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Are Stock Market Returns Related to the Weather Effects Factors? Empirical Evidence from Malaysia

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Abstract

In this study, we attempted to determine whether a relationship exists between stock returns and the weather variables using the econometric technique of the regression with the GJR – GARCH model. The major weather factors have been studied include temperature, rainfall and humidity in Malaysian stock market by using monthly data for the period of January 1983 until December 2008. From our findings, we find out that temperature has strong effects on stock market returns and stock return tend to be lower when the weather is extremely hot. The high or low temperature as suggested by psychologist would make people impatient and upset, thus it would affect investors behavior when they make decisions in view of the bounded rationality.We hope that our empirical findings further support the previous arguments that advocate the inclusion of economically neutral behavioral variables in asset pricing models. The results also might have significant implications for individual investors and financial institutions planning to invest in the Malaysia stock market.

Keywords: *Stock market returns, Weather factors, Regression with GJR-GARCH model*

1. INTRODUCTION

Weathers sometimes it can affect human in making a judgments, it can be sunny day, rain, cloudy, storm and snowfall. A literature in psychology considers how emotions and moods affect human behavior. According to Wright and Bower (1992), it is found that people who are in good mood make more optimistic choices and judgments than people in bad moods. Mood most strongly affects relatively abstract judgments about which people lack concrete information. It is a reality that human psychology is affected by weather conditions. The assumption that some mental illness in spring and that cloudy day adversely affect human psychology while sunny days cause positive effects and even the expectation that tsunami may occur when the weather is hot or when the humidity level is high according to Malaysian people can be shown as a simple explanation for the relationship between psychology and weather. Market anomalies in stock markets should be related to investors' trading strategies, which are based on their psychologies along with other factors. According to Dowling and Lucey (2002), the fact that some weather variables affects investors' performance and mood can also affect market prices substantially. At this point, the question whether it affects investors' psychology may be asked. Consequently, weather could be one of the reasons for market anomalies, so it should be investigated to find the evidence against Efficient Market Hypothesis.

There are several researches on weather effects on stock returns. Kamstra, Kramer and Levi (2002) claim that there is a positive effect of sunny days on stock exchange returns. They tested for 12 stock exchange indexes in two hemispheres, four of which belong to U.S. Goetzmann and Zhu (2002) have investigated weather effects on traders for five major U.S cities by using individual investors account information. They have virtually reported that there is no difference in individual's propensity to buy or sell equities on cloudy days as opposed to sunny days. However, the behavior of market makers may be responsible for the relation between returns and weather. Chang et.al(2006) also noted that temperature and

cloud cover exerted a negative effect on returns in the Taiwan stock market. Cao and Wei (2005) and Keef and Roush(2007) previously reported a negative correlation between temperature and stock returns. On the other hand, Jacobsen and Marquering(2008) have suggested that the influence of temperature may be spurious, but market anomalies are assocoated with winter and summer seasonality.
In respect of humidity, sunny, cloudy, snowy and rainy days, weather effect has been tested on stock returns and liquidity in literature. For example, Hirshleifer and Shumway(2001) have followed the same ways for 26 stock exchanges and reported that sunshine is highly significantly correlated with daily stock returns after controlling the sunshine and other weather conditions such as rain and snow, which are unrelated to returns.Dowling and Lucey(2002) have investigated weather effect on investors' mood; consequently, stock exchange returns, to use sunny, rainy days variables, humidity level and biorhythm variables for Ireland. They found that weather has an influence on investors' mood, thus on determination of share prices.

With providing evidences in favour of weather effect on stock exchange returns, there are some researches who claim that there is no effect or it can be neglected. Some samples of them are Loughran and Schultz (2003), Pardo and Valor (2002, 2003) and Kramer and Runde (1997). Loughran and Schultz (2003) have formed some portfolios with 4,949 firms' shares, which are located in 25 cities of U.S and traded in NASDAQ Stock Exchange. They have investigated weather effect on these portfolios with respect to the investors who live in the same area with firms CEO's. They have reported that there is no cloudy day's effect on portfolios returns. It is also supported by Tufan and Hamarat (2004), where they found that cloudy days are not the cause of or have no relationship with ISE 100 Index returns and also that there exists an evidence of weak from efficiency for Turkish stock market. Pardo and Valor (2002, 2003) have investigated the possible relation between weather and market index returns in the context of the Spanish market. Too see whether or not there is an influence of sunshine hours or humidity levels of stock prices, independent of trading system, they have used daily closing values of the Madrid Stock Exchange Index. They have found that there is no influence of sunshine hours humidity levels on stock prices and this result is also independent of the trading system. Negative evidence has been given by Kramer and Runde (1997). They tested on weather effect for Frankfurt Stock exchange and found that short-term stock returns are not affected by the local weather conditions. They also mentioned that the reason of presented different evidences about weather effect is used of different of statistical methods.

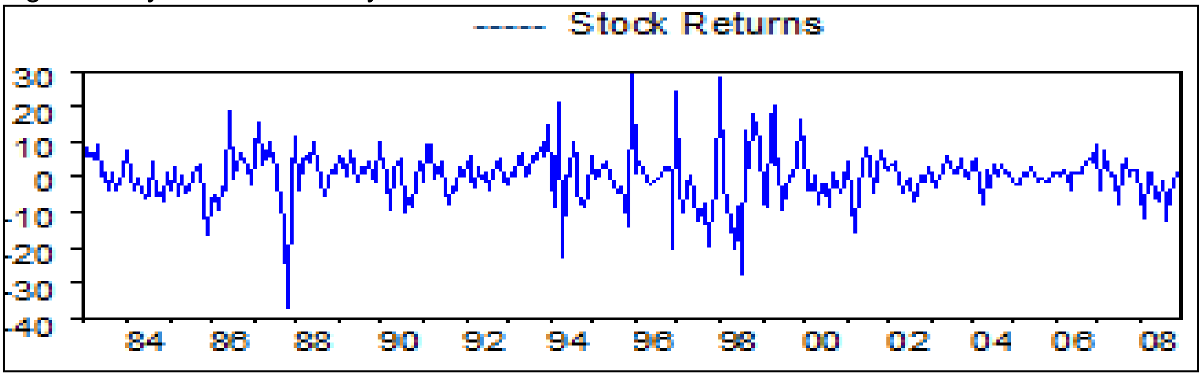
In this study, as weather factors are not an economical explanatory variable, they are generally considered dummy variable. However, there is currently no consensus in the relevant literature regarding the construction of dummy variables. Assuming that extreme weather conditions may results in more significant effects on stock return than would normal weather conditions, we generated two dummy variables for each weather factors, depending on extremely above average and extemely below average weather conditions. These two dummy variables provided additional insight into the weather effects occuring in the Malaysia stock market. In Section 2, we provide the statistical characteristics of the stock return and weather data, and discuss the weather dummy variables and methodology. In Section 3, we assess the relationship between weather and stock returns. In Section 4, we summarize the most relevant conclusions.

2. DATA

2.1 Market return

We considered the monthly closing price of the FBM Kuala Lumpur Composite Index from January 1983 until December 2008, obtained from Thompson Datastream. Figure 1 shows the monthly nominal percentage return series for FBM KLCI, that is $r_t = \ln (P_t / P_{t-1}) \times 100$ for $t = 1, 2.......T$, where P_t is the current price and P_{t-1} is the previous day's price.

Figure 1: Dynamics of mothly FBM KLCI returns



We calculated the descriptive statistics and unit root tests for sample return(Table 1). In panel A of Table 1, the sample mean of returns is small and the variance is significantly higher. The distribution of returns is not normal distributed, as is indicated by skewness, kurtosis and Jarque Bera test. The null hypothesis of no serial correlation is rejected by the Ljung-Box Q statistic, with a lag of 12 and 24 for the level of return series and the squared return series;denoted by Q(n) and Qs(n) respectively. Thus there is significant evidence of serial correlation in the level of return and squared returns. Additionally, Panel B of Table 1 provides the results of three unit root tests: Augmented Dickey fuller(ADF), Phillips Perrons(PP) and Kwiatkowski, Phillips,Schmidt, and Shin(KPSS). From the ADF and PP test, the negative values significantly reject the null hypothesis of a unit root, while the KPSS test statistics does not reject the null hypothesis of stationarity at a significant level of 1%. Thus the return series is a stationary process.

Table 1: Descriptive statistics and unit root test for FBM KLCI returns

Panel A:Descriptive statistics	
Number of observations	312
Mean	0.355682
Standard Deviation	7.371857
Maximum	29.03409
Minimum	- 36.73334
Skewness	- 0.212920
Kurtosis	7.019641
Jarque-Bera	212.4050(0.0000)*
Q(12)	25.848(0.011)**
Q(24)	43.924(0.008)*
Qs(12)	71.349(0.000)*
Qs(24)	98.421(0.000)*
Panel B: Unit Root Tests	
ADF	- 14.246 *
PP	- 14.661*
KPSS	0.061

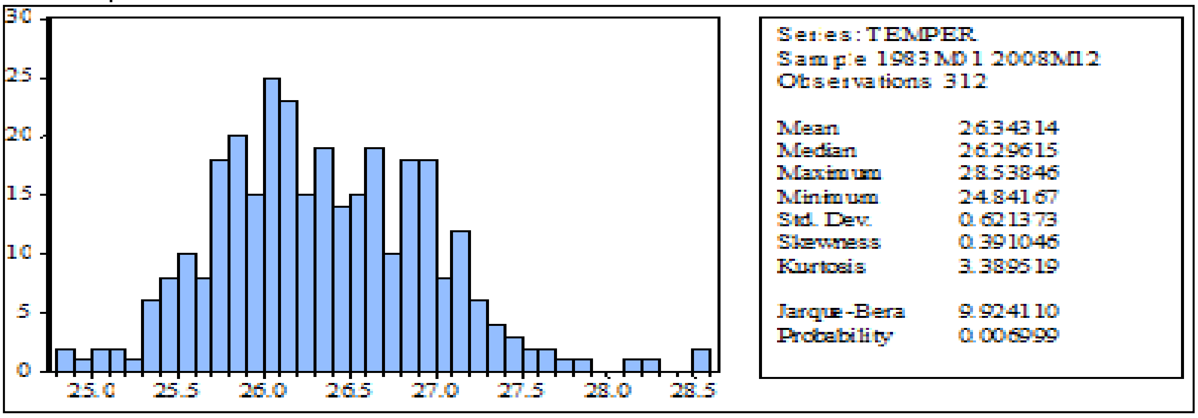
Notes: The Jarque Bera corresponds to the test statistics for the null hypothesis of normality in sample returns distribution. The Ljung-Box statistics Q (n) and Qs(n) check for the serial correlation of the return series and the squared returns up to the *n*th order. Mackinnon's 1% critical value is -3.451 for the ADF and PP tests. The critical value for the KPSS test is 0.739 at the 1% significance level.
* Indicates a rejection of the null hypothesis at the 1% significance level.

2.2 Weather variables

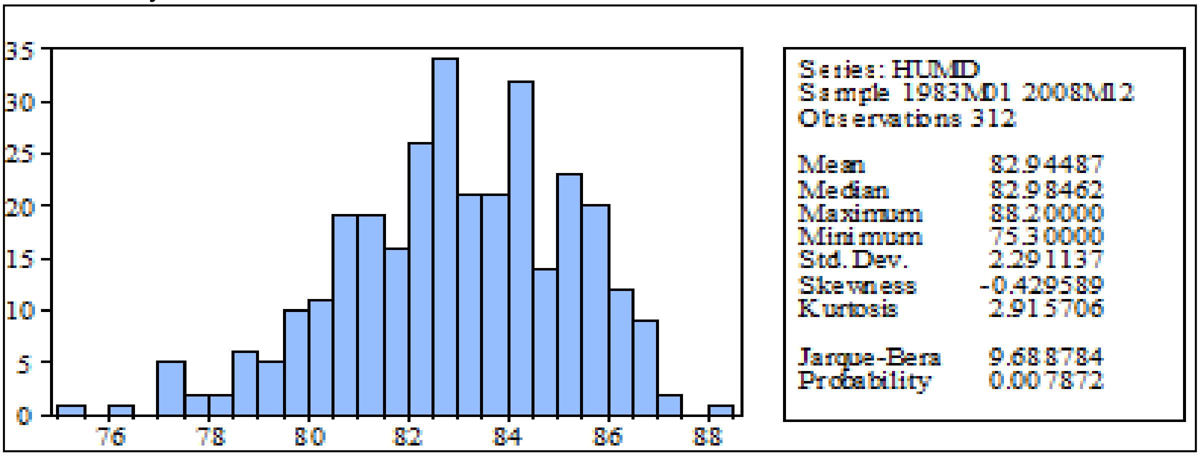
We explore the 24 hour mean weather data for temperature (TEMPER), humidity(HUMID) and rainfall (RAIN) in Malaysia from January 1983 to December 2008, obtained from the Malaysia Meteorological Department. We provide histograms and descriptive statistics for the three weather variables in Figure 2.

Figure 2: Histograms and descriptive statistics for the three weather variables

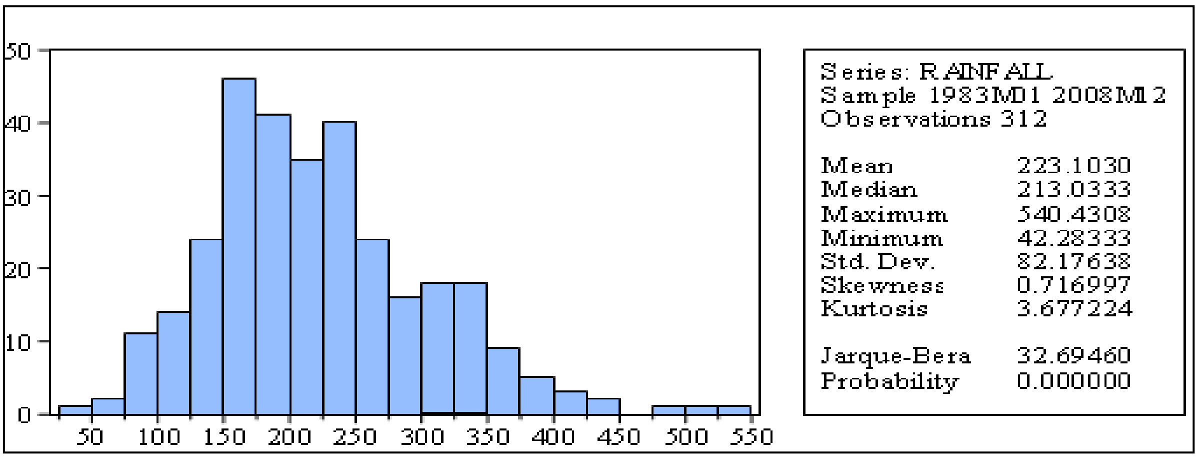
a. Temperature



b. Humidity



c. Rain



The TEMPER variable is measure in degrees Celcius. The histogram of TEMPER is skewed towards low temperature weather. The HUMID variable is the percentage relative humidity. The histogram of HUMID is skewed towards high humidity weather. The RAIN variable is measure in mm(milimeter). The histogram of RAINFALL is skewed towards low rainfall weather.

3. METHODOLOGY AND RESULTS

3.1 Unit root tests

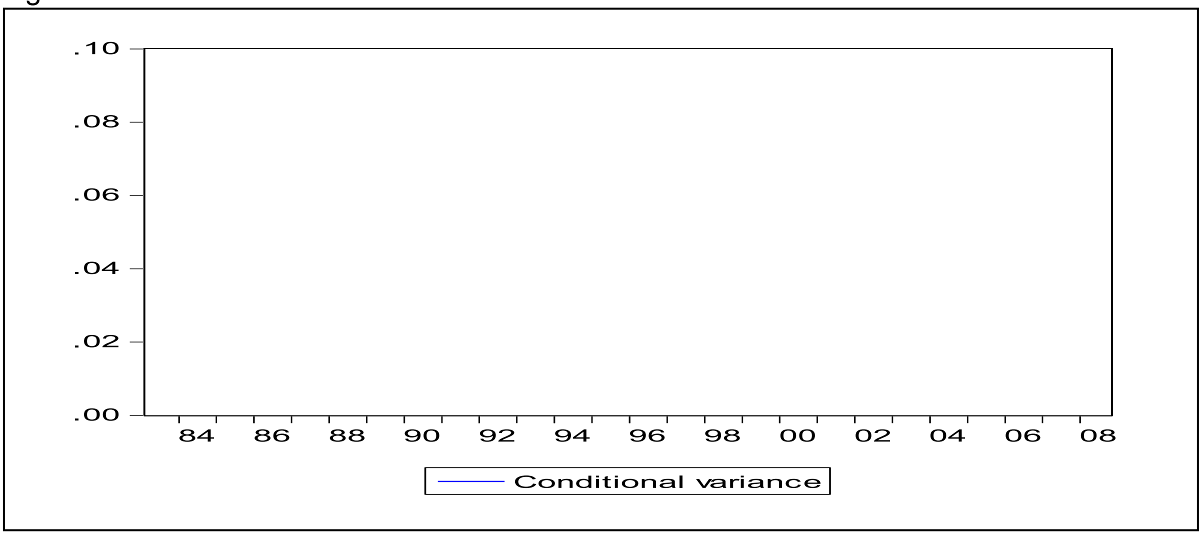
Table 2 provides the results of three unit root tests:Augmented Dickey Fuller(ADF), Philips Perron(PP), and Kwiatkowski, Phillips, Schmidt and Shin(KPSS).The null hypothesis of the ADF and PP tests is that a time series contains a unit root, I(1)process,whereas the KPSS test has null hypothesis of a stationary, I(0) process. Large negative values for the ADF and PP test statistics reject the null hypothesis of a unit root, whereas the KPSS test statistics does not reject the null hypothesis of stationarity at a significance level of 1%, Thus, all series are stationary process.

Table 2: Traditional unit root tests

	Stock return	Temperature	Humidity	Rainfall
ADF	-14.26354(0)***	-3.24(13)**	-14.28375(10)***	-13.996(11)***
PP	-14.17369(6)***	-4.8615(22)***	-8.8849(16)***	-10.638(23)***
KPSS	0.060364(3)	0.6901(5)	1.229(6)	-0.59(14)

Notes: *,** and *** indicate significance at the 10%, 5 % and 1% level respectively.
Numbers in parentheses represent the lag periods of the tests.
The lag periods of the ADF tests are determined to ensure the residuals of the test equation have no autocorrelatios;the lag periods of the PP and KPSS tests are determined by the Newey-West method.

Figure 3 : Conditional variance of stock returns



In order to determine the general relationships between stock returns and weather variables, our variables are converted to dummy variables because they are not economical explanatory variables. The dummy variables are created based on the median each weather(Wiley,2008). Assuming that below and above average weather conditions would be appropriate for an explanatory dummy variable, we can generate two dummy variables for each weather variable, as follows:

IfWLDt = Wt < median , then WLDt = 1; = 0 otherwise, and
If WHDt = Wt > median, then WHDt = 1; = 0 otherwise,

Where WLDt is a dummy variable for low average weather, and WHDt is a dummy variable for high average weather.
In order to determine the relationship between stock returns and the three weather factors, we have adopted a linear autoregressive (AR) model with the GJR-GARCH(1,1) process, as follows:

$$R t = \alpha 0 + \sum_{i=1}^{k} \emptyset i R_{t-i} + \alpha_1 \ \mathrm{WLD_t} \ + \ \alpha_2 \mathrm{WHD_t} + \varepsilon_t \qquad (1)$$

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

$$h_t = \omega + \ \delta\varepsilon_{t-1}^2 + \gamma\varepsilon_{t-1}^2 D_{t-1} + \theta h_{t-1}, \qquad (3)$$

Where R*t* is the monthly return of the FBM KLCI at time t , $\mathrm{WLD_t}$ and $\mathrm{WHD_t}$ is a dummy variable for below and above average weather variables, and ε_t is an error term. In this model, autoregressive processes [5,17,23,-23] are utilized to correct the autocorrelation of returns. In Equation (6), Ω_{t-1} is the information set at time t -1. D_{t-1} is a dummy variable, where D_{t-1} equals one if ε_{t-1} is less than zero, and D_{t-1} equals zero otherwise. This allows good news (ε_{t-1} > 0) and bad news (ε_{t-1} < 0) to have different impacts on the conditional variance. For example, good news has only an δ impact on volatility, whereas bad news has an $\delta + \gamma$ impact on volatility. Thus , if γ is significant, an asymmetric effect exist.

3.2 Preliminary analysis

The first step in our empirical analysis was to conduct a simple t-test to check for differences in returns between the two weather conditions for each weather variable. Then, we estimate the parameters of Equation (1) to examine the influence of the weather dummy variables on stock returns. Before estimating the regression model, we conducted a preliminary testing of the weather effects on stock returns. In Table 3, we assessed the t-statistics of stock return in both low and high weather conditions. From the test also it shows there is significant t-statistics value for temperature. Temperature (-0.58) indicates that low or high temperature might influence stock return. However,the insignificant t-statistics for humidity and rainfall factors exerted that this two weather factors has no influence on the returns, so we failed to reject null hypothesis .

Table 3: Test statistics for the comparison of stock returns between below average (EL) and above average weather (EH) conditions.

	Temperature		Humidity		Raining	
	EL	EH	EL	EH	EL	EH
Number obs	156	156	156	156	156	156
Mean	0.1109	0.6004	0.6310	0.0803	0.7335	- 0.0201
SD	7.59531	7.15750	6.73589	7.96959	6.98494	7.73944
t-statistic	-0.586*	0.659	0.905			

Notes: Assuming that the sample mean in below average condition is μ_1 and the sample mean in above average weather condition is μ_2, the null hypothesis of the t-test for equality is $H_0 = \mu_1 = \mu_2$.

3.3 Weather effect

We further assessed the weather effects on the FBM KLCI returns via linear regression analysis. We assessesed the weather effects for the three weather variables over the period of study(Table 4). For the influence of weather effect, the coefficient α_1 (-3.0562) for temperature was significantly negative, thereby indicate that low temperature exerted a negative influence on stock returns. By the way the coefficient α_2(0.1321) also indicate significantly positive, thereby explain that high temperature exerted a positive influence on stock return. From the results also it is evident that humidity and rainfall exerted minimal or no effects, due to the insignificance of their coefficients α_1 and α_2 .

Table 4: Weather effect on stock returns

Coefficient	Humidity	Rainfall	Temperature
α_0	31.1217	-0.160	79.09
	(25.235)	(1.943)	(29.66)**
α_1	-0.3759	0.0004	-3.0562
	(0.3111)	(0.0122)	(1.147)**
α_2	0.00979	-0.0032	0.1321
	(0.0167)	(0.0066)	(0.0530)**
F-statistic	0.385	0.8714	0.0258*

Notes: The coefficient α_1 and α_2 represent the dummy of lower weather factors and high weather factors, respectively. The F-statistic is for the joint test for coefficients α_1 and α_2. The null hypothesis is H0 is α_1 and $\alpha_2 = 0$.
Standard errors are in parentheses; *p < 0.05, ** p < 0.01

Table 5 reports the results of the GJR-GARCH model. The results show that both coefficient γ and θ are significant only in temperature weather regression models. That is, the volatility tends to be more vulnerable to unfavourable news(ε_{t-1} < 0) than favourable news (ε_{t-1} > 0). A possible finding for this phenomenon is that risk taking investors would be more speculative, and noise traders follow market price trends upon unexpected negative news in the Malaysian market. The insignificance of the residual variance tests Qs(12) and Qs(24) and ARCH(5), indicates that the GJR-GARCH model is well-specified with weather variables over the sample periods. Thus, the inclusion of weather variables may prove approriate for the modeling of volatility asymmetry in the Malaysian stock market.

Table 5: The estimated results from the GJR – GARCH model

Weather	Humidity	Rainfall	Temperature
ώ	3.1982	4315.16	0.0912
	(1.5786)*	(2877.51)	(0.0735)
δ	0.1894	0.0400	-0.1330
	(0.1258)	(0.1229)	(0.1149)
γ	-0.0971	-0.2320	0.0472
	(0.0881)	(0.1451)	(0.0998)*
θ	0.0452	0.3805	0.3848
	(0.4799)	(0.4280)	(0.5200)*
Qs (12)	171.61(0.140)	83.929(0.359)	184.18(0.297)
Qs(24)	320.44(0.167)	174.65(0.453)	386.09(0.315)
ARCH(5)	0.0500	0.4718	0.9887
	(0.9985)	(0.7972)	(0.4247)

Notes: Standard error are in parentheses and P-values are in brackets; *P< 0.05, ** P < 0.01

4. CONCLUDING REMARKS

In this study, we employed a regression model using the GJR- GARCH process on error terms model in order to determine the relationships between three weather factors and stock market returns in Malaysia using monthly data covering the period of January 1983 to December 2008. We use temperature, humidity and rainfall as the major weather factors. Empirical evidence shows that only temperature has the greatest influence on stock market returns in Malaysia. Weather is an important factor that may affect human moods, and also may affect investor’s behaviour in stock market. Overall, we found that temperature has strong effects on stock market returns and stock return tends to be lower when the weather is extremely hot. The high or low temperature as suggested by psychologist would make people impatient and upset, thus it would affect investors behavoir when they make decisions in view of the bounded rationality. Finally, our empirical findings are consistent with Chang et. al (2006), Cao and Wei (2005) and Yoon and Kang (2009) which there is significant relation between temperature and stock market returns. The empirical findings of our study fully advocate the inclusion of the economically the non economical variables in asset pricing models. In this context, this study provides in depth contributions to market anomalies with regards to weather effects in the Malaysian stock market.

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