7360	0.7113
Hostility	0.6160	0.7639	0.6910
POMS	0.5185	0.6454	0.8331
Returns	0.5217	0.6757	0.6025
18 April 2011 (full moon)			
Cognition	0.6112	0.7232	0.9436
Emotion	0.5922	0.7301	0.6436
Anger	0.5617	0.6943	0.7347
Verbal	0.631	0.7721	0.7572
Physical	0.5957	0.7465	0.7113
Hostility	0.6152	0.7601	0.6910
POMS	0.5221	0.646	0.8331
Returns	0.5389	0.6899	0.6025

Table I. Results of measurement model

This study has two tables of discriminant validity: the discriminant of the full moon set, and the discriminant of the new moon set (Tables II and III). For both sets, the AVE by the indicators measuring the construct was higher than the squared correlations for each construct, indicating adequate discriminant validity. In total, the measurement model demonstrated adequate convergent validity and discriminant validity.

3.4 Experimental estimation

This research then proceeded to test the hypotheses using path analysis. As this research is a time series quasi experimental, it has two groups of results. First, the results during the full moon are introduced, followed by the results of the psychometric questionnaire under the new moon phase.

Figure 3 and Tables IV and VI present the results of the experimental under the full moon phase. It is noteworthy that the R^2-values ranged from 0.151 to 0.212 suggesting that the trading performance could be explained by the 15.1 percent aggressiveness. Meanwhile, 13.6 percent of the anger aggressiveness, 16.2 percent verbal aggressiveness, 16.7 percent physical aggressiveness, 21.2 percent mood disorder, and 18.4 percent hostility aggressiveness can be explained by the emotional and cognition decisions of the investors. The value at the arrow (Figure 3) is the coefficient value for the model.

Table V shows the results of the experimental during the new moon phase, which are also used as the control of this study. By comparing the results of the full moon and the new moon phases, the study measures the existence of the moon effect on investors' behaviour. The statistical analysis procedural was identical to the full

Table II. The discriminant analysis of full moon data set

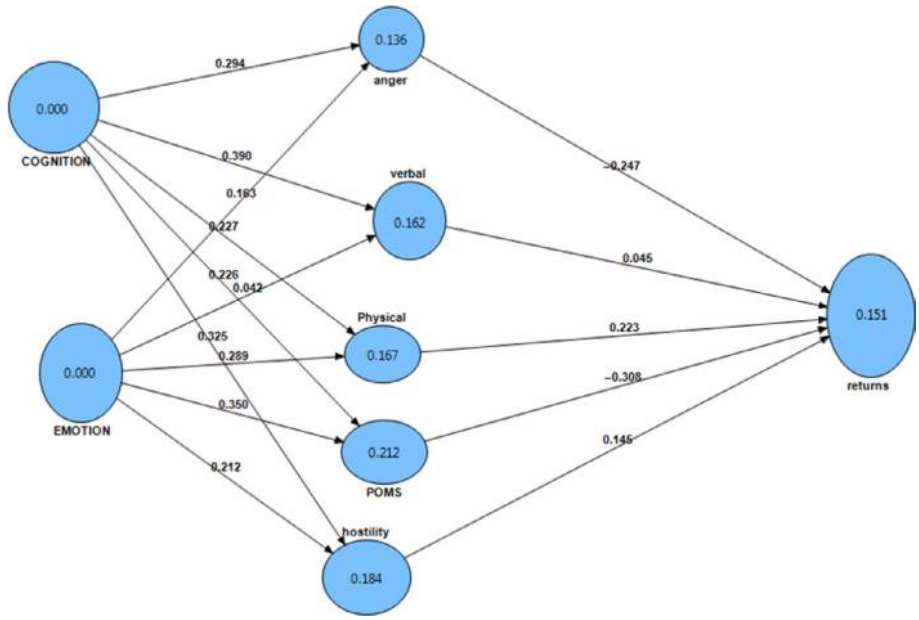
	Cognition	Emotion	POMS	Physical	Anger	Hostility	Returns	Verbal
Cognition	*0.598*							
Emotion	0.1716	*0.5811*						
POMS	0.2914	0.1640	*0.5185*					
Physical	0.3287	0.1190	0.0339	*0.5822*				
Anger	0.2560	0.0548	0.1211	0.3505	*0.5663*			
Hostility	0.2280	0.0847	0.1043	0.2767	0.3422	*0.616*		
Returns	0.4817	0.0027	0.0900	0.0137	0.0121	0.0013	*0.5217*	
Verbal	0.1318	0.0188	0.0222	0.2034	0.3600	0.1521	0.0001	*0.6117*

Note: Diagonals represent the square the AVE, while the off-diagonals represent correlations

Table III. The discriminant analysis of new moon data set

	Anger	Cognition	Emotion	Hostility	Physical	Returns	Verbal	POMS
Anger	*0.6112*							
Cognition	0.0942	*0.5922*						
Emotion	0.0001	0.0671	*0.5617*					
Hostility	0.2034	0.0328	0.0299	*0.631*				
Physical	0.1764	0.0595	0.0605	0.1218	*0.5957*			
Returns	0.0202	0.0045	0.0384	0.0037	0.0253	*0.6152*		
Verbal	0.2144	0.1102	0.0034	0.0708	0.1340	0.0014	*0.5221*	
POMS	0.0502	0.0692	0.4597	0.1600	0.1163	0.0276	0.0079	*0.5389*

Note: Diagonals represent the square of the AVE, while the off-diagonals represent correlations



Notes: The value on the line is the β-coefficient value; the value inside the balloon is R^2 -value

Figure 3.
The full moon research model

Hypotheses		β	SE	*t*-statistics	Decision
H1	Cognition → POMS	0.226	0.081	2.800	Yes
H2	Cognition → physical	0.227	0.143	1.584	No
H3	Cognition → anger	0.294	0.125	2.354	Yes
H4	Cognition → hostility	0.325	0.100	3.237	Yes
H5	Cognition → verbal	0.390	0.122	3.197	Yes
H6	Cognition → returns	−0.027	0.067	−2.400	Yes
H7	Emotion → POMS	0.350	0.091	3.841	Yes
H8	Emotion → physical	0.163	0.100	1.620	No
H9	Emotion → anger	0.289	0.139	2.080	Yes
H10	Emotion → hostility	0.212	0.109	1.979	Yes
H11	Emotion → verbal	0.042	0.132	0.316	No
H12	Emotion → returns	−0.051	0.064	−1.991	Yes
H13	POMS → returns	−0.308	0.107	−2.875	Yes
H14	Physical → returns	0.223	0.151	1.475	No
H15	Anger → returns	−0.247	0.173	−2.429	Yes
H16	Hostility → returns	0.145	0.142	2.020	Yes
H17	Verbal → returns	0.045	0.116	0.390	No

Notes: The $p < 1$ per cent if *t*-statistic <2.57; $p < 5$ per cent if *t*-statistic <1.96

Table IV.
The results of full moon

Table V.
The result of new moon

	β	SE	t-statistic	Decision
Anger → returns	0.285	0.178	1.604	No
Cognition → anger	0.332	0.166	1.924	No
Cognition → hostility	0.146	0.208	0.701	No
Cognition → physical	0.193	0.157	1.232	No
Cognition → returns	0.036	0.083	0.437	No
Cognition → verbal	0.372	0.108	3.459	Yes
Cognition → POMS	0.094	0.090	1.041	No
Emotion → anger	− 0.095	0.228	0.414	No
Emotion → hostility	0.135	0.206	0.658	No
Emotion → physical	0.196	0.148	1.320	No
Emotion → returns	− 0.166	0.077	1.156	No
Emotion → verbal	− 0.154	0.112	1.374	No
Emotion → POMS	0.654	0.060	10.908	Yes
Hostility → returns	− 0.065	0.189	0.345	No
Physical → returns	− 0.216	0.158	1.371	No
Verbal → returns	0.013	0.133	0.101	No
POMS → returns	− 0.131	0.109	1.201	No

Notes: The $p < 1$ per cent if t-statistic < 2.57; $p < 5$ per cent if t-statistic < 1.96

moon procedure, but used a different set of data (the data was taken from the psychometric questionnaire during the new moon phase).

To check for a mediation effect, the Sobel test was used to examine whether a mediator variable significantly carries the influence of an independent variable to a dependent variable, i.e. whether the indirect effect of the independent variable on the dependent variable through the mediator variable is significant. This analysis used a free source software web-calculator, found at: http://quantpsy.org/sobel/sobel.htm

Influences on market returns during full moon. A close look on the findings surmises that the coefficient value of the relationship between independent variable and full moon returns varies. The effect on returns has a negative coefficient, indicating that the higher levels aggressiveness, mood disorders, cognition and emotional decisions diminish stock trading performance.

At the 5 percent significance level, all the trader responses were considered significant and have an effect on stock market behaviour. However, two of Buss and Perry's (1992) aggressiveness measures have no significant influence on stock trading performance, namely, physical aggressiveness and verbal aggressiveness. The disarray of cognition and emotion of an investor during the full moon are shown to have a significant role on their stock trading performance, which was significantly negative at a 1 percent significance level. This suggests that an investor with greater cognition and emotion disarray will have poorer stock trading performance.

Other measures also affected stock trading performance. During a trading day with a full moon, investors were influenced by the mood disorders, anger aggressiveness, and hostility aggressiveness in a negative relationship. This means that higher levels of mood disorders and aggressiveness result in poorer stock trading performance of investors.

Influences on market returns during the new moon. The β-coefficient of the new moon returns results are of similar magnitude to the full moon phase results, however, all of the new moon model relationships were not significant, not even at

10 percent level. Instead of a significant association to the new moon returns, the results show significance to the investor responses verbal aggressiveness and mood state. This strengthens the main hypothesis that cognition and emotional disarray affects investor stock trading performance through aggressiveness and mood disorders, and it only occurs during the full moon phase. The lack of any evidence of significant influences on new moon market returns, suggests investors' decision-making was not biased during days without full moon. Hence, this indicates their rationality in stock trading would not be disturbed on a new moon day. These findings are in line with previous research, such as Herbst (2007) and Brahmana *et al.* (2012).

Does mood play a role? The findings also show whether mood played important role on stock trading performance in two different moon phases: full moon and new moon. The results document that investor mood decreases the stock trading performance during full moon phase with a *t*-statistic of 2.875 and coefficient value of 0.308, indicating that a one unit increase of mood would decrease stock trading performance by 0.308 units. Conversely, new moon results show that mood has no role in inducing stock trading performance. As there are no mood-disturbance factors (it was new moon phase), therefore, stock trading performance was not associated with mood. These findings support our hypothesis and previous research, such as Cunningham (1979).

Aggressiveness in moon-induced stock performance model. The impact of another outcome of the irrationality stimulants, aggressiveness, on stock trading performance has been examined. This research covers all the dimensions of aggressiveness characteristics, which are physical, verbal, anger, and hostility. The physical and verbal aggressiveness are the controls for the parsimony of the research because those two variables are related to psychosocial (interaction). Anger and hostility are the main variables.

The results for the different aggressiveness dimensions in each moon phase (full moon and new moon) are shown in Table IV. Physical aggressiveness, which is more an act of aggressiveness, is not significantly associated to stock trading performance at either moon phase. The same goes for verbal aggressiveness, which shows no significant relationship to stock trading performance in either moon phase. However, anger aggressiveness shows a significant relationship with a negative coefficient value (-0.247) and the *t*-statistic of -2.429. This result suggests that if the anger aggressiveness increases one unit, it might lower the investor returns by 0.247. When the dimension of aggressiveness is hostility, the association with stock trading performance is significant at a 5 percent significance level. Note that these significant relationships are only found during a full moon phase. Meanwhile, the new moon research model showed anger aggressiveness and hostility aggressiveness, physical aggressiveness, and verbal aggressiveness, did not significantly influence investor stock trading performance. In short, aggressiveness has significant relationship to stock trading performance during the full moon only, no significant association was measured during the new moon phase. The influence of anger aggressiveness and hostility aggressiveness on investors' stock trading performance during the full moon phase is congruous to previous research, such as Lieber (1978), Katzeff (1981) and Kazemi-Bajestani *et al.* (2011) whose papers address full moon influences of aggressiveness, and papers such as Dodge and Newman (1981) and Barber (2009), who address how decision-making might be biased due to aggressiveness.

The mediating effect. This research also addresses the mediating effect of aggressiveness and moods on the relationship between cognition disarray and stock

trading performance, and between emotion and stock trading performance. First, it is noteworthy that there is no mediating effect in the new moon model. This section addresses only the results of full moon model. The findings in Table VI indicate that the extent of collaboration mediated the relationship between the disarray of cognition and emotion as well as the aggressiveness and mood disorders. The physical aggressiveness has had neither a direct nor an indirect effect on stock trading performance because no paths are found to be significant. Similarly, even though the disarray of cognition and emotion plays an important role on verbal aggressiveness, it did not have a significant effect on stock trading. The method suggested by Baron and Kenny (1986) was used to assess if there is full or partial mediation.

The mediation effect check uses the Sorbel test, which reveals three important effects. First, the mood disturbances were the mediators on the relationship between the independent variables (cognition and emotion disarray) and stock trading performance, indicating a partial mediating effect. Second, two types of aggressiveness mediated the relationship of the independent variables and stock trading performance in full mediation, which are anger (in the relationship between emotion and stock trading performance) and hostility (in the relationship between emotion and stock trading performance, and also between cognition disarray and stock trading performance). The cognition and emotion did not need the full magnitude of the aggressiveness to influence the stock trading performance. Lastly, physical and verbal aggressiveness had no effect whatsoever on the relationship.

As there was no hierarchical model on the data set of the new moon, we did not run the Sorbel test to examine the mediation effect of the entire model. There were no effects of disarray of cognition and emotion on aggressiveness and mood disorders. There was also no effect detected on stock trading performance. Moreover, the aggressiveness and mood disorders did not affect the stock trading performance. As, this did not fulfil the hierarchical model requirement of Baron and Kenny (1986), we concluded that, unlike the full moon phase, the new moon did not have any mediating effect on the relationships.

Behaviour disturbances during full moon and new moon. The study results suggest there is evidence of behaviour disturbance during a full moon but not on a new moon. For example, cognition disarray was significantly associated with most of the mediating variables, such as mood disturbance, anger, hostility, and verbal aggressiveness during the full moon phase. Similarly, investor emotion plays an important role on moods,

	t-statistic	SE	*p*-value	Status
Cognition → POMS → returns	−2.006	0.035	0.045	Partial
Emotion → POMS → returns	−2.302	0.047	0.021	Partial
Cognition → anger → returns	−1.222	0.059	0.222	Full
Emotion → anger → returns	−1.178	0.061	0.239	Full
Cognition → hostility → returns	0.973	0.048	0.331	Full
Emotion → hostility → returns	0.902	0.034	0.367	Full
Cognition → physical → returns	1.080	0.047	0.280	No effect
Emotion → physical → returns	1.091	0.033	0.275	No effect
Cognition → verbal → returns	0.388	0.046	0.698	No effect
Emotion → verbal → returns	0.246	0.008	0.806	No effect

Notes: The $p < 1$ per cent if *t*-statistic <2.57; $p < 5$ per cent if *t*-statistic <1.96

Table VI.
The mediation effect on full moon model

anger, and hostility during the full moon. However, during a new moon, our results show only two significant associations. First, the relationship between cognition disarray and verbal aggressiveness is significant, and second, emotion was significantly associated to mood disturbance. Note, that even though there are significant associations between dependent variables and independent variables in new moon model, no indication of significant influence on stock trading performance was detected. New moon phase might influence cognition to induce the verbal aggressiveness, and or influence emotion to induce the moods, but these variables do not influence stock trading performance during a new moon. To account for other factors that may influence the relationships of cognition disarray, emotion, aggressiveness, and moods on the day the investors (our sample) filled in the questionnaire, paired *t*-test was employed.

4. Econometrics model results

The results of the quantitative model show the R^2-values, at 7.7 percent, imply that the independent variables (tax dummy, moon dummy, Monday dummy, and lagged returns) explain the dependent value. The *F*-value was significant at a 1 per cent level signifying the model was robust enough. These data are shown in Table VII.

The Monday, moon, and lagged returns have effects on the market returns at a 1 percent significance level, but the role of the tax dummy for market behaviour was rejected. Interestingly, the moon phase had a negative effect on market behaviour. If there was a full moon the stock market would have negative returns, and the magnitude of the full moon phase on market returns was very high with a coefficient value of 0.6.

In short, this quantitative model confirmed the time series quasi experimental study, showing that the moon phase affects market performance. This is in line with existing studies by Yuan *et al.* (2006) and Dichev and Janes (2003) who showed the moon phase affects the market.

5. Robustness: *t*-difference test

The time series quasi experimental results show that investor behaviour tends to exhibit more irrational cognitive and emotion responses during the full moon phase. The econometric model confirms the full moon, on a close orbital path to earth, has an impact on stock market performance. To further check robustness the paired *t*-test was conducted to investigate whether cognition and emotion disarray, aggressiveness,

Variable	Coefficient	SE	*t*-statistic
Tax	−0.1148	0.1187	−0.9674
Moon	−0.5965	0.1546	−3.8579***
Monday	−0.2255	0.1701	−2.3251**
RM(−1)	0.1310	0.0611	2.1444**
R^2	0.0771		
Adjusted R^2	0.0626		
F-statistic	5.3230		
Prob. (*F*-statistic)	0.0004		

Notes: The $p < 1$ per cent if *t*-statistic < 2.57; $p < 5$ per cent if *t*-statistic < 1.96

Table VII. The quantitative model result

mood disorders, and the stock trading performance of investors during the full moon period were significantly different to investor psychology during a new moon.

This test produces two important findings: first, it shows the correlation of the full moon data set and the new moon data set; second, it documents the significant differences. In terms of correlation, the range from − 0.244 to 0.065 is considered very small. And this suggests that the psychology of investors during a full moon, is different, or not correlated with their psychological thinking during new moon.

In terms of significant difference, the full moon effect on physical aggressiveness is not significantly different compared to the new moon's effect on physical aggressiveness. Meanwhile, the psychology of investors during a full moon, (verbal aggressiveness, hostility aggressiveness, anger aggressiveness, mood disorders, cognitive disarray, and emotion disarray) is significantly different to the psychology of investors during a new moon. Not only are differences in psychology displayed by investors during a full moon compared with a new moon, differences are also seen in stock trading performance (Table VIII).

6. Discussion

The results presented in this paper correspond with existing theories. First, cognition disarray influences the aggressiveness of investors and their stock market trading performance during the full moon; they are more aggressively verbal, hostile, and angry. But the cognition did not have an impact on physical aggressiveness. Such a result is in line with the "gravoreceptors" hypothesis of Campbell (1982), who suggested the role of the moon phase on humans is different from its role on the ocean. An object with momentum and accelerating experiences a stronger force of gravity from the earth than from the moon. For example, when playing tennis the earth's gravity gives a 5,012 times stronger pull than the moon's gravity (see the classical work of Lieber (1978)). This argument explains why there is no effect of physical aggressiveness in this study.

Unlike the physical aggressiveness results, other aggressiveness dimensions affected by the full moon also influence stock trading performance with the result of negative returns. Wilkinson (1997) stated that the full moon phase affects anxiety feelings, depression, and regret avoidance, which are embodied in aggressiveness manners. Higher levels of irrationality muddled investors' thinking and degraded their judgment, which translates into poor stock market performance.

The moods disturbance variable has a significant and negative impact on investor stock trading performance. As moods are the sentiment for human behaviour, being in

Table VIII. The paired *t*-test and correlation

	Mean	Paired sample *t*-statistic	Correlation
Physical aggressiveness	0.07158	0.962	− 0.055
Verbal aggressiveness	0.04947	2.176**	0.065
Hostility aggressiveness	0.01684	2.181**	− 0.112
Anger aggressiveness	0.08000	2.901***	− 0.038
Mood disorder	0.00729	3.889***	− 0.244
Cognition of behavioural	0.09219	2.660***	− 0.035
Emotion of behavioural	0.09219	2.844***	− 0.108
Returns	− 0.24909	− 4.853***	− 0.233

Notes: The $p < 1$ per cent if *t*-statistic < 2.57; $p < 5$ per cent if *t*-statistic < 1.96

a bad mood during a full moon affects the stock trading style of investors and the market performance. Previous work by Barr (2000), who noted that the moon is a comprehensive source of moods and increases the psychotic disorders of humans, supports this finding.

The same conclusions can be made from the results of the quantitative method in the interactive regression model. The full moon phase is significantly and negatively related to market returns. The findings confirms earlier work of Sivakumar and Satyanarayan (2009) who conclude that the moon cycle is linked to market returns, and DeBondt and Thaler (1995) who suggest that the finance theory is based on participants' psychology.

Further explanation of these findings draws on four existing theories: somatic marker theory, Ellis' ABC model, Forgas' (1995) affect infusion model, and cognition process hypothesis.

Somatic marker

Based on somatic marker theory, the full moon is the somatic marker of investor's behaviour. Because gravity of the full moon disturbs investors' decision-making mechanisms, they make biased decisions. This, coupled with cognition and emotion disarray, means investor's stock trading performance is negatively influenced through mood state and aggressiveness.

Ellis' ABC model

The relationship between moon, human psychology, and investment decision-making can also be explained using Ellis' ABC model. The relationship is analysed as follows. First, the full moon gravity causes humans to bias decision-making. This is known as an activating event (the A from ABC). Next, combining the biased decision-making and the beliefs of the human physiological system produces a phase where humans experience cognition and emotion disturbance. In this phase, investors change their utility objective from rational utility to hedonic utility. This is the B of Ellis' ABC model. As the belief and foundation of decision-making has been changed from rational to hedonic, investors make trades based on their feelings or moods. This is the C of Ellis' ABC model, known as the "consequence phase".

Forgas' (1995) affect infusion model (FAIM)

The results are in line also with FAIM. As the full moon influences the investor through its gravity (direct access process), it disturbs the human biological and physiological systems (motivational process), which then leads to human irrationality. This irrationality produces heuristic bias (heuristic process). Lastly, confusion within the human leads to the biased decisions (substantive process). Our findings appear to follow the same process, with the full moon influencing the mood state and cognition disarray (direct access and motivational). The mood state and cognition disarray influences investor aggressiveness, and mood disturbance (heuristic process). In the end, it affects the stock trading performance (a proof of substantive process).

Cognition process hypothesis

The fourth theory that validates our results is the cognition process, which includes four stages of how external factors influence human behaviour:

(1) sensing;

(2) neural code;

(3) cognitive code; and
(4) memory stage, where it postulates that the cognition process is driven by senses.

For instance, if the behaviour is irrational, it is because the cognition process was interrupted by incoming stimuli. Elaborating further, the sensing stage is a moment where the senses received the stimulus, which in this case is the full moon gravity. The stimulus is encoded in our brain during the neural code stage, and then transforms into energy in our physiological system, where, in this research, the energy influences cognition disarray and emotion. In the final stage, investor behaviour is affected by these psychological factors (cognition, emotion, mood, and aggressiveness), causing poor stock trading performance. This theory also underpins the hypothesis that the full moon affects the human cognition and emotion processes through mood disturbance and aggressiveness, which in turn negatively influence stock trading performance.

7. Conclusion

In summary, this study has investigated the postulation of Campbell (1982) who suggested the study of the moon phases be stopped. Contradicting Campbell's assertion, our results reveal that the effect of the full moon on human behaviour should be further investigated, especially in the area of behavioural finance. By combining time-series quasi experimental research with the traditional quantitative approach under falsification epistemology, this research has determined that the full moon affects investor behaviour. Moreover, the use of secondary data in previous studies failed to catch the moon effect because many scholars neglected the fact that the moon effect lasts for several days (a day before and after).

Cognition and emotion disarray, aggressiveness, and mood disorders have all been shown to play a role in influencing investors' decision-making and generating low market returns through the time-series quasi experimental. Interestingly, these relationships only occur on full moon phase days. Hence, it is reasonable to draw the conclusion that the full moon phase manipulates investors' emotion and cognition, producing aggressiveness and mood disorders, which through biased decision-making negatively impact stock trading.

The traditional quantitative model arrived at the same conclusion, finding investors tended to have lower returns if the trading day was under the orbital of a full moon. Moreover, the *t*-test results confirm the entire set of studies show that the mood disorders, aggressiveness, and market returns during a full moon are significantly different to the non-full moon phase.

In conclusion, this study has successfully argued that further experimental research is needed to investigate the moon effect on investor behaviour, contributing to the body of knowledge and industrial practice. Advancing the body of knowledge, the existence of moon effects on investor behaviour bridges the underlying assumption of traditional finance (rational behaviour assumption) into behavioural finance, changing it from utility maximisation to hedonic utility. These findings remark that psychological biases might occur to disturb rational decision making in investment. For industrial practice, if the moon effect on investor's irrationality is true, equity analysts should be able to construct securities evaluations based on the phases of the moon.

Notes

1. Refer to DeBondt and Thaler (1995), Tvede (2002) and Brahmana *et al.* (2012) for the explanation of using psychology theory in finance.
2. For the development and use of Allinson and Hayes (1996) work, refer to Allinson *et al.* (2000), Hayes *et al.* (2004) and Cools and Bellens (2012).
3. Refer Van Katwyk *et al.* (2000) and Shockley *et al.* (2012) for the use of the RSI of Warr (1987).
4. In finance, we see aggressiveness as the outcome of irrationality resulting in trader overconfidence or risk-value trade-off. Please refer to Benos (1998) for finance or Forman (1981) for psychology.
5. Refer to Bryant and Smith (2001) and Saleem *et al.* (2012) for the use of AGGR psychometric of Buss and Perry (1992).
6. Refer to Baker *et al.* (2002) and Tinlin *et al.* (2012) for the use of POMS questionnaire.
7. We did pre-test of McNair *et al.* (1989) and Cella *et al.* (1987) items by using students as respondents. We found two important issues. First, McNair *et al.* (1989) was too lengthy and students lost interest in responding. Second, we did cross loading factor analysis and most of the items (42 items) did not pass the criteria. Then, we conducted the Cella *et al.* (1987) metric, which is more concise. Note that the POMS test arrived at the same conclusion when measuring mood state.
8. We adopt Cunningham (1979) and Bollen *et al.* (2011) in constructing our experimental research. Instead of data mining like Bollen *et al.* (2011), we did replicate and modify Cunningham (1979) quasi experimental intuitively.

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