Stock returns and economically neutral behavioral variables: evidence from the Nepalese stock market

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Stock Returns and Economically Neutral Behavioural Variables: Evidence from the Nepalese Stock Market

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This article investigates whether or not the Nepalese stock market is efficient in weak form with respect to economically neutral behavioural variables. Simple OLS technique with White's heteroskedasticity-corrected standard errors is used to test the relationship between stock returns and economically neutral behavioural variables represented by weather (cloud cover and temperature) and biorhythms (seasonal affective disorder). The findings indicate the existence of weak-form efficiency in the market for "temperature" and "seasonal affective disorder" but not for the "cloud cover". These findings are not consistent to those of results documented for developed and emerging stock markets.

I. INTRODUCTION

There is a growing research in the field of behavioural finance that examines the effect of moods and feelings on stock market returns. These studies argue that economically neutral behavioural variables (mood proxy variables) influence the mood of investors, which in turn influence the stock returns (Jacobsen & Marquering, 2004). These variables are categorized as a continuous or of a single event (Edmans, Garcia & Norli, 2006). Examples of the continuous variable are weather (cloud cover or sunshine and temperature), seasonal affective disorder (biorhythms) and lunar cycle while that of a single event are daylight savings time changes (biorhythms), nonsecular holidays and international soccer results.

The seminal work in this aspect is that of Saunders (1993). He finds that for the US, cloud cover is significantly and negatively correlated with stock returns. Focusing on the three indices—the DJIA index, value-weighted index and NYSE/AMEX equal weighted index—he documents that less cloud cover (sunshine) is associated with higher returns and the return differences between the categories with the most cloud cover and that with

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the least cloud cover is statistically significant. He further shows that the results are robust with respect to a variety of market "anomalies" including the January, weekend, and small firm effects and are also not unduly influenced by infrequent, large returns on stock (2 percent or more). Hirshleifer and Shumway (2003) make a detailed study on the Saunders findings by focusing on the 26 international stock exchanges for the period from 1982 to 1997. [1] Using simple regression and logit model they confirm Saunders findings and also show that the results remain consistent even after controlling for adverse weather conditions such as snow and rain. The research on this was given further impetus when Cao and Wei (2004, 2005) found a statistically significant and negative correlation between temperature and stock returns. Furthermore, they show that the result is robust to various alternative tests and specifications, and it remains strong even after controlling for the geographical dispersion of investors relative to the city. In an expansion on the investigation of weather variables, recent research has argued that there is a connection between biorhythm and stock returns. For instance, Kamstra, Kramer and Levi (2000) report that stock returns following daylight savings time changes are significantly more negative due to sleep disruptions. Accordingly Kamstra, Kramer and Levi (2003) show that stock markets experience the highest returns during the short, dark days of winter and the lowest returns during the long bright days of summer. They attribute this to risk aversion resulting from Seasonal Affective Disorder (SAD). [2] In a similar vein Dichev and Janes (2001) and Yuan, Zheng and Zhu (2001) illustrate the negative relationship between stock returns and lunar phases. Further, Frieder and Subrahmanyam (2001) argue that for US, nonsecular Jewish holy days (on which the US stock market opens) have significant impact on equity prices.[3] Moreover, average return is significantly positive for the days surrounding Rosh HaShanah (Jewish New Year) and significantly negative for Yom Kippur (the Day of Atonement) and the day after. A recent study by Edmans, Garcia and Norli (2006) however use international soccer outcomes as a mood proxy variable. They document a significant decline in stock returns after soccer losses. Moreover, the loss effect is stronger in small stocks and in more important games, and is robust to methodological changes. The relationship between the stock returns and economically neutral behavioural variables has not been yet explored for the Nepalese stock market. It is the purpose of this study to test for such relationship by focusing on three mood proxy variables, all continuous: two of these are the weather variables (cloud cover and temperature) and the third one is a biorhythm variable (SAD). The benefit of use of data from single country against multi-country is that it takes into account the market structure, customs and culture specific to that country.

The paper is organized as follows. Section II discusses previous studies on the mood proxy variables and stock returns. Section III describes the data and methodology employed for the study. Section IV consists of the empirical analysis and findings of the study. The final section concludes the study.

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[1] This study tests deseasonalised cloud cover instead of absolute cloud cover. This measure is argued to lead to a more accurate measure of the relationship between cloud cover and equity prices, as it avoids the possibility of identifying a relationship that is a proxy for other seasonal affects. However, no psychological literature is cited to support this argument.

[2] The mild version is called "winter blues". SAD results from reduced sunlight or daylight hours during the fall and winter months. Details are available in Kamstra *et al*, 2003.

[3] Jews form only about 2% of the U.S. population.

II. Review of Literature

This section reviews the global findings on the relationship between the stock returns and economically neutral behavioural variables represented by weather (cloud cover and temperature) and biorhythms (SAD).

Weather and Stock Returns

Weather has long held a central place in human experience, and if lay psychology is to be believed, weather continues to be an important determinant of everyday mood and behavior in modern life (Persinger, 1980; Watson, 2000; quoted in Keller, et al., 2005, p. 724). Saunders (1993) is the first to study the effects of cloud cover on stock returns.[4] For the sample period of 1927 to 1989 (Dow Jones Industrial Average (DJIA)) and 1962 to 1989 (New York Stock exchange (NYSE) /American Stock Exchange (AMEX)), he categorizes cloud cover into two categories (0-20 and 100) and then computes average returns for each categories for three indices. He finds that very sunny weather (0-20) and totally cloudy weather (100) influences stock prices. Further the effect is more pronounced on sunny days for most of the NYSE/AMEX data. [5] Saunders shows that the findings are robust with respect to a variety of market "anomalies" including the January, weekend, and small firm effects and are not unduly influenced by infrequent, large returns on stock (2 percent or more). Kramer and Runde (1997) replicate the findings of Saunders (1993) using German data and conclude that short term stock returns are not affected by local weather and argue that results of Saunders may be due to Type I error.

Hirshleifer and Shumway (2003) make a detailed study on the weather effect by citing several psychological literatures of moods effect on decision making and then focusing on the 26 international stock exchanges for the period from 1982 to 1997. Using simple regressions and logit model they find that sunshine is very significantly correlated with stock returns. Even after controlling for adverse weather conditions such as snow and rain, they find sunshine to be very significantly correlated with both the sign and magnitude of returns. Instead of studying sunshine or cloud cover Cao and Wei (2004, 2005) examine this relationship for 8 international stock exchanges using the temperature as a weather variable.[6] They cite the relevant psychological literature and hypothesize that lower temperature is associated with higher stock market returns due to aggressive risk taking, and higher temperature can lead to either higher or lower stock returns since both aggression (associated with risk-taking) and apathy (associated with risk-averting) are possible behavioural consequences and the net impact on investors risk taking depends on

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[4] Saunders uses this weather variable because it represents or is highly correlated with those variables (hours of sunshine, humidity, precipitation) that previous research (psychological) has found to be most influential on mood. Further New York City weather is used as a proxy on the assumption that it is the "local trading agents" (marginal investors or investment professionals) on the floor of the exchanges that affect prices rather than other market participants who are geographically dispersed.

[5] But he notes that sunshine effect is insignificant in recent samples (1983-1989).

[6] This consists of New York, Toronto, London, Frankfurt, Stockholm, Sydney, Tokyo and Taipe. They also examine additional 19 stock exchanges to test the robustness of the effect. 23 of 27 international stock exchanges examined are similar to that employed by Hirshleifer and Shumway (2003). 19 of these end in 1997 whereas six end in 2001, one in 1999 and one in 2000. The starting period, however, differs for each.

the trade-off between the two. [7] The authors find that stock returns are negatively correlated with temperature: the lower the temperature, the higher the returns, and vice versa. They called this as anomaly and mention that this relationship is slightly weaker in the summer than in the winter, implying that when the temperature is high, apathy dominates aggression, resulting in lower returns. Nevertheless, a statistically significant, overall negative correlation exists between temperature and stock returns. They further show that their result is robust to various alternative tests and specifications, and it remains strong even after controlling for the geographical dispersion of investors relative to the city.

While most of the research papers document evidence of weather effect there are also counter evidences on such existence, for instance, Pardo and Valor (2003) on Spanish stock returns using sunshine hours and humidity level, Tufan and Hamrat (2003) on Turkish stock returns using cloud cover and Loughran and Schultz (2003) for NASDAQ stock returns using cloud cover. Moreover, Goetzmann and Zhu (2002) find that weather effect is due to behavior of market makers rather than individual investors. They confirm the results of Saunders (1993) and Hirshleifer and Shumway (2003) for New York City weather but when they examine database of the trading accounts of investors for the period January 1991 to November 1996, which represents about 40 percent of total individual records and includes cities from eastern and western parts of US, they find virtually no difference in the propensity to buy or sell equities on cloudy days as opposed to sunny days trading patterns attributable to the weather and hence rule out individual traders as the source of weather effect. In addition, they also ruled out institutions as likely candidates by presenting two reasons. First, they are typically assumed to be more sophisticated and less susceptible to behavioural biases than individuals. Secondly, they are geographically dispersed like individual investors so that they should also be less influenced by the local weather of New York City. Therefore the market makers act as the last candidate attributing to the source of the weather effect. For this they hypothesize that total sky cover has no significant influence on liquidity (using bid–ask spread as a measure) and examine the daily relation between the average spread change and the local New York City weather. They conclude that spread widens on cloudy days and hence the lower returns on these days.[8]

Biorhythms and Stock Returns

In an expansion on the investigation of weather-related mood proxy variables, recent research has argued that there is a connection between biorhythm (a hypothetical cyclic pattern of alterations in physiology, emotions, and/or intellect) and stock returns. This

[7] For the psychological research papers see Cao and Wei (2004, 2005). Jacobsen and Marquering (2004, p.7) argue that these research papers relate to the experiments on temperature and human behavior under extreme warm and extreme cold temperatures which investors do not frequently experience since in most countries in their study, temperatures are closer to moderate temperatures. In another study (Theissen , 2003, p.10) for German private investors, the finding is that there is no relationship between implied returns (returns based on forecast value and previous trading day) and the average daily temperature but for other prevailing weather (sunshine, cloud cover and rain) there exists relationship but not monotonic.

[8] This follows from Chordia et al. (2001, quoted in Goetzmann & Zhu 2002, p. 13) who show that there is the negative relationship between spread change and stock returns.

research can be argued to be motivated by the same arguments that motivate the research on the relationship between the weather and equity returns. The Seasonal Affective Disorder (SAD) is the biorhythm mood proxy used in this regard. The SAD (in the northern hemisphere) essentially is a seasonally recurrent depression with typical onset during the autumn or winter and remission in the spring or summer (Magnusson, 2000). The prevailing explanation of autumn-winter SAD is that it is a biological response to seasonal change in the photoperiod (hours of daylight). Research shows that rates of autumn winter SAD will tend to increase with latitude, because of the increased seasonal differences in daylight hours. Accordingly, experimental research in psychology documents a clear link between depression and lowered risk-taking behavior in a wide range of settings, including those of a financial nature. Through the links between SAD and depression and between depression and risk aversion, Kamstra *et al*. (2003) hypothesize that seasonal variation in length of day can generate seasonal variation in equity returns. [9] Using daily data from nine international stock exchanges (the sample period varies with longest time series of 70 years and shortest time series of 10 years) located at various latitudes around the world—from Sweden in the northern hemisphere to New Zealand in the southern hemisphere—they show evidence of significant SAD effect in the seasonal cycle of stock returns (i.e. stock markets experience the highest returns during the short, dark days of winter and the lowest returns during the long, bright days of summer) and it holds even after controlling for well-known market seasonals and other environmental factors. The study also finds that SAD effect is more pronounced in the markets at higher latitude (i.e. furthest from the equator) irrespective of whether market is located in the northern and southern hemispheres, although the southern markets, where the seasons are reversed, react six months out of phase. In addition they find that SAD effect is asymmetric by including the fall dummy variable. [10]

The psychological links that Kamstra *et al*. (2003) suggest have recently been criticized by Kelly and Meschke (2005). They argue that psychological (and/or medical) literature that links time varying depression to time varying risk aversion has not yet been established (although the cross-sectional relation between depression and risk aversions has been established). They also claim that other studies found that depression peaks as the SAD did not occur during the fall but during the period December-February. Jacobsen

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[9] Based on the incidence of medical evidence on SAD, this seasonal relates to the length of day, which depends on season and latitude, not with amount of *sunshine*, which depends on cloudiness (Garrett, Kamstra & Kramer, 2004).

[10] Psychological literature (Kamstra *et al.*, 2003) suggest the depressive effects of SAD and hence risk aversion may be asymmetric about winter solstice. Thus, two dates symmetric about winter solstice (December 21) have the *same length of night* but possibly *different expected returns*. In this background, Kamstra et al. (2003) anticipate unusually low returns before winter solstice (fall) and abnormally high returns following winter solstice (winter). Lower returns should commence with fall, as SAD-influenced individuals begin shunning risk and rebalancing their portfolios in favor of relatively safe assets. They expect this to be followed by abnormally high returns when days begin to lengthen and SAD-affected individuals begin resuming their risky holdings. As long as there are SAD sufferers shunning risk at some time of the year relative to other times, market returns will contain seasonals. This has been further clarified by Kelly and Meschke (2005, p.2) as follows: "With the onset of winter depression results in greater risk aversion in investors affected by seasonal depression, who therefore sell stock, decreasing prices in the fall (and hence lower expected return) as the days get shorter. As the days lengthen and the mood of the seasonally depressed investors improves in winter, they buy stock, driving up prices (and hence higher expected return). This generates cyclical pattern of lower returns in fall followed by higher returns in winter called as “SAD effect”.

and Marquering (2004) further cite the psychological literature to argue that people in positive moods and not depressed state seem to become more risk averse, the reason being that they have the emotional goal of maintaining their mood.

III. DATA AND METHODOLOGY

The equity data consists of 2587 observations of the daily closing values of Nepal Stock Exchange (NEPSE) index. The index is a value weighted and is available on daily basis for eleven years from January 23, 1995 to December 31, 2005. [11] The data are obtained from the Securities Board of Nepal. The daily logarithmetic returns on index are calculated using the following equation.

$$r_t = 100 * Ln(Index_t / Index_{t-1}) \quad \textbf{(1)}$$

where, r_t is the continuously compounded rate of change in stock market index, $Index_t$ is the stock market index at time t and $Index_{t-1}$ is the stock market index at time t-1.

The weather data consists of cloud cover and temperature and are obtained from Government of Nepal, Department of Hydrology and Meteorology. The weather station used is Tribhuvan International Airport (the latitude is 27° 41' 47.3"N) and the sample period corresponds to that of equity data. The choice for using this station is because of nearly complete data availability and because of its proximity to the city of the stock exchange. [12]

Cloud Cover or Total Sky Cover (SKC)

The SKC variable varies from 0 to 8 indicating the percentage of cloud cover; an 8 signifies cloud cover all day (overcast) and 0 indicates the absence of cloud cover all day (fine). The SKC variable under study is measured 3 hourly (the first observation of day being taken at 2.45 a.m. Nepal Standard Time (NST) with the next observations at 5.45 a.m., 8.45 a.m. and so on). For the analytical purpose we calculate the average SKC for each day from 5.45 a.m. to 5.45 p.m. NST to consider NEPSE trading hours. In addition we use the deseasonalised SKC in line with Hirsheleifer and Shumway (2003). This method is argued to capture the impact of daily SKC shock as opposed to overall seasonal impacts on returns.[13] For deseasonalizing, the average cloudiness value for each month of

[11] See www.globalfinancialdata.com for more on the construction of index.

[12] This is in line with Saunders (1993). Saunders argues that local weather effects must work through local trading agents rather than productive agents of listed firms. In addition, market participations in Nepal are much less geographically dispersed (with individual and institutional ownership of stocks mostly concentrated in Kathmandu) vis-à-vis developed markets; so Kathmandu weather is a good proxy. On this, see also Goetzman and Zhu (2002).

[13] Loughhran and Schultz (2003), however, point out two potential problems associated with this procedure. First, it is not clear that investors "seasonalize" weather observations in their heads. That is, it may not be true that investors say, "today is a sunny day in January if I account for yearly overcast trends." The weather today is either sunny or not sunny. Second, it possibly introduces a look-ahead bias into the analysis, for instance, as of the first week in January of 1984, no person could perfectly forecast early January weather patterns for the future 13 years. Not withstanding these caveats, the cloud cover data is deseasonalized as is done by other authors, for instance, Loughhran and Schultz (2003) and Goetzman and Zhu (2002).

the year is calculated; then each month's mean cloudiness is subtracted from each daily mean. For example, the average value of SKC for each month of the year (January through December) is calculated as averages of the 11 observations on SKC for that particular month of the year during our 11-year sample. Finally, the daily seasonally-adjusted SKC (SKC_t*) is computed as the SKC of a particular day minus the SKC of the month (the positive deviation means cloudier than normal day and a negative means the opposite) to which it belongs (All SKC hereafter is season-adjusted SKC (SKC_t*).

Temperature (TEMP)

TEMP variable is in degree celsius. It is measured twice each day at fixed time of 8.45 a.m. NST and at 5.45 p.m. NST. The maximum and minimum temperature observed at that time is reported as maximum and minimum temperature. We calculate the daily temperature in line with Cao and Wei (2004) as the average of maximum and minimum temperature. We then deseasonalise TEMP variable by month in the same way as that for the SKC variable and denote it by $TEMP_t$*.

Seasonal Affective Disorder (SAD)

The SAD variable (SAD_t) is based on the number of hours between sunset and sunrise in the fall and winter.[14] The SAD variable (SAD_t) is given by (Kamstra et al., 2003).

$$SAD_t = \begin{cases} H_t - 12 & \text{for trading days in the fall and winter} \\ 0 & \text{otherwise} \end{cases}$$

where H_t is the time from sunset to sunrise at a particular location (Kathmandu) i.e. number of hours of night, given by standard approximations from spherical trigonometry,

$$H_t = 24 - 7.72 \times \arccos\left[-\tan\left(\frac{2\pi\delta}{360}\right)\tan(\lambda_t)\right]$$

where δ represents the latitude north of the location from the equator (Kathmandu is 27 º 42' North); and λ_t is the sun's declination angle given by

$$\lambda_t = 0.4102 \times \sin\left[\left(\frac{2\pi}{365}\right)(\text{julian}_t - 80.25)\right]$$

where julian_t is a variable that ranges from 1 to 365 (366 in leap year) , representing the number of the days in the year. Julian_t equals 1 for January 1 , 2 for January 2 and so on.

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[14] The fall and winter period is defined as September 21 to March 20 for the Northern Hemisphere. The fall and spring equinoxes are assumed to occur on September 21 and March 21, though the timing can vary by a couple of days. By subtraction of 12, SAD_t reflects the length of the night in the fall and winter relative to the mean annual length of 12 hours. Note that by working with hours of night, as opposed to day (number of hours of day from sunrise to sunset), the expected impact of the SAD measure on returns will be positive.

IV. Empirical Analysis and Findings

The first part of this section delineates the summary statistics for the variables under the study and second part reports the empirical findings for the regression model.

Summary Statistics

The summary statistics for stock returns and weather variables are reported in Table 1. For stock returns, the mean is 0.016 percent and the standard deviation is 0.808 percent. The largest single day loss was -8.014 percent and the largest single day gain was 5.958 percent. The stock returns exhibit negative skewness and strong kurtosis. To illustrate the return progressions throughout the calendar year, the historical average daily return is plotted in Figure 1.

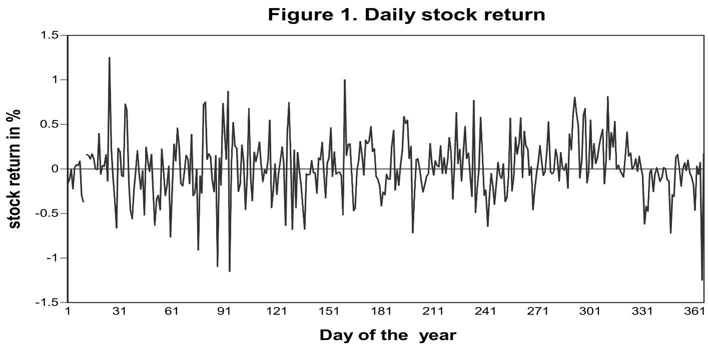
TABLE 1: Summary Statistics

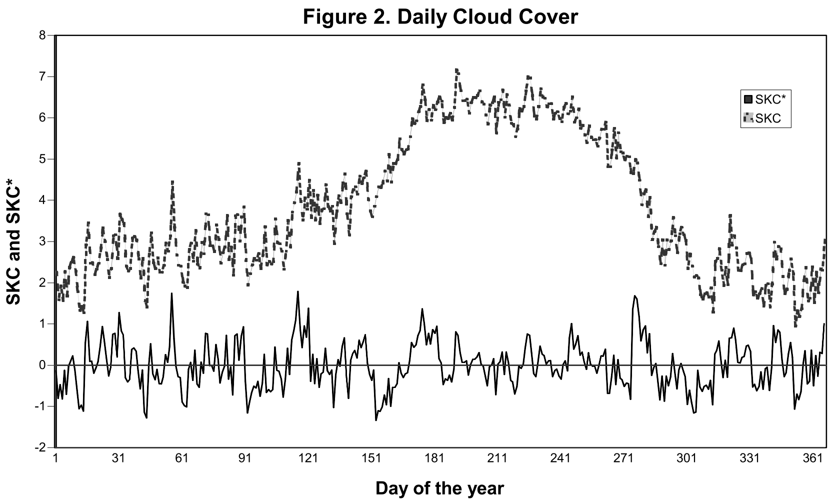
Variables	*No of Obs.*	*Mean*	*Std. Dev.*	*Min*	*Max*	*Skewness*	*Kurtosis*
Return (%)	2586	0.02	0.81	-8.01	5.96	-0.62	13.88
Total Sky Cover	3993	3.85	2.27	0.00	8.00	0.05	-1.28
Temperature (^{o}C)	3996	19.11	5.04	4.60	27.45	-0.42	-1.14

Notes: This table displays the summary statistics for the sample period Jan 23, 1995 to Dec 31, 2005. The variable described as return is daily percentage return for NEPSE index. Data regarding index are obtained from SEBO/N. The weather mood proxy variables are daily cloud cover that ranges from 0 to 8 and daily temperature in degree Celsius. Column 2 includes the number of observations for sample period and column 3 and 4 report the mean and standard deviation. Column 5 and 6 show the minimum and maximum value of the variables. The last columns 7 and 8 describe the skewness and kurtosis.

For daily cloud cover, the mean is 3.85 and the standard deviation is 2.27. The largest and lowest cloud cover was 8 and 0 respectively. The skewness is close to zero indicating the existence of symmetrical (normal) distribution while kurtosis is less strong. To illustrate the cloud cover progressions throughout the calendar year, the historical average daily cloud cover is plotted in Figure 2.

For daily temperature the mean hovers around 19°C while standard deviation is close to 5°C. The lowest temperature was 4.60°C and the highest temperature was 27.45°C. The temperature series reflects a negative skewness, indicating that it is more common to have extremely cold days than extremely hot days. To illustrate the temperature progressions throughout the calendar year, the historical average daily temperature is plotted in Figure 3. Figure 4 shows the value of the daily SAD measure. The SAD variable equals 0 at the autumn equinox (September 21), takes on higher values until it peaks at +2 on winter solstice (December 21), then takes on lower values until it equals 0 at the spring equinox (March 20) and remains at zero through the spring and summer. [15]





[15] For convenience the winter solstice is assumed to take place on December 21 whereas summer solstice to take place on June 21 although the timing may vary by a couple of days (Kamstra *et al.*, 2003).

Figure 3. Daily Temperature

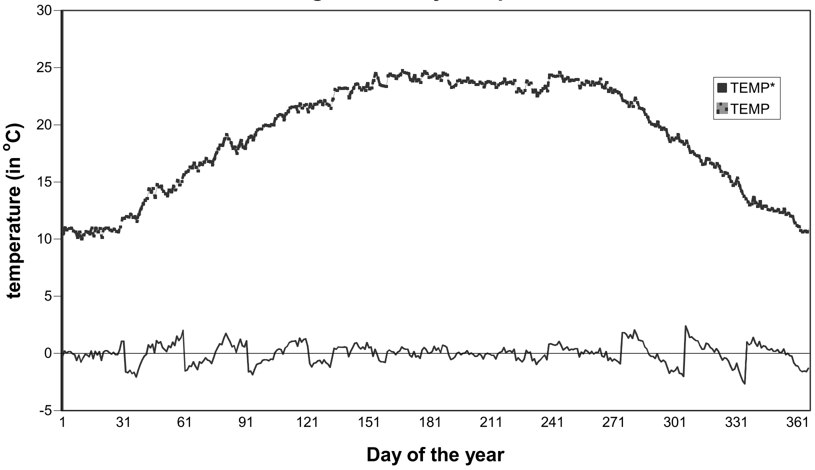
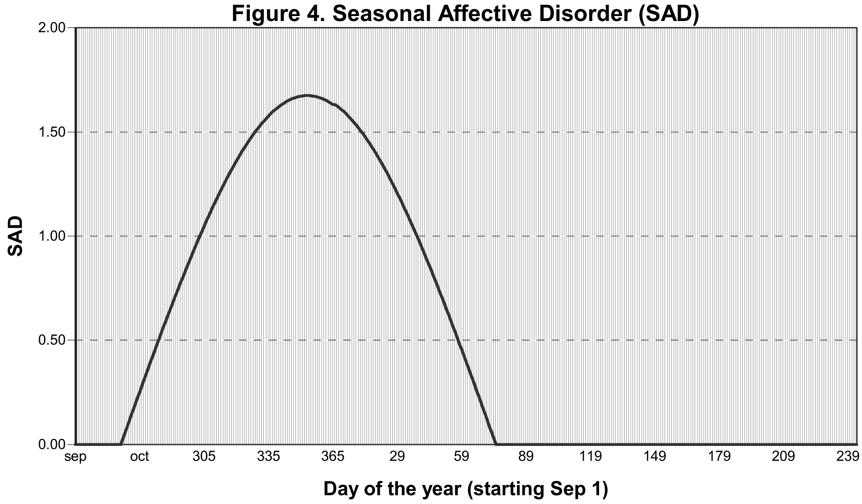


Figure 4. Seasonal Affective Disorder (SAD)



Regression Analysis

To assess the relationship between the economically neutral behavioural variables and stock returns we run the following regressions. Similar to Kamstra et al. (2003) and Cao and Wei (2004), returns (r_t) are regressed on constant (β_0), lagged returns where necessary (one lag is required for NEPSE index[16]) and each of the economically neutral variables (total sky cover, temperature, the SAD). However we do not control for the Monday effect and the tax-loss effect.[17]

$$r_t = \beta_0 + \rho_1 r_{t-1} + \beta_C SKC_t * + \varepsilon_t \tag{2}$$

$$r_t = \beta_0 + \rho_1 r_{t-1} + \beta_T TEMP_t *_t + \varepsilon_t \tag{3}$$

$$r_t = \beta_0 + \rho_1 r_{t-1} + \beta_S SAD_t + \varepsilon_t \tag{4}$$

where variables are as defined in section III except that r_{t-1} is the lagged dependent variable.

Table 2 reports the results from running the regression equations 2, 3 and 4 for the entire sample period. The results indicate that cloud cover coefficient is positive (*t*-statistic = 1.69) and significant at 10 percent level of significance, suggesting that returns increase during the cloudy days. Similar to cloud cover we also document the positive coefficient of temperature but the *t* value is not significant at the conventional level of significance. With regard to the coefficient of SAD, it is negative and statistically insignificant. The value of adjusted R^2 reported in the last column of Table 2 shows that each of the mood proxy variables explain more than eight percent of variation in stock returns. Overall the results indicate that when we include each economically neutral behavioural variables in the regression individually, we find the significant relationship (positive) for the cloud cover only but not for temperature and SAD.

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[16] The lag length is determined using Ljung-Box χ^2 test (Kelly & Meschke, 2005). For this, we first run each regression without lagged returns. If a Ljung-Box χ^2 test rejects the hypothesis of no residual autocorrelation for up to ten lags at the one percent significance level, we include another lag and repeat the procedure up to two lags.

[17] Because Joshi and K.C. (2005) and Joshi (2006) report that tax loss selling effect and Monday (day-of-the-week effect) do not exist for the Nepalese stock market (at the conventional level of significance) we do not include these non weather variable controls in our analysis.

TABLE 2: Regressions results using one economically neutral behavioural variable only: the total sky cover, the temperature and the SAD variable

Explanatory Variables	β_0	ρ_1	SKC*	TEMP*	SAD	Adj.R^2
	0.0109	0.2839	0.0154			
Total Sky Cover	0.71	15.04*	1.69***	-	-	0.0806
	0.0116	0.2842		0.0066		0.0803
Temperature	0.76	15.07*	-	0.86	-	
	0.0218	0.2838			-0.0208	0.0803
SAD	1.13	15.04*	-	-	-0.88	

Notes: This table reports the regression results of estimating a regression of daily stock returns on lagged returns and for each of the economically neutral behavioural variables (cloud cover, temperature and the SAD). The weather variables are deseasonalised (indicated by asterisk) for estimation purpose. The reported *t*-statistics are based on White's heteroskedasticity-corrected standard errors. The sample period covers Jan 23, 1995 to Dec 31, 2005.

* Significant at the 10-percent level, two-sided.

** Significant at the 5-percent level, two-sided

*** Significant at the 1-percent level, two-sided

In order to test the power of each economically neutral variables in the presence of all the other economically neutral variables we run a following regression equation.

$$r_t = \beta_0 + \rho_1 r_{t-1} + \beta_C SKC_t * + \beta_T TEMP_t * + \beta_S SAD_t + \varepsilon_t \quad \textbf{(5)}$$

Similar to Kamstra *et al*. (2003) and Cao and Wei (2004), returns (r_t) are regressed on constant (β_0), lagged returns where necessary (one lag is required for NEPSE index) and all economically neutral behavioural variables (total sky cover, temperature, the SAD). As in previous regression equations, we do not control for the Monday effect and the tax-loss effect.

Panel A of Table 3 reports the results from running the regression equation 5 for the entire sample period. The results in Panel A of Table 3 is consistent to that observed for Table 2 when economically neutral variables are included individually in the regression model. For instance, the cloud cover coefficient is positive (*t*-statistic = 1.80) and significant at 10 percent level of significance, the temperature coefficient is also positive but the *t* value is not significant and that the coefficient estimate of SAD is still negative and statistically insignificant. Moreover, the value of adjusted R^2 reported in the last column of Table 3 (Panel A) shows that mood proxy variables still explain more than eight percent of variation in stock returns. Overall the results indicate that there is significant relationship (positive) between stock returns and mood proxy variables represented by the cloud cover.

TABLE 3: Regressions results using all economically neutral behavioural variables (the total sky cover, the temperature and the SAD variable)

	β_0	ρ_1	SKC*	TEMP*	SAD	Adj.R^2
Panel A						
Entire sample	0.0193	0.2841	0.0159	0.0075	-0.0175	
period	0.98	7.09***	1.80*	0.99	-0.76	0.0808
Panel B						
First sub-period	0.0306	0.1182	-0.0002	0.0014	0.0093	
	1.24	4.24***	-0.02	0.17	0.30	0.0110
Second sub-period	0.0032	0.3842	0.0296	0.0185	-0.0260	
	0.10	15.02***	2.06**	1.26	-0.73	0.1512
Panel C						
Commercial	0.0609	0.0471	0.0434	0.0111	-0.0603	
Bank Index	1.18	0.64	1.89*	0.42	-1.19	0.0027

Notes: This table reports the regression results of estimating a regression of daily stock returns on lagged returns and three economically neutral behavioural variables (cloud cover, temperature and SAD).The weather variables are deseasonalised (indicated by asterisk) for estimation purpose. The reported *t*-statistics are based on White's heteroskedasticity-corrected standard errors. Entire sample period covers Jan 23, 1995 to Dec 31, 2005 whereas first and second subsample periods cover Jan 23, 1995 to Jun 30, 2000 and Jul 1, 2000 to Dec 31, 2005 respectively.

* Significant at the 10-percent level, two-sided.

** Significant at the 5-percent level, two-sided

*** Significant at the 1-percent level, two-sided.

To provide further evidence, we report the results for the sub-periods in Panel B of Table 3. For this purpose the entire sample period is cut into two sub-periods with the number of observations across each sub-period approximately equal. As depicted in Table 3 (panel B) the coefficient estimates of cloud cover and SAD are dissimilar across the two sub-periods. During the first sub-period, the coefficient of cloud cover is negative but not significant while that of SAD is positive, again insignificant at conventional level. Notwithstanding during the second sub-period, the coefficient estimate of cloud cover is positive (0.0296) with a statistically significant *t*-statistics of 2.06 while the coefficient of SAD is insignificant and negative. The results indicate that while the returns on cloudy days tend to be lower than that on non-cloudy days during the first sub-period, they tend to be higher than that on non-cloudy days for the second sub-period. In contrast to the cloud cover and SAD, the coefficient estimate of temperature is consistent across the sub periods; the magnitude, however, differs. The mood proxy variables are able to explain more than 15 percent of variation in stock returns for the second sub-period.

Motivated by the documentation of the significant relationship between the cloud cover and stock returns in broad index, we examine whether this effect exists in industry indices. For this we employ NEPSE Commercial Bank index as a proxy index. The results for NEPSE Commercial Bank index are consistent with previous findings on broad index. For instance, as depicted in panel C of Table 3, the cloud cover coefficient estimate is positive with a statistically significant *t*-statistic of 1.89.

In summary, the results in Table 3 indicate that the relationship between the cloud cover and stock returns is significant and positive. Moreover the result is consistent across broad index and industry index. However, the relationship across the sub-periods are different, they tend to be negative (not significant) during the first sub-period, but positive during the second sub-period. There is no striking pattern regarding other mood proxy variables viz. temperature and SAD.

V. CONCLUSIONS

In this study we extend the research on the nexus between economically neutral behavioural variables and stock returns documented in Saunders (1993), Hirshleifer and Shumway (2003), Cao and Wei (2004, 2005) and Kamstra et al (2003) by examining the Nepalese stock market. In particular we focus on three mood proxy variables, all continuous: two are the weather variables (cloud cover and temperature) and third one is a biorhythm variable (SAD). The results of our study shows that there is significant relationship (positive) between stock returns and economically neutral behavioural variable represented by the cloud cover. This finding is inconsistent to that reported by Saunders (1993) and Hirshleifer and Shumway (2003) who observed significant negative relationship between stock returns and cloud cover.

With respect to temperature and SAD variable we do not observe such significant relationship. These result are also inconsistent to the findings demonstrated in Cao and Wei (2004, 2005) and Kamstra *et al* (2003) who reported the significantly negative relationship between stock returns and temperature and positive and significant relationship between stock returns and SAD variable respectively. Interestingly, our findings are however consistent for the sub-period (the exception is first sample period) and for one of the industrial indexes.

The findings indicate that the Nepalese stock market is not efficient in weak form with respect to the one (cloud cover) of the three mood proxy variables and thus support the arguments for the inclusion of this mood proxy variable in the models of asset pricing. [18] The practical implication is that investors can benefit from becoming aware of their moods, in order to avoid mood–based errors in their judgements and trades (Hirshleifer & Shumway, 2003). However as Jacobsen and Marquering (2004) opine, many things are correlated with the seasons and it is hard to distinguish among them while trying to explain seasonal pattern in stock returns. Therefore, further research should be undertaken to confirm the results of the present study. Moreover, as many behaviorists point out, a useful direction for future experimental research will be to examine the effects of mood or weather on trading behavior (buy and hold decisions) and the extent to which investors who are primed to attend to their moods can make better decisions.

[18] This is one form of "Efficient Market Hypothesis". Other includes semi-strong form and strong form of market efficiency. For the present case, we define a market as weak-form efficient if it is impossible to achieve abnormal profits by using past prices to formulate buying and selling decisions. See Fama (1970, 1991).

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