A study on effects of astrophysical phases in Indian stock market

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Abstract: One of the most influential parts of the famous Ancient calendar which depends on agricultural influence is lunar cycle. Lunar cycle is the time when moon goes round the earth in approximately 29.53 days and it influences human behavior more than solar motion. The beginning and end of lunar cycle are new moon and full moon phase. Many studies in the field of behavioral finance suggest that human behavior is greatly affected by astrophysical phases.

Majority of cases of extreme behavioral changes are noticed on new moon and full moon phase of the lunar cycle. This provides conclusive evidence for the fact that; human beings behave in a different way during two different lunar phases- new moon and full moon phase. It forms a base to support a popular belief that lunar phases affect human financial behavior. This study is an attempt to investigate the impact of these lunar phases on decisions of the investors regarding investments in stock market. Tools have been used to find statistically significant difference, if any, on aggregate returns, volatility of daily stock returns during new moon full moon phase and other normal days for nifty, finance, bank, reality, energy and metal sectors along with correlation of stock returns during new moon phase and full moon phase.

The study will prove to be fruitful in case statistically significant differences are observed on the daily stock returns during lunar phases as predictions about closing prices will become comparatively uncomplicated, mounting the likelihood of earning returns. It will even induce investors to increasingly invest in stock market by taking accurate buy and sell decisions and earn handsome returns.

The findings reveal statistically significant difference in aggregate and volatility of daily returns of stock prices only for some of the sectors. But high level of correlation is observed between returns of new moon phase and full moon phase.

Keywords: New moon phase, full moon phase, statistical significance, aggregate change, volatility, correlation.

I. INTRODUCTION

Calendar organization has an extensive method demanded by people of the country depending on agricultural influence, named Ancient Calendar. Lunar cycle is one of the most influential parts of this calendar and numerous ancient calendars are based on moon motion as lunar cycle naturally influences human being more than solar motion. Lunar cycle is the time of moon going round the earth in approximately 29.53 days. It influences the whole aura in the universe especially human psychology. New moon and Full moon are the beginning and end phases of lunar cycle period.

There are numerous studies which state psychological effects of lunar/astrophysical phases on human beings. There are even cases of suicide influenced by phases of the moon. These include selective exposure, selective perception, and self-fulfilling prophecy. Even diseases like asthma and gout peak around new moon and full moon (Mikulecky and Rovensky,

2000). In respect to external behaviour, evidences have shown that that abnormal human behaviour climaxes around the full moon, with rises in aggression, suicides, and mental instability (Dichev and Janes, 2003; Cao and We, 2005). Full moon is associated with crime just like it brings out werewolves in fables, as supported by studies in Florida and U.K. which have witnessed increased crime during full moon. This has provided weight to astronomical finance which is inclusive of the effect of astrophysical phases on stock returns of various indices.

Furthermore, calendar has an influence on animals, human beings and nature during new moon and full moon periods exerting far-reaching effects on outcomes in stock market, agriculture, medicine, etc. There are three types of calendars in existence – solar calendar, lunar calendar and lunisolar calendar. Solar calendars are based on tropical year or solar motion, lunar calendars are based on synodic month or lunar motion, and lunisolar calendars are integration of the two.

The Lunar cycles affects human eccentric behaviour which reaches climax around the full moon. Thus, this study is conducted to confirm the effect of lunar cycle on investors' decisions in the stock market and the effects thereon. This is to check whether Astronomical finance is applicable in the context of Indian stock market or not. From "Behavioural finance" point of view, this study is an attempt to find whether investor behaviour is affected by psychology and then this behaviour affects the finance decision and stock market (Shefrin, 2000; Jacobsen and Marquering, 2008).

Effects of astrophysical phases on investors' decisions are found for Indian economy in the study. The effect is investigated for various sectors like Nifty, Finance, Banking, Reality, Energy, and Metal to study the overall impact on GDP by the way of investors' investing decisions.

II. LITERATURE REVIEW

Synthesis between astrophysical phases and stock returns can provide indispensable design about investors' sentiments and decisions during these phases. This can be beneficial in predicting future flow of stock returns. A number of studies have been done to find relationship between investors' decisions and various natural phenomena like lunar phases as well as sunny weather. Saunders (1993) and Hirshleifer and Shumway (2001) found psychological evidence that sunny weather is associated with an upbeat mood i.e. sunshine is strongly positively correlated with stock returns Also, Kamstra, Kramer and Levi (2001) have given evidence regarding seasonal time variations of risk premia in stock market returns and documented medical phenomenon. They have found significant relationship between Seasonal Affective Disorder and stock market returns and have related yearly daylight fluctuations to stock market returns. Further it has been argued that lunar effect is an exogenous proxy for mood since lunar phases do not have tangible effects on economic and social activities (Yuan et. al. (2002)).

Ancient roots are present regarding this idea that moon affects individual sentiments and psychological behaviour of human beings. Disparate events like epilepsy, somnambulism, crime, suicide, mental illness, disasters, accidents, birth rates, fertility and lunacy are also linked to full moon phase (Lu Zheng (2002)). Recent studies like, Neal and Colledge (2009) has evidenced an increase in general practise consultations during full moon. Disproportionately high numbers of criminal offences are observed during full moon (Liber et al. (1978)). Hicks-Caskey and Potter (1992) shows that there are significantly more misbehaviours on full moon day than on any other day during lunar period indicating acting out behaviour of 20 developmentally delayed and institutionalised women.

According to a study in U.S., 49.4% respondents believe in lunar effect (Rotten and Kelly 1985) while 74% psychiatric nurses believe the same (Agus, 1973). Danzl (1985) has found that 80% of emergency department nurses and 64% of the department's doctors believe that lunar effect is observed on patients. The correlation between lunar phases and behaviours of human beings like sleep deprivation, suicides and depression leads to less valuation of financial assets (Kathy Yuan et. al. 2002).

Studies like Rotten and Rosenberg (1984) have investigated relation between lunar phases and Dow Jones average closing prices but results are not found to be significant. On the other hand, Dichev and Janes (2001) has examined the effect of lunar

phases on stock returns for different sample of countries for a different time period and results of lunar effect on stock prices are found to be significant. Similar study by Kathy Yuan et al. (2002) on a set of 48 countries has also found cyclical pattern in stock returns that corresponds to lunar phases. Further, Dichev and Janes (2003) have agreed on a crucial point stating that during the 15 days of the lunar month closest to new moon phase, the stock returns are much higher than those of other half month by as much as 10 percent a year, depending upon the stock index and number of decades included for study. It has also been argued that lunar cycle in stocks reminds about how much changes in mood can affect human behaviour in potentially irrational ways and mechanical studies have to be undertaken to avoid such irrational effect. Also, a study on G7 nations has supported the belief "lunar phases do affect human financial behaviour" as it found that volatility and average daily returns are significantly different during new moon and full moon phase of lunar cycle than other normal days. Hence, there are fertile grounds to prove that lunar phases effect human behaviour which in turn significantly effect investors' decisions stimulating the stock prices.

III. OBJECTIVES

The study intends to explore the effect of astrophysical phases on investors' decisions by the way of changes in mean returns for various sectors of Indian Economy. The market under study would be explored for a period of 5 years from 2008 to 2012. The objectives can be stated as follows:

- To investigate the aggregate mean of returns and the level of volatility over full moon period for the following sectors:

    ✓ Nifty

    ✓ Finance

    ✓ Bank

    ✓ Reality

    ✓ Energy

    ✓ Metal

- To investigate the mean of returns and the level of volatility over new moon period for the following sectors:

    ✓ Nifty

    ✓ Finance

    ✓ Bank

    ✓ Reality

    ✓ Energy

    ✓ Metal

- To investigate correlation between new moon and full moon returns.

- To investigate whether the difference between the mean returns over new moon full moon and other normal days is statistically significant.

IV. METHODOLOGY

GDP in India is affected by numerous factors but adequate representation is provided through sectors like Nifty, Finance, Banking, Reality, Energy and Metal. Daily returns from the time series of respective sectors for the period of January 2008 to January 2013 are used to calculate Mean Returns for both New Moon and Full Moon periods and paired sample correlation.

Further investigation is made whether these astrophysical phases significantly affect investors' decisions, tested out through changes in mean returns, standard deviation and relationship between new moon and full moon returns verified through paired sample correlation.

A. *The Model*

a) *Return Calculation and Descriptive Statistics*: The raw series of daily closing prices is converted into return series so as to avoid the problem of stationarity and volatility which interferes in hypothesis testing and calculation of Correlation. Returns are calculated by following equation:

$$r_t = \log(p_t) - \log(p_{t-1}) \tag{1}$$

Here, p_t= closing price of respective sectors, r_t=log returns

The descriptive statistics for the daily return series of closing prices for the sectors Nifty, Finance, Banking, Reality, Energy and Metal is carried out for the period from 2008 to 2012.

B. *Mean Returns*

Mean or average is one of the most significant tools of statistics to inspect overall changes on a particular situation. Mean returns are found for data of 5 years to investigate changes for both new moon and full moon phase in cyclical form. For a time series where X $=X_{-3}, X_{-2}, X_{-1}, X_0, X_1, X_2, X_3$ where -3 to -1 denote days pre full and new moon and 1 to 3 denote post full and new moon, mean values are found by the following equation:

$$\text{m} = \frac{1}{n} \sum_{i=1}^{n} X_i$$

Here, X_i denotes daily return series of respective sectors for full moon and new moon. Positive values of mean change indicate increase in returns and negative indicate decrease.

C. *Standard Deviation*

Standard deviation is calculated for 3 days pre and 3 days post full moon as well as new moon to inspect volatility in investors' investing decisions as per astrophysical phases by the formula:

$$S_t = \sqrt{\frac{1}{t} \sum_{i=1}^{t} (X_i - u)^2} \tag{2}$$

Here, u denotes mean from X_1 to X_t,

D. *Paired Sample Correlation*

Correlation is a tool given by Karl Pearson which measures the degree to which two data sets' observation moves together. If two data sets are found to be highly positively correlated, it implies that if one data set moves up, the other data set is also likely to move up. Correlation between log returns of new moon and full moon is calculated to assess level of correlation between the two astrophysical/lunar phases. It helps to investigate if there is a relationship between investors' decisions in accordance with full moon phase and new moon phase. Highest degree of correlation is depicted by value of paired sample correlation being equal to 1 and lowest degree is depicted by the value being 0. Correlation is calculated by:

$$r_t = [n(xy) - (\textstyle\sum x)(\sum y)] \div [\sqrt{\{n\sum x^2 - (\sum x)^2\}\{n\sum y^2 - (\sum y)^2\}}] \tag{3}$$

Here, *x* denotes new moon log returns, *y* denotes full moon log returns 3 days pre and post new moon and full moon.

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E. Hypothesis Testing

Hypothesis test is undertaken in order to determine the truth or falsity of the proposition on which the study is based. Amongst the various types of t-test, paired samples t-test is conducted to determine whether there is a significant difference in the mean value of returns during new moon, full moon phases and other normal days. The null hypothesis is represented by H_0, whereas, the alternate hypothesis is represented by H_a. The result of the test is checked by the significance probability or the p-value. The p-value is the smallest level of significance at which the observed outcome will lead to the rejection of the null hypothesis. The following hypothesis has been coined out:

H_0: There is no statistically significant difference in Indian stock market returns during new moon, full moon phase compared to other days.

H_a: There is statistically significant difference in Indian stock market returns during new moon, full moon phase compared to other days.

The paired sample t-test is conducted with a significance level of 5% (Park, 2003). If the p-value is less than or equal to 0.05, the null hypothesis will be rejected, else it will not be rejected. If null hypothesis is rejected, the proposition that new moon and full moon phases affect Indian stock market returns will be empirically true. On the other hand, if the null hypothesis is rejected, it can be inferred that the new moon, full moon phases do not affect the Indian stock market returns and the scope of earning abnormal returns during these phases will be considered void as per the test results.

V. FINDING AND DISCUSSION

A. Descriptive Statistics

TABLE 1: Descriptive statistics

Descriptive Statistics of Nifty						
	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
New moon	1239	2.5244	-1.3486	1.1758	.000443	.1213825	.015
Full moon	1239	3.3469	-1.8792	1.4677	-.003588	.1582759	.025

Descriptive Statistics of Reality						
	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
New moon	1240	5.7824	-3.0726	2.7098	-.006142	.2364242	.056
Full moon	1240	8.7168	-4.8907	3.8261	-.012974	.3496766	.122

Descriptive Statistics of Finance						
	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
New moon	1240	4.0868	-2.2775	1.8093	.000185	.1657646	.027
Full moon	1240	5.5238	-2.8134	2.7104	-.001802	.2139832	.046

Descriptive Statistics of Bank						
	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
New moon	1240	4.2019	-2.4062	1.7957	.000776	.1723648	.030
Full moon	1240	5.3631	-2.5456	2.8175	-.002085	.2202683	.049

Descriptive Statistics of Energy

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	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
New moon	1240	2.4918	-1.4414	1.0504	-.000838	.1096801	.012
Full moon	1240	4.1357	-2.5770	1.5586	-.005592	.1733259	.030
Descriptive Statistics of Metal							
	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
New moon	1240	4.5910	-2.5192	2.0718	-.002855	.1940271	.038
Full moon	1240	4.7374	-2.6438	2.0935	-.005101	.2300234	.053

B. Mean Returns

Mean or average of a time series is one of the most appropriate measures to investigate significant changes, if any, in the collected data. It is calculated using equation 2. Mean of daily return series shows aggregate changes in returns of stocks caused due to full moon and new moon phases for various sectors. It is instituted that there is no significant change in returns of stocks due to both full moon and new moon phase as mean of all sectors are very near to zero.
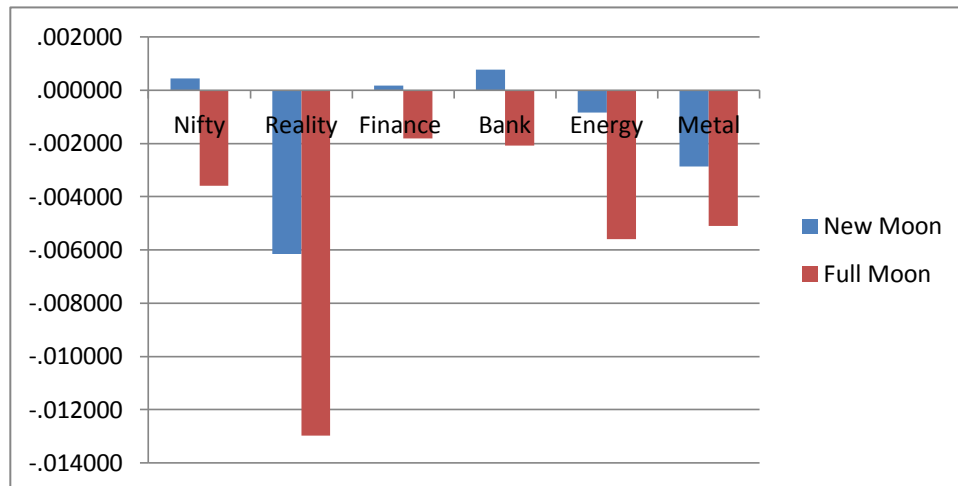

Figure 1: Mean returns for 6 sectors

Table 2: Values of Mean Returns for 6 sectors

Sectors	Mean for New Moon Period	Mean for Full Moon Period
Nifty	.000443	-.003588
Reality	-.006142	-.012974
Finance	.000185	-.001802
Bank	.000776	-.002085
Energy	-.000838	-.005592
Metal	-.002855	-.005101

It is apparent from figure 1 that all the full moon mean returns are towards the negative side, whereas, it is not the case with mean returns during new moon.

a) New Moon period

The values of mean of daily return for new moon phase of lunar cycle are found to be negligible. The negative values of reality, energy and metal sector depict the reduction in daily returns which hint towards negative perception during new moon phase in those sectors while the positive mean of nifty, finance and bank show an appreciation in daily returns, which indicates the neutral effect of new moon phase on those sectors' investors.

b) Full Moon period

The mean of daily return series calculated for various sectors is also found to be near to zero which shows no significant change during full moon phase. But the negative values reflect reduction in returns caused during full moon phase of lunar cycle, implying pessimistic view of investors caused due to full moon.

C. Standard Deviation

An appropriate and popular measure for calculating volatility of a time series data is standard deviation. Standard deviation of daily return series is generated and the daily returns are found to be marginally volatile during both new moon and full moon phases.
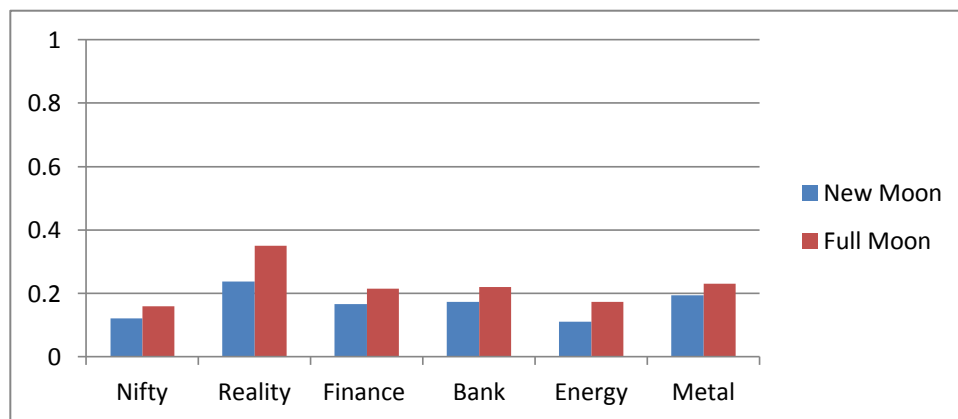

Figure 2: Standard Deviation for all 6 sectors

Table 3: Values of Standard deviation for all 6 sectors

Sectors	Standard Deviation for New Moon period	Standard Deviation for Full Moon period
Nifty	.1213825	.1582759
Reality	.2364242	.3496766
Finance	.1657646	.2139832
Bank	.1723648	.2202683
Energy	.1096801	.1733259
Metal	.1940271	.2300234

Figure 2 depicts increased volatility during full moon phase as compared to new moon phase. From this, one can infer increased pessimism among investors during full moon phase as compared to the new moon phase. However, from table 3, one can infer that the volatility is only marginal pointing towards little effect on investors' philosophy during these phases.

a) New moon period

The values are observed to be near to zero during new moon phase, which shows less volatility in daily returns of stock prices of all the sectors during new moon phase of lunar cycle. Hence, new moon period causes volatility but to a very little extent in daily returns of stock prices in these sectors.

b) Full moon period

All the calculated values are less than 1. This implies the marginal level of volatility in daily returns of stock prices is caused due to full moon phase of lunar cycle for all observed sectors.

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D. Paired Sample Correlation

Paired sample correlation helps to depict degree of correlation between two data series. It is used to find degree of correlation between return values of various sectors during full moon and new moon phase of lunar cycle.
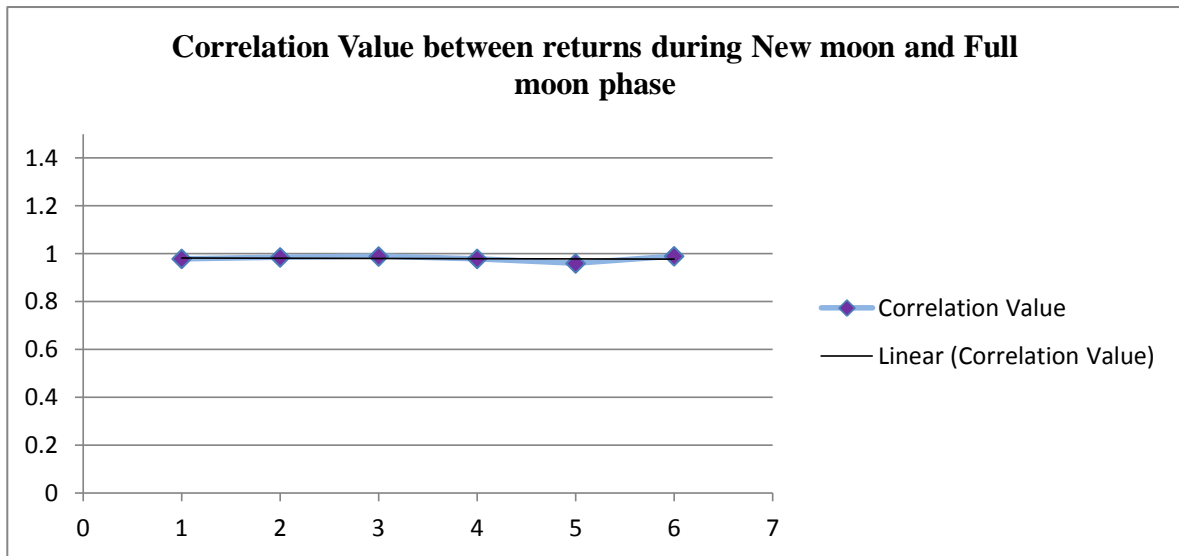

Figure 3: Paired sample correlation between new moon and full moon returns

Table 4: Values of Paired Sample Correlation for all 6 sectors

Sector	Correlation Value
Nifty	0.979
Reality	0.985
Finance	0.989
Bank	0.979
Energy	0.96
Metal	0.99

The values of paired sample correlation of all considered factors are found to be near to 1. This indicates similar co-movements in the same direction of stock returns of all the sectors considered under study. For instance, if there is a recovery during full moon phase, the recovery will continue in the new moon phase as well. The highest correlation was found in the metal sector which is almost 1 showing perfect positive correlation. This shows that there is a strong relationship between daily returns of stock during full moon phase and new moon phase for all the included sectors.

E. Paired Sample T test

Paired sample t-test depicts the statistically significant difference between the mean values of two data sets. The result is interpreted in terms of the p-value. A p-value is less than or equal to 0.05 which rejects null hypothesis and the proposition that the lastrophysical phases affect stock market returns will be accepted.

Table 5: p-values of Paired Samples t-test conducted for all 6 sectors

SECTOR	P VALUE
Nifty	0.002
Reality	0.053
Finance	0.211
Bank	0.105
Energy	0.025
Metal	0.091

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As is evident from the table, only two sectors namely Nifty and Energy have shown statistically significant difference during new moon, full moon phase and other days. On the other hand, all other sectors do not show this difference. Hence, null hypothesis is rejected in case of Nifty and Energy sector while it is not rejected in case of all other sectors. Therefore, it can be followed that under the various sectors studied, Nifty and Energy sector might provide opportunity to earn abnormal profits during astrophysical phases. However, conclusive evidence for the same requires further research.

VI. CONCLUSION

Phases of moon have numerous effects on mind of human beings, as proved by various studies of behavioral finance. New moon and full moon phases are the most influential phases of lunar/astrophysical cycle. In the study, daily stock returns of various sectors i.e. nifty, reality, finance, bank, energy and metal are considered pre and post new moon and full moon to find the effect of these astrophysical phases on returns from different viewpoints.

Tools like Mean, Standard deviation, paired sample correlation and paired sample T test are used to find the effect of astrophysical phases on investors' decisions in terms of average change, volatility, correlation and statistical significance of difference between mean values. For all sectors, tools are applied on log returns separately for full moon and new moon considering 3 days pre and post lunar phase to find out the change in stock returns caused due to new moon and full moon phase. The low and negative values of mean for both the phases depict negligible negative aggregate change in mean returns for all sectors except nifty, finance and bank sectors which have shown positive change. Values of standard deviation are also found to be very low indicating low level of change in volatility during both new moon and full moon phase. But value of paired sample correlation near to 1 has provided evidence for a significant relationship between the return values during new moon and full moon phase for all 6 sectors. Further, nifty and energy sectors have statistically significant difference in mean values unlike all other sectors.

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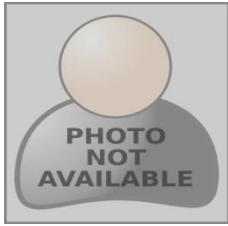
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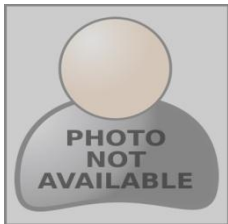
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