

ANALYSIS OF WEATHER ON STOCK RETURN

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1. INTRODUCTION

Investment decision is an important factor in the finance function, because to achieve company goals by maximizing shareholder wealth that will be generated through investment activities in the company (Hidayat, 2010). In this case, people have an important role in making the investment decision process, because they always think rationally in every action, so that each decision is a rational choice. To get a rational decision, someone cannot make a decision directly, so one of the main factors that affect the mood and financial decisions of investors is the socio-psychological environment. According to the financial approach, a person's psychological influence has an important effect on investment decisions. Thus, investors' moods influence risk assumptions and provide a safe strategy for the investors themselves (Tuna, 2014).

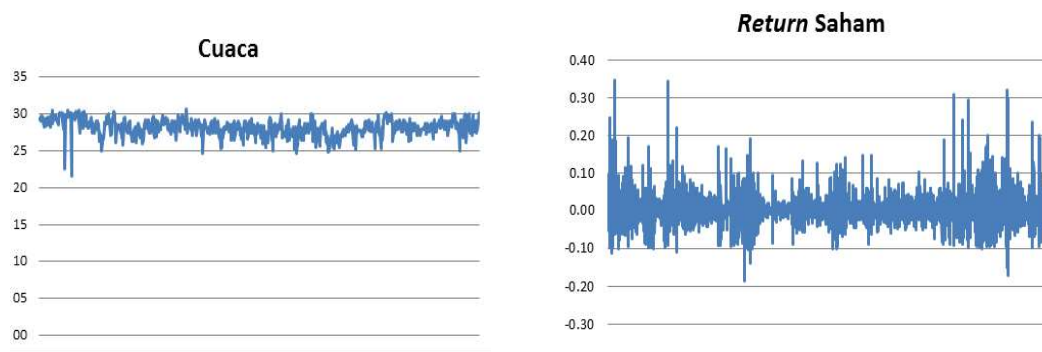
Weather is said to be one of the factors that can affect someone's mood. Howarth & Hoffman (1984) described how weather can have an effect on concentration levels and can predict an optimistic feeling in a person. The mood has an influence on the behavior or how someone makes economic decisions. In his study, Kourtidis et al. (2006) explained that with a positive mood (described through more energetic attitudes and more pleasant voice intonation), an investor is able to achieve higher stock returns. The optimistic attitude is also said to have an effect on the attainment of an investor's stock return (Goetzmann, et al., 2015).

From the study above, can be drawn an assumption that there is a relation between weather and the stock condition. Several previous studies have tested this theory with many results. There have been several studies to prove the relationship between the weather and stock conditions, including Saunders (1993) on the effects of weather on NYSE / AMEX stock indexes in New York, Keef & Roush (2002) regarding the effect of weather on stock retakes in New Zealand and Wang et al. (2012) on the effect of weather on stock risk in Taiwan. However, there are studies that do not find any influence between weather and stock conditions, including Pardo and Valor (2003) related to the stock price at the Madrid Stock Exchange (MSE) in Spain, Tufan & Humarat (2004) Stock Exchange 100 in Turkey, as well as Floros (2011) which found no direct link between weather and stock returns on the PSI20 stock index in Portugal.

In Indonesia itself, has been conducted study by Brahmana et al., (2012) to prove the effect of weather on stock return. The results show that temperature and weather can affect a certain day (called day-of-week anomaly or DOWA), which is on Monday that tends to cause fluctuation of investor's mood, thus impacting on higher stock return rate. Based on Capital Market Statistics data, it was found that the Composite Stock Price Index (IHSG) at the closing of December 29, 2017 increased to 19.99% compared to 2016. Although, IHSG experienced an increase in one of the indexes that experienced a decline, the index of agricultural sector with a decrease to -13.30% compared to 2016.

The decrease in stock indices in the agricultural sector was caused by a single sub-sector, a plantation sub-sector that is affected by weather factors in the city of Jakarta (www.investasi.kontan.co.id, accessed on 27 January 2018). Weather fluctuations that occur in the city of Jakarta affect the mood of investors in making share transaction decisions. Based on the data from BMKG Indonesia and BEI that weather data and stock returns of plantation sub-sector was fluctuated as shown by the following graph.

Graph 1.
Weather Fluctuation and Stock Return of Plantation Sub-Sector 2015-2017



It is known that the average maximum temperature of Jakarta is 30.60 ° C and the minimum temperature is 21.50 ° C. This indicates that Jakarta more often have high or hot temperature. While the highest stock returns owned by the estate sub-sector of 0.35 and the lowest stock return is -0.19. From the data of weather fluctuation and stock return above can be said that the weather and stock return have a relationship. Based on the graph above, when the temperature of Jakarta is at a high point (hot), stock return tends to increase from the number of stock demand. Conversely, when the temperature is at a low point (rain / cold), the stock return declines due to stock sales. Based on these data, it is necessary to do further study to determine the effect of weather on stock returns.

Weather changes that occur also affect the business in the plantation industry. The reason, the plantation industry is the strength and support of the national economy. In 2016, the plantation sector contributed significantly to the national Gross Domestic Product (GDP) of IDR 429 trillion. The income of the plantation sector has been able to exceed the oil and gas sectors, which amounted to only IDR 365 trillion. However, the results are still said to be a result from poor conditions due to several factors (www.mediaindonesia.com, accessed on 14 February 2018). Weather conditions have a very close relationship with the results obtained in the plantation sector. Some plantation commodities depend on the amount of rainfall and soil absorption, but it will not be good if the weather is prolonged.

Not only has an influence on the plantation industry, the effects of weather can also be felt by an investor who wants to invest. Someone will have different behavior when there is a difference of hot weather and cold weather. When bright sunlight will form a good mood for investors, investors will be optimistic and more eager to analyze stock movements that will eventually raise stock prices in the capital market (Yang, 2004).

In the explanation above can be concluded that the study related to the effect of weather on stock still shows varying results. So in this study will have a study of the weather effects in Indonesia, especially air temperature, on stock returns in Indonesia Stock Exchange. The duration of this study is based on the average daily air temperature taken from the Meteorology Climatology and Geophysics Agency (BMKG).

2. LITERATURE REVIEW

a. The effect of weather on stocks

There are various weather elements used in the previous study, which generally use elements of the cloud state (Saunders, 1993, Keef & Roush, 2002; Hirsleifer & Shumway, 2003; Pardo & Valor, 2003; Tufan & Humarat, 2004; Tuna, 2004; Goetzmann et al., 2015; Keef & Roush, 2007), wind speed (Keef & Roush, 2002; Sariannidis et al., 2016), humidity levels (Pardo & Valor, 2003; Tuna, 2004; Sariannidis et al., 2016), as well as air temperature.

The study using clouds as an element of weather has generally been conducted in various countries, including Hirsleifer & Shumway (2003) in 26 major cities in the world, including New York, Paris, Melbourne, and Kuala Lumpur. The results generally show that the cloud conditions have a positive effect on stock conditions. This can be explained because the psychological state can affect investor behavior, a bright day can provide a good mood for someone, and a good mood will cause a positive reaction to the news in circulation (Saunders, 1993; Hirsleifer & Shumway, 2003; Goetzmann et al., 2015).

Meanwhile, the result of Tuna (2004) explained that the mood of investors affects the perception of risk and gives instinct to create a safe strategy for investors. The financial behavior approach explains that there is a relationship between weather and returns. Environmental factors such as rain, snow, humidity, sunny or cloudy days are thought to affect investors' moods. However, there are studies that explain that there is no relationship between the state of clouds to stock prices (Tufan and Humarat, 2004; Pardo & Valor, 2003; Keef & Roush, 2002; Kourtodis, Sevic & Partalidou, 2016), which indicate the rational behavior of investors in the stock market.

Results of study using wind speed indicators have been conducted in New Zealand (Keef & Roush, 2002). The results showed that wind speed has a significant effect on stock return, that the higher the wind speed the lower the rate of stock return. However, Keef & Roush (2002) explained that wind velocity cannot be directly linked to stock returns, but may have an effect on investor pessimism or optimism, which has an impact on the company's future cash flow and discount rate. The results of this study are also reinforced by Sariannidis et al. (2016) conducted on stock exchanges in Europe. However, Sariannidis et al., (2016) explained that the psychological aspects of an investor can influence in making investment decisions.

Sariannidis et al., (2016) explained that the impact of weather conducted in New Zealand using the air humidity shows a positive relationship between air humidity and the rate of returns. The level of humidity described can encourage investors to become more aggressive, resulting in an increase in stock returns. But in contrast to the results of Pardo & Valor's (2003) study, the humidity level has no effect on stock trading that indicates investors' rational behavior.

b. The effect of temperature on stock return

There are some different results related to the influence of air temperature on stock return. Keef & Roush (2002) study showed that there is a correlation between air temperature and stock returns in New Zealand. It is said that the higher the air temperature the lower the value of stock index. This can happen especially in countries with hotter temperatures, such as Singapore or Kuala Lumpur. Kang et al. (2009) also found a correlation between weather (including temperature, humidity level, cloud state and radiation time or sunshine) to the trade return rate in Shenzhen, which is described as a weather impact on investors' emotional condition.

However, there are also study results explained that air temperature has no effect on stock returns. Cao & Wei (2005) tested the theory that low temperatures can be associated with high returns, and higher temperatures can be attributed to low returns, but this study found no correlation between air temperature and returns. It is explained that the temperature has no effect on the investors, because generally the office workers have been equipped with a room that has a cooling or heating system to adjust the comfort to air temperature. Floros (2011) also noted that there is no direct relationship between air temperature and returns in Portugal, but it was found that the effect of temperature in January had an impact on higher returns. Investors are described as being more aggressive in January, impacting on the high rate of returns to the month.

The study in Indonesia has also found that there is no positive correlation between weather and returns, which means that stock market trading does not depend on weather conditions (Brahmana et al., 2012). But the study also found that weather can affect investors' moods on certain days such as Monday when higher temperatures (referred to as day-of-the-week anomaly or DOWA), have an impact on market returns that are higher than other days. The previous study findings on the effect of air temperature on stock returns are shown in Table 1. below.

Table 1. Summary of Past Research Results

No	Researcher	Weather Dimension	Duration of study	Stock Index	Study Results
1	Keef & Roush, 2002	Cloudy weather, air temperatures, and wind conditions	June 1968 – October 2002	New Zealand Stock Exchange	Wind and air temperature conditions have a relationship with the stock index on the New Zealand Stock Exchange.
2.	Cao & Wei, 2005	Air temperature	July 3, 1962 – July 9. 2001	8 international stock markets, including America, Canada, UK, Germany, Sweden, Australia, Japan and Taiwan	The air temperature is not affected to stock return level in 8 international stock market.

No	Researcher	Weather Dimension	Duration of study	Stock Index	Study Results
3.	Apergis & Gupta, 2007	Combination of daily temperature data, wind speed, rainfall, humidity, and cloud conditions	January 2, 1973 - December 31, 2015	South Africa stock in New York Stock Exchange	Weather (including daily temperature, wind speed, rainfall, humidity levels, and cloud conditions) were found to have an effect on South African stock returns in New York.
4.	Kang <i>et al.</i> , 2009	Temperature, humidity level, cloud state and duration of irradiation	January 1999 - December 2008	Hong Kong and Shenzhen stock market	The weather (including temperature, humidity, cloudiness and sunshine) influences the Shenzhen market.
5.	Floros, 2011	Air temperature	January 1, 1995 – July 31, 2007	The PSI20 stock index on Lisbon Stock Exchange	Air temperature has no direct effect on the rate of return of stock PSI20, but the air temperature in January have an influence on the mood of investors, which is shown through a higher return value at month.
6.	Brahmana <i>et al.</i> , 2012	Air temperature	January 1999 - December 2015	Indonesia Stock Exchange	Temperature has no direct effect on market return rate in Indonesia
7.	Wang <i>et al.</i> , 2012	Rainfall, duration of irradiation and air temperature	2001-2007	TAIEX (Taiwan) stock index	Air temperature has no effect on stocksets, but has an effect on stock volatility.

No	Researcher	Weather Dimension	Duration of study	Stock Index	Study Results
8.	Apergis <i>et al.</i> , 2016	Combination of daily temperature data, wind speed, rainfall, humidity, and duration of exposure	September 2000 - December 2013	58 stock indexes on the markets of New York and London	Weather (including daily temperature, wind speed, rainfall, humidity level, and duration of irradiation) were found to have an influence on international stock exchange returns.

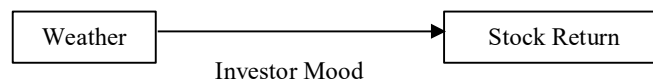
3. RESEARCH FRAMEWORK

This study uses daily weather data in the city of Jakarta and returns of plantation sub-sector shares in the period from 29 August 2015 to 1 November 2017. Previous study (Keef *et al.*, 2002; Apergis & Gupta, 2007; Kang *et al.*, 2009; Apergis *et al.*, 2016) stated that the weather effect on stock returns. While study (Cao & Wei, 2005; Floros, 2011; Brahmana *et al.*, 2012; Wang *et al.*, 2012) stated that the weather has no effect on stock returns. Thus, this study needs to be retested in the context of plantation sub-sector. Hence the hypothesis of this study as follows.

H₀: Weather has an influence on stock returns in the plantation sub-sector.

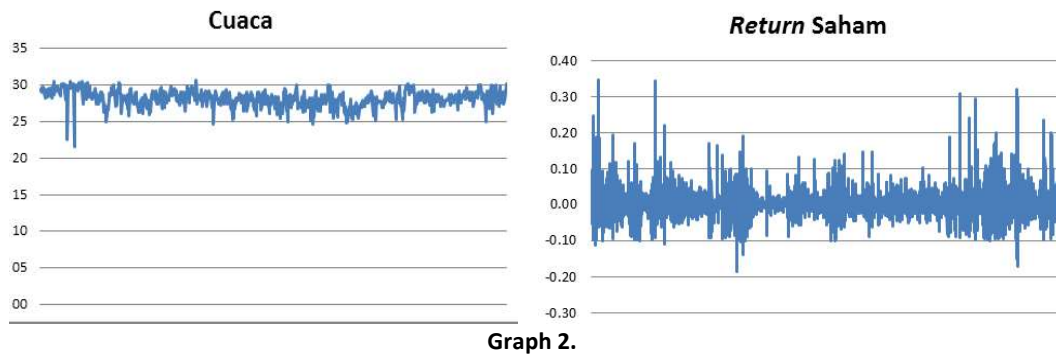
H₁: Weather has no effect on stock returns on plantation sub-sector.

From the 8 studies support the hypothesis in this study that the weather effect on stock returns. Changing weather conditions can affect a person's mood (mood). When a person has a positive mood, it makes someone think positive and more passionate about their activities, while negative mood tends to make people feel pessimistic and uninspired. This can be felt by an investor who wants to invest in a business. Good and bad mood of an investor who is affected by weather conditions can affect stock returns. Mood can be said to be one factor for investors in determining decision-making that will affect the rise and fall of a company's stock demand. A rising stock demand will lead to a rise in stock prices and an impact on rising stock returns.



4. FINDINGS AND DISCUSSION

In this study obtained the results of descriptive statistical analysis based on Jakarta weather fluctuations and fluctuations of stock returns in the period August 29, 2015 - November 1, 2017 as follows.



Based on the weather fluctuation chart from BMKG Indonesia data, Jakarta in the period of August 2015 to October 31, 2017 has an average temperature of 28.08 ° C, with the maximum temperature conditions occurring on May 19, 2016 and the minimum temperature conditions occurring on October 23, 2015 amounting to 21.5° C. Seen from the graph of weather fluctuation shows the weather trend in that period tends to decrease at the end of 2016 until early 2017 which then rise again in the middle of 2017. As for the return data of shares of plantation sub-sector has average value of 0.00. Meanwhile, the minimum return value of shares of plantation sub-sector of -0.19 or -19% obtained by PT. Provident Agro, Tbk on March 27, 2017. The maximum return value of shares of plantation sub-sector of 0.35 or 35% obtained by PT. BW Plantation, Tbk on January 26, 2016.

To prove the result of study need to be tested hypothesis influence of weather to stock return. But before doing hypothesis testing, it is necessary to test chow using Eviews 8.0 application to determine using common effect or fixed effect. The chow test shows the probability of 0.4370 which is where Prob. > 0.05, then chow test does not suggest using fixed effect and better use common effect. Because the chow test suggests to use a common effect, it is necessary to test Lagrange multiple to determine the use of common effects and random effects. The result of Lagrange multiple test obtained result at Breusch-Pagan both equal to 0.0000, so Breusch-Pagan <0.05 (5% significant level) hence concluded that Lagrange multiple test suggested to use random effect.

From the results using random effect model obtained results that show the panel data regression and the coefficient of determination as follows.

Table 2. Random Effect Test Results

Dependent Variable: Y
Method: Panel Least Squares
Date: 02/07/18 Time: 21:14
Sample: 2015 2016
Periods included: 2
Cross-sections included: 4794
Total panel (balanced) observations: 9588

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.016272	0.014131	-1.151473	0.2496
X	0.000598	0.000503	1.188119	0.2348

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.394357	Mean dependent var	0.000514
Adjusted R-squared	-0.211413	S.D. dependent var	0.026316
S.E. of regression	0.028964	Akaike info criterion	-3.938660
Sum squared resid	4.020966	Schwarz criterion	-0.353778
Log likelihood	23676.94	Hannan-Quinn criter.	-2.722658
F-statistic	0.651001	Durbin-Watson stat	3.072234
Prob(F-statistic)	1.000000		

Source : Data by writer, 2018

Based on the test data in Table 2, we can see the regression equation of panel data as follows.

$$Y = - 0,016272 + 0,000598 + e$$

The value of weather regression coefficient (X1) expressed positive effect on stock return of company sub-sector of plantation. This indicates if the weather variables rose by 1 unit then the return of shares of plantation sub-sector companies increased by 0.000598 times. This shows when the weather is hot then the stock returns up, because the investors' mood is well and eager so that it affects decision making in taking investment risk. Meanwhile, when the weather is cold or rain, stock returns fall, because the mood of investors is bad so that it affects decision making and more likely to sell its shares that cause the decline in stock returns. The result of using random effect model also shows the result of coefficient of determination R-square (R2) equal to 0,3943, so it can be concluded that the weather explain the rise and fall of stock return equal to 39,43%, while the rest equal to 60,57% explained outside of this study.

After knowing the weather has a positive effect on stock return of estate sub-sector, then tested hypothesis by using partial test (t test). The results of partial test of one-sample test can be seen in Table 3. as follows.

**Table 3. Partial Test
 One-Sample Test**

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Cuaca	2458,080	9587	,000	28,08343	28,0610	28,1058

The weather variable has a significance value of 0.000. This indicates that H₁ is rejected because of Sig <0.05. So it can be stated that weather variables have a significant influence on stock returns. The results of this study indicate that the weather in the city of Jakarta has a significant positive effect on stock returns in sub-plantation companies. This is in line with study conducted by Keef & Roush (2002) that the climate in Wellington, New Zealand has a relationship with the return on the stock index. The study divides the weather into three factors: clouds, temperatures, and winds where two factors are related to stock indices. Besides weather is said as one of the factors that can affect one's mood (mood). Brahmana et al. (2012) indicated that temperature and weather can affect a particular day (called day-of-week anomaly or DOWA), which is on Monday that tends to cause fluctuations in the mood of investors, resulting in higher stock returns.

Someone's psychology has an important effect on investment decisions, as in the study conducted by Tuna (2004) explained that investors' moods influence perceptions of risk and give instinct to create a safe strategy for investors. The financial behavior approach explained that there is a relationship between weather and stock returns. Environmental factors such as rain, snow, humidity, sunny or cloudy days are thought to affect investors' moods. Thus, it can be concluded that the weather affects the mood of investors in making investment decisions. The mood affects investors in buying and selling shares of the company. When the weather of Jakarta is at its maximum temperature (hot) it affects the mood of investors, as investors become more eager in making investments.

Thus, affecting the interest of investors to buy the company's shares and increasing demand for shares of the company. When the demand for stocks increases then the stock price of the company increases, this causes the stock returns obtained by investors also increased. Meanwhile, when the weather in the city of Jakarta is at a minimum (rain) affects the mood of investors to be less excited that makes the lack of interest in investing so that it sells shares owned. The sale of these shares led to falling demand for stocks followed by falling stock prices and stock returns obtained by investors. Based on the results of this study can be stated that the weather is a variable that can affect the stock return.

5. CONCLUSION

This study resulted in the finding that the weather had a significant effect on stock returns. An investor is influenced by his own mood in making a decision to invest, when the hot weather, an investor has a positive mood and eager to make an investment. Positive mood is able to increase the desire of investors to make investments that increase the demand for stocks and stock prices, then the stock return also increased significantly. Conversely, when the rainy or cold weather, an investor has a more negative mood and is not eager to make an investment that is even more likely to sell its shares, so the stock price falls and then the stock return also decreases.

This study can give implication for investor who want to do investment so that investor can take into account the weather factor in decision of buying and selling stock, because weather influence to fluctuation of stock return. When the weather is hot there is an indication of the number of investors who buy shares, it can be used by selling stocks with higher stock prices. Conversely when the weather is cold or rain investors are more likely to make a sale, it can also be exploited by buying stocks at a cheaper price because the number of stock sales will result in falling stock prices. These results may be different for other sectors, so further study is needed in other sectors. As for companies in the plantation sector should be able to maintain the company's performance when the weather is bad. Companies can increase sales volume when the weather is cold or rainy.

For further study can group climate-based climates that occur in their respective areas such as dry season and rainy season, or spring and others based on the weather situation in the region. The results of this study may not be the same with the results of study on other sectors, therefore can be further study to determine the effect of weather on stock returns in other sectors. As for adding other variables such as demographics and behavioral can expand the results obtained in the study.

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