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The effect of El Niño on stock markets

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Previous research found a significant link between El Niño and the macro economy. Enough reason to see whether it also has an effect on the stock market. Significant, positive effects are found of El Niño on the stock market in Canada, Chile, Germany, Peru and the USA. Further research could provide more answers about the robustness of the results; whether this effect is related to El Niño, the weather related to El Niño or feelings that are generated because of El Niño.

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Introduction

2015-2016 is an El Niño year and its implications have been all over the news. According to the WMO (2015) this El Niño belongs among the three strongest since 1950. Some of the headlines include: Commodities Prices Are Heating Up on El Niño, The Hottest El Niño yet and El Niño wreaks havoc in Africa. Since El Niño has such broad effects on different areas, it would also be interesting to see how it affects the stock market. The goal of this thesis is to see whether El Niño has also an effect on this, on the first eye, unrelated matter. Therefore the research question of this thesis is; Does El Niño have an effect on stock markets?

Previously Cashin, Mohaddes and Raissi (2015) find that El Niño has an effect on the macro economy and that the effects of an El Niño should be taken into consideration when considering macroeconomic policies. Besides the effects found, it would also contribute to literature if there would be related research which looks into the effect of El Niño on the stock market. Although upfront the stock market and the macro economy may seem related, found implications may differ a lot. Earlier research already found effects of for example the effect of sunshine on the stock market (Hirshleifer & Shumway, 2003). Since El Niño is also weather related and because of its interaction with the macro economy it is an interesting subject to research. By doing this research I will contribute to a better understanding of both the stock market and El Niño.

By combining an El Niño related index and the stock market index I generate a database which contains information on the stock market and El Niño. To see whether El Niño affects the stock market multiple different regression are done. These multiple regressions aim to provide an answer to the research question.

Significant, although not very strong, effects are found. These effects indicate that El Niño has an effect on the stock market. The countries for which significant, positive effects of El Niño on the stock markets are found in the Ordinary Least Squares Regression are Canada, Chile, Peru and the United States, countries located in the East Pacific. The other effects found almost all show a positive, although not significant, effect of El Niño on the stock market. Not every regression shows significant results, it is found that El Niño does not have a significant effect on Abnormal Returns. This might be related to the fact that Abnormal Returns smooth out shocks and trends, which is something El Niño is. Furthermore, in the

VAR regression significant effects are found for Canada, Peru and Germany. This regression also shows that yesterday has a significant influence on the returns of today in most countries. Although previous research predicts differently, no clear differences can be distinguished between winners and losers of El Niño, since all countries show a positive effect of El Niño on the stock market. But a significant difference is found between the countries in South America, Chile and Peru, and countries that lie in Asia, Europe and Northern America, such as Japan, Germany, the USA and Canada.

These findings contribute new insights into the implications of El Niño. Besides the already found macroeconomic effect of El Niño found by Cashin, Mohaddes and Raissi (2015), this thesis contributes to the understanding of El Niño. The most important insight is that El Niño has a small, and for some countries significant, effect on the stock market. Due to the small effect one should be careful interpreting these results. Furthermore, this research shows that increases in the stock prices that cannot be explained by the market mechanism, might be explained by El Niño. The last important insight from this thesis is that a lot of effects can impact the stock price; it is an interaction of multiple factors. Therefore it is not surprisingly that effects found are not large.

The structure of the thesis is as follows: Section 1 and 2 provide a review of the existing literature and develop hypothesis based on the insights gained through the literature review. Section 3 explains the research design extensively. Section 4 describes the results and section 5 provides robustness checks. Section 7 concludes.

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1. Literature Review

In this paper I try to explain the effect of El Niño on the stock markets, this can be divided into two parts for literature review: El Niño and anomaly performance on the stock market. This section will start with providing a literature review about El Niño, followed by the anomaly performance on the stock market and in the end combining them both.

1.1. El Niño

There has been a lot of talk about El Niño, but what exactly is El Niño? El Niño can be defined as the occasional development of warm ocean surface waters along the coast of Peru (Pidwimy, 2006). This is of importance, since in normal years the Southern Oscillation, the Pacific Ocean circulation system, causes cold, nutrient-rich water to well up in Peru to replace the displaced warmer water. These cold waters are proved to be ideal living circumstances for many fish, which is beneficial for fishermen. Furthermore, the Southern Oscillation leads to precipitation in Indonesia and Australia, which is beneficial for industrial and agricultural purposes. This all happens because of easterlies, which are caused by the high pressure systems in Peru and low pressure systems in Australia and Indonesia, which makes the trade winds go from east to west.

This is different during El Niño, then air pressure drops in South America and the low pressure system in the Western Pacific turn into a weak high pressure, thereby switching their normal positions. This change in air pressure creates reduced trade winds and often westerlies, which allows the equatorial counter current to accurate warm ocean water along the coastlines in South America, which in turn causes the thermocline to drop, which cuts of the upwelling of cold, nutrient water in Peru. These westerlies also indicate a shift of the region of heavy rainfall from the extreme Western Pacific, such as Australia, towards the Central Pacific (Rasmussen and Wallace, 1983). These droughts in the Western Pacific lead to a fear of famine due to crop losses. In the Southern United States it leads to cooler and wetter weather, due to an increase in storms. In Eastern Africa and large parts of South America it leads to heavier storms, warmer weather and heavy rain, while the western flank of the United States and Canada experience milder winters (aka higher temperatures than normal). Furthermore, the drought in the Western Pacific leads to an increase in temperature, because of reduced cloudiness, which also leads to an increase in sunshine hours. Furthermore, El Niño contributed to making 2015 the hottest year on record (The Economist, 2016). This is not something special for 2015, every year after an El Niño the world temperature is a little bit

higher (KNMI, 2016). An El Niño episode therefore has multiple consequences, which have an influence on industries such as agriculture and fishery, but also has its effects on commodity prices.

El Niño, which means Little Boy or Christ Child in Spanish, often appears around Christmas time and lasts, depending on the intensity of the episode, a few weeks to a few months. Important to note is that El Niño also has a sister called La Nina, Little Girl in Spanish. La Nina occurs when the pressure systems intensify, there are extremely strong easterlies and an abnormal upwelling of cold water in the Central and Eastern Pacific. La Nina leads to wetter weather in most countries. Simply said, an El Niño episode leads to opposite conditions from normal, while a La Nina episode leads to intensified conditions.

El Niño can have influence on multiple aspects of the society, but how exactly? Cashin, Mohaddes and Raissi (2015) look into this subject with regards to the effect on the macro economy. They find that the effect of El Niño differs among countries; "While Australia, Chile, India, Japan, New Zealand and South Africa face a short-lived fall in economic activity following an El Niño weather shock the United States, Europe and China actually benefit (possibly through third market effect) from such a climatological change." (p.25-26). Additionally they find that most countries, following an El Niño episode, face short–run inflationary pressures because of increasing global energy and non-fuel commodity prices. Changnon (1999) looks into the effect of the 1997-1998 El Niño on the United States. He finds that "the benefits realized greatly outweighed the losses, both in terms of the lives lost and in damages. (p.1825) "

There are also numerous researches into the effect of El Niño on agriculture and commodity prices. Droughts and heavy rains can lead to crop destruction, but more rainfall compared to 'normal' years can also lead to better yields on crops. Iizumi, Luo, Challinor, Sakurai, Yokozawa, Sakuma, Brown and Yamagata (2014) find that El Niño has positive effects on 22-24 % of harvested areas, while it has negative effects on 30-36% of the harvested areas, depending on the sort of crop. Limited effects of La Nina are found, positive effects on 2-4% of harvested areas and negative effects of 9-13% on harvested areas. Furthermore, Brunner (2002) finds significant effects on world real commodity prices; "ENSO (El Niño-Southern Oscillation) appears to account for almost 20% of real commodity price inflation movements over the past several years" (p.11). Academic literature mostly discusses the impact of El

Niño on the supply, but by the law of demand and supply this should also have its impact on price, this will be discussed in the next paragraph.

Numerous news outlets provide information about the effect of El Niño on commodity prices. The Economist (2015) states that cocoa prices can rise almost 2% and mining can be affected by a disrupted zinc, nickel and copper supply. Gunzberg (2015) finds the following on commodity sector returns; “On average the annual increase using El Niño periods for agriculture is 2.6%, energy 2.0%, industrial metals 1.8% and precious metals 2.4% ”. Terazono (2015) reports the following impact of El Niño; “Food prices in October posted their largest month-on-month rise in three years, up almost 4 per cent from September” Increases are higher, when one looks at the different raw products last October Craymer (2015) reports an increase of 31% of sugar prices, an increase of 36% in diary prices, an increase of 13.1% in palm oil and an increase in wheat of 6.1% over the past three weeks, al due to El Niño. All these increases have an effect on finished products such as chocolate, yoghurt and bread.

Further impacts of El Niño can vary a lot among countries. In southern Africa it leads to severe drought, which leaded to a decrease of one-third in maize crops and famine (Smyth and Terazono, 2016). Smyth and Terazona (2016) also report the effect of delayed monsoons in Indonesia, which leaded to more extensive forest fires and its consequences. El Niño also has its impact on the usage of electricity, in Venezuela there are not enough rains to generate electricity in its main dam and hydroelectric plant, which generates two-third of the needed electricity (Reuters, 2016). As a consequence its government shortened the workweek and cancelled school on Friday, which leads to a less productive economy.

1.2. The stock market

Stock markets are difficult to predict. Therefore, numerous papers look into other things besides information that might have an effect on the stock price. Novy-Marx (2014) finds that “standard predictive regressions fail to reject the hypothesis that the party of the US president, the weather in Manhattan, global warning, El Niño, sunspots or the conjunctions of the planets are significantly related to anomaly performance”.

Numerous researches also look deeper into the link between weather and stock prices. This is important because of the effect of El Niño on the weather. To better understand this, it is useful to first acquire more knowledge about the relationship between mood and weather. Sanders and Brizzolara (1982) provide evidence that indicates that there exists an positive relationship between mood and sunshine hours, but an inverse relationship between humidity and mood. Howarth and Hoffman (1984) find similar results. They find humidity to be the most important predictor for the mood variable. For concentration and potency they find an inverse relationship, while they find a positive relationship between sleepiness and humidity. Furthermore, they find that skepticism is positively related to temperature and negatively to hours of sunshine, while optimism increases with the hours of sunshine. So, there exists a relationship between mood and the weather. But how does this relate to decisions an individual makes? Emotions have multiple influences, among other things on the encoding, retrieval and processing of information (Wright and Bower, 1992). Wright and Bower (1992) find that; "happy subjects overestimate the likelihood of positive events and underestimate that of negative events; sad subjects display the opposite tendencies, overestimating bad and underestimating good events" (p. 285) .

With the increased knowledge it will be easier to understand the following results. Saunders (1993) finds that there is a significant correlation between the cloud cover in New York City and the major stock indexes. He explains this link psychologically, since there is a mood difference between cloudy days and non-cloudy days. This research shows that markets do not always act rationally, since a rational market would not respond to a mood difference. Due to this irrationally of the market, one can also expect that El Niño has an influence. This found correlation might also be related to the previous mentioned effect of optimism which increases with the hours of sunshine. On the contrary, Trombley (1997) duplicated Saunders' research using a variation of his approach. He finds little evidence there exists a relation between weather and stock returns and finds the indicated relationship by Saunders (1993) neither as clear as strong as suggested.

As earlier discussed sunshine is an important determinant in mood, or as Hirshleifer and Shumway (2003) state it most evidence suggests a relation between good mood while exposed to more sunshine. But one has to keep in mind the fact that; "they may incorrectly attribute their good mood to positive economic prospects rather than good weather" (Hirshleifer and Shumway, p. 1013). Which may lead to unfavorable consequences, this may cloud their

judgement and the decision making process in the stock market. Furthermore, Hirshleifer and Shumway (2003) find further evidence for the effect of sunny days on stock prices. They find robust results that sunny days are highly significant positively related to stock returns on a daily basis, because of the influence of sunlight on mood. Chang, Chen, Chou and Lin (2008) also find a significant, negative effect of cloud cover on market returns, but only for a short period just after the opening of the market. The importance of weather as a predictor of stock returns drops after more information becomes known on the market. Therefore one should not expect the explanatory power of El Niño to be large, since the there are many more shocks that effect daily stock returns, such as notable news.

Sunshine is not the only indicator of weather. Cao and Wei (2005) find that there is a significant, negative correlation between temperature and stock market returns. Furthermore, they show that the impact of hours of sunshine and the length of the night is much weaker than the effect of temperature on stock market returns. More recent is the research of Bansal and Ochoa (2012) whom find that; "(..) temperature shocks have a larger negative impact on countries closer to the Equator than countries farther away from the Equator" (p. 11). This can be explained by the higher reliance on climate-sensitive sectors, such as agriculture, which makes them more sensitive to changes in temperature. According to Bansal and Ochoa (2012) up to 51% of cross-sectional variation in mean returns across countries can be explained by these temperature risks. On the Korean stock market Yoon and Kang (2009) find that extreme weather effects have the most noticeable effects on the stock market pre-Asia-crisis, where extremely low temperatures have a positive effect and extreme humidity and heavy cloudiness generate the opposite effect on the stock market returns. They also find that extremely high temperatures lead to negative returns on the stock market over the whole sample.

So far we have mostly looked into the relation between stock market returns and the weather, but how does the weather affect the volatility on the stock market? Symeonidis, Daskalakis and Markellos (2010) find that different measures of volatility (historical, implied and realized) all find significant, negative relations of cloudiness and the number of hours a night. Furthermore they find that "extreme weather conditions do not offer additional explanatory power" (p.222). Chang, Chen, Chou and Lin (2008) find a positive relation between cloud cover and volatility, they argue; "when investors are in a poor mood, there is more disagreement in opinion among them, and hence return volatility increases" (p.1764-1765).

Finally, Kang, Jang, Lee and Moon (2010) find that the Shanghai stock market exhibits a weather effect in the volatility. So, there is an effect which relates weather and volatility on the stock market, but the direction differs among the researchers.

1.3. Putting it together

So far, El Niño, its implications and anomaly performance on the stock market are discussed, but how can one link these two together? Important to mention is that the direct weather effects of El Niño are not the only things that affect the stock market. One should also take into account the effect of El Niño on the harvest and its implications for the stock market, which are indirectly related to the weather.

As discussed El Niño leads to weather situations which are different from normal situations. The increase in sunshine hours (reduced cloud cover) in the Western Pacific, would lead to a positive effect on mood. But El Niño related effects, such as the fear of famine would lead to a decrease in happiness. Overall, El Niño leads to an increase in world temperature, which has a negative relation with stock prices. Effects of El Niño and stock prices are therefore hard to predict, but the directions for the different countries will be further discussed in the hypothesis development.

Besides an effect of El Niño on the mood of the investors, it also has another effect. The impact of El Niño on agriculture (a positive impact on 22-24 % and a negative impact on 30-36% of harvested areas) is pretty large. Positive impacts due to a better crop yield lead to a more positive outlook on the market, while negative impacts lead to a supply shortage, which leads to higher prices by the law of demand and supply. The negative impacts are larger than the positive impacts, therefore according to agriculture and its effect on the stock market, one would expect a negative effect of El Niño on the stock market.

Concluding this literature review one can state that the weather, and therefore also El Niño, have an effect on the mood of investors. Hirshleifer and Shumway (2003) therefore make a broad message: “To understand security price movements, it is important to go beyond the behavior of prices and fundamentals to study what influences investors moods and emotions” (p. 1030). In this paper, I hope to provide an understanding of the security price movements related to El Niño and to see what influences this effect.

2. Hypothesis development

The implications of El Niño found in previous literature are broad and differ across countries. Therefore, hypotheses may differ from country to country. The main questions of this paper is whether El Niño has an effect on the stock market, this develops into the following hypotheses and explanations.

$Hypothesis_0$ 1: El Niño has no effect on the stock market of a country
$Hypothesis_1$ 1: El Niño has an effect on the stock market of a country.
Explanation: From literature review one can expect an effect of El Niño on the stock market by its effect on the weather and the commodity prices.

$Hypothesis_0$ 2: El Niño has no effect on the stock market of a country
$Hypothesis_1$ 2: El Niño has a positive/negative effect on the stock market of a country.
Explanation: Effects may differ among countries. For instance, one would expect the stock market in the USA and Canada to be positively affected since there is a milder winter, which leads to happier people. In Australia there will be a negative effect due to the droughts and its effects on crops. Finally, in South America it leads among other things to heavy rains, which is dreadful to crops, so a negative effect is expected there. Furthermore, all countries may experience effects due to differences in the weather and lower-than-average crop yields, expected directions are shown in the research design.

$Hypothesis_0$ 3: The United States and Europe perform as good as Australia, Chile, India, Japan and South Africa during an El Niño episode.
$Hypothesis_1$ 3: The United States and Europe perform differently than Australia, Chile, India, Japan and South Africa during an El Niño episode.
Explanation: Similar to Cashin, Mohaddes and Raissi (2015), they find that the effect on El Niño benefits the United States and Europe, while Australia, Chile, India, Japan and South Africa experience a fall in economic activity.

$Hypothesis_0$ 4: The winners of El Niño generate similar benefits then losses of the losers of El Niño. So overall the costs are equal to the benefits.
$Hypothesis_1$ 4: The winners of El Niño generate different benefits that then losses of the losers of El Niño. So overall the benefits differ from the costs.
Explanation: The benefits are larger than the cost following from El Niño, since literature suggests that this was the case in USA. Changnon (1999) finds that while the benefits where economic gains of 19,6-19,9 million dollars, economic losses amounted to 4,2-4,5 billion dollars following the 1997-1998 El Niño episode. This generates a net positive economic effect of 15,4 billion dollars.

$Hypothesis_0$ 5: During an El Niño episode the stock market of a country is normal volatile.
$Hypothesis_1$ 5: During an El Niño episode the stock market of a country shows a different volatility.
Explanation: More volatility on the stock market is expected, because it seems most likely there is more disagreement in opinion which leads to a higher volatility as Chang, Chen, Chou and Lin (2008) state in their paper.

3. Research design

3.1. Sample

Similar to Cashin, Mohaddes & Raissi (2015) I obtained data about the Southern Oscillation Index anomalies from the National Weather Service: Climate Prediction Centre. These SOI anomaly values can help indicate whether there is an El Niño episode or not. SOI anomaly values are measured as the difference in air pressure anomaly between Tahiti and Darwin (National Weather Service: Climate Prediction Centre, 2016). Below-normal air pressure at Tahiti and above-normal air pressure in Darwin generate negative SOI anomaly values which indicates that there are warm ocean waters, on the contrary positive values coincide with cold ocean waters (National Weather Service: Climate Prediction Centre, 2016). But when can one speak of an El Niño episode? Therefore, I follow Cashin, Mohaddes & Raissi (2015): "Sustained negative SOI anomaly values below -1 indicate El Niño episodes." (p.8) The frequency from the El Niño data used is monthly, ranging from January 1951 to March 2016, which contains 783 data points in total.

Daily stock market data is obtained from DataStream. For the countries in the dataset the absolute price indexes are obtained from their major stock market. Starting data are dependent on the availability of data, which leads to different starting points for each country. The next chapter provides more detailed information about the stock market indices, which also indicates the starting data and name of the stock market for the different countries. The dataset contains the absolute price values, but not the returns. Therefore, the returns where calculated through Stata by using $d = \frac{P_t - P_{t-1}}{P_{t-1}} * 100$, which turns the observations into the difference in percentage terms. After obtaining the data needed, I combined the datasets. Since the SOI index is monthly and the stock market data is daily, first the SOI index observations had to be turned into daily observations to be able to merge the datasets. After merging there was a sample with 17,025 observations.

3.2. Control variables

To check the robustness of the results it is important to include control variables, this to see if the relationship cannot be explained by another factor than the dependent and the independent variables. Following Saunders (1993) there will be controlled for the January effect (general increase in stock prices during January, because of the increase in buying, which follows the drop in price that happens in December, when investors seek to create tax losses to offset

capital gains [Investopedia, 2016]). Following literature also a control will be added for the Monday effect/weekend effect, on which returns are always negative. When using the vector autoregression method, there will be automatically controlled for lags in the data.

3.3. Methods

To test the hypothesis different methods are going to be used to generate more reliable results.

3.3.1. Ordinary least squares

To start simple, I will start by doing an Ordinary Least Squares Regression. The dependent variable is the day-to-day difference in percentage terms on the stock market in country *x*. The independent variable is the SOI value, for which values bigger than -1 indicate an El Niño episode. Regression were done using the *reg* command in Stata and no control variables were included to keep it simple. The first model looks as follows;

$$SM_x = \beta_0 + \beta_1 SOI + \epsilon \quad (1)$$

Where SM_x, the dependent variable, is the stock market return in country *x*. β_0 is the intercept, the value the dependent variable takes when SOI would be zero. β_1, which is the most important variable for the hypotheses, shows the effect of a one unit increase in SOI on the dependent variable, and ϵ is the error term. In the second OLS regression the dependent and independent variable stay the same. Control variables for January and Monday are included. The second model looks as follows;

$$SM_x = \beta_0 + \beta_1 SOI + \beta_2 JAN + \beta_3 MON + \epsilon \quad (2)$$

The extra variables are the control variables for January and Monday. These are dummy variables that take on a value of 1 when it is either January or Monday, and 0 otherwise. The first regression will mainly test whether there is an effect and which direction it is going. The expectation is that SOI has an effect on the dependent variable. For all countries the expectation of the January control variable is positive, since in January there is an increase in prices. The expected effect of the Monday control variable is negative, since returns are in general negative on Mondays. Table 1 shows the expectations of the signs for the effect of SOI on the stock market in country *x*, these expectations are derived on basis of literature review. Important to

take note is that, because of the -1 that indicates an El Niño episode a negative sign means a positive effect of El Niño. Example; the positive sign of Australia implies El Niño has a negative effect, while the negative sign of Canada implies a positive effect. Droughts in the Western Pacific, such as Australia and India, would lead to a negative effect of an El Niño episode. For Peru a negative effect is expected, since El Niño has its main influence there. A negative effect is expected for Chile as well, due to its close proximity to Peru and the effects of El Niño on the adjacent seawaters. For Northern America a positive effect of an El Niño episode is expected since it leads to a milder winter. Due the absence of mentioning a clear effect on the weather in Europe of El Niño and Europe's interaction with the US, also a positive effect of El Niño is expected there.

Table 1 shows the expectations for the OLS regression. A negative direction means a positive effect, since an El Niño episode indicates a SOI value of -1 or larger.

Country	Direction of SOI
Australia (S&P/ASX200)	+
Canada (S&P/TSX)	-
Chile (IGPA)	+
France (CAC40)	-
Germany (DAX30)	-
India (NIFTY500)	+
Japan (Nikkei225)	+
Mexico (Bolsa)	-
Netherlands (AEX)	-
Peru (IGBVL)	+
South Africa (FTSE/JSE)	+
UK (FTSE100)	-
USA (NASDAQ)	-

3.3.2. Volatility

The second regression takes volatility of the stock market in country *x* as the dependent variable. This will indicate whether through an El Niño episode stock returns become more volatile compared to normal times. A new variable has been generated, by using the *std* command in Stata. Tor each stock market index a standardized value of the stock market index is generated, which is the standard

deviation of the day-to-day difference in the stock market. Therefore the new variable SD_x is a daily variable with the standard deviation of that day.
The first model looks as follows;

$$SD_x = \beta_0 + \beta_1 SOI + \epsilon \quad (3)$$

SD_x is the standard deviation of country *x*. β_0 is the intercept, the value the dependent variable takes when SOI would be zero. β_1, which is the most important variable for the hypotheses, shows the effect of a one unit increase in SOI on the dependent variable, and ϵ is the error term The second model looks as follows;

$$SD_x = \beta_0 + \beta_1 SOI + \beta_2 JAN + \beta_3 MON + \epsilon \quad (4)$$

This model also includes control variables for the January effect and the Monday effect.

3.3.3. Abnormal returns

To see whether El Niño has an effect on abnormal returns, regressions have performed by using the abnormal returns of the stock market in country *x* as dependent variable. Abnormal returns are measured as $AR_x = SM_t - Moving\ Average$. The moving average is the average of the last 30 days. This abnormal returns regression has been done to eliminate sudden shocks or trends in the data, so the estimation will be better. The first model looks as follows:

$$AR_x = \beta_0 + \beta_1 SOI + \epsilon \quad (5)$$

AR_x are the abnormal returns of country *x*. β_0 is the intercept, the value the dependent variable takes when SOI would be zero. β_1, which is the most important variable for the hypotheses, shows the effect of a one unit increase in SOI on the dependent variable, and ϵ is the error term The second model looks as follows;

$$AR_x = \beta_0 + \beta_1 SOI + \beta_2 JAN + \beta_3 MON + \epsilon \quad (6)$$

This model also includes control variables for the January effect and the Monday effect.

3.3.4. Vector auto regression

For a more extensive regression and to control for lags of the dependent variable vector auto regression is the third regression that has been done. Since the SOI variable is the independent variable the VAR model with exogenous variables has been used. Because of the complicated model, it has been kept easy. The model for the vector auto regression, looks as follows;

$$SM_{x_t} = \beta_0 SM_{x_{t-1}} + \beta_2 SM_{x_{t-2}} + \beta_3 SOI \quad (7)$$

3.3.5. Differences

As in the hypotheses stated different results are expected across different regions, this is the reason why the last regression uses the difference between two regions as the dependent variable. $SM_x - SM_y$ is therefore the dependent variable where SM_x represents the stock market in country *x* and SM_y represents the stock market in country *y*. Since if all difference between all countries would have to been tested it would lead to a lot of regressions, choices have been made based on significance and literature. The differences that are tested can be seen in Table 2.

Table 2 shows the tested differences, based on literature review.

X	***Y***
USA	Australia
USA	Chile
USA	India
USA	Japan
USA	South Africa
USA	Germany
Canada	Australia
Canada	Chile
Canada	India
Canada	Japan
Canada	South Africa
Canada	Germany
Chile	Australia
Chile	India
Chile	Japan
Chile	Germany
Germany	Australia

Germany	India
Germany	Japan
Germany	South Africa
Australia	India
Australia	Japan
Australia	South Africa
India	Japan
India	South Africa
Japan	South Africa
Peru	Australia
Peru	Chile
Peru	India
Peru	Japan
Peru	South Africa
Peru	Germany
Peru	USA
Peru	Canada

The choices have been made on basis of significance in the previous regressions, therefore the USA, Canada, Germany, Chile and Peru have such a prominent role. Australia, Chile, India, Japan and South Africa are chosen based on literature and its difference compared to the United States and Europe and the position of these countries as winners and losers according to Cashin, Mohaddes & Raissi (2015) . Furthermore, some differences that are tested are included to see if there are differences between the losers. The final regressions are compared to Peru, since this is the most significant country in previous regressions. These choices lead to 34 regressions. The first model looks as follows:

$$SM_x - SM_y = \beta_0 + \beta_1 SOI + \epsilon \quad (8)$$

$SM_x - SM_y$ is the difference between country *x* and *y*. β_0 is the intercept, the value the dependent variable takes when SOI would be zero. β_1, which is the most important variable for the hypotheses, shows the effect of a one unit increase in SOI on the dependent variable, and ϵ is the error term. The second model also includes control variables for the January effect and the Monday effect;

$$SM_x - SM_y = \beta_0 + \beta_1 SOI + \beta_2 JAN + \beta_3 MON + \epsilon \quad (9)$$

4. Results

4.1. Summary statistics

Summary statistics are shown in Table 3. Differences in beginning dates are dependent on the availably of the data. Medians of 0 can be explained by the fact that the observations contain 6 decimals, and therefore it's not that strange for 0 to be the most common. Minimum and maximum values are pretty similar. In the light of the aim of the research, I don't find it necessary to account for extreme outliers, because winsorizing the dataset would delete abnormal returns that might result from an El Niño shock. For the USA the NASDAQ has been chosen, since this stock market index is mainly comprised out of technology stocks, which are less sensitive to changes in commodities than other indexes.

Table 3. Summary Statistics for the stock market variables.

Table 3 displays summary statistics that describe the sample of the stock markets. The variable shown is the return of the index. These variables are daily observations. Column 1 describes the country (stock index used). The country listed in column 1 begins on the date reported in column 2 and ends on 31 March 2016. Further columns describe the mean, median, standard deviation, minimum value and maximum value.

Country	Begin Date	Mean	Median	St. Dev.	Min.	Max.
Australia (S&P/ASX200)	2 June 1992	0.022	0.013	0.950	-8.336	5.891
Canada (S&P/TSX)	1 January 1969	0.025	0.024	0.912	-11.126	9.823
Chile (IGPA)	5 January 1987	0.060	0.014	0.859	-11.577	9.481
France (CAC40)	4 August 1987	0.024	0	1.385	-9.641	11.176
Germany (DAX30)	4 January 1965	0.030	0.008	1.219	-12.812	11.402
India (NIFTY500)	3 January 1991	0.056	0	1.546	-13.340	16.223
Japan (Nikkei225)	1 January 1951	0.037	0.006	1.185	-14.901	14.150
Mexico (Bolsa)	5 January 1988	0.095	0.033	1.525	-13.337	12.923
Netherlands (AEX)	4 January 1983	0.035	0.029	1.323	-11.996	11.831
Peru (IGBVL)	2 January 1991	0.105	0.005	1.473	-12.445	13.673
South Africa (FTSE/JSE)	4 July 1995	0.051	0.025	1.207	-11.918	7.705
UK (FTSE100)	3 January 1984	0.028	0.017	1.091	-12.216	9.839
USA (NASDAQ)	2 March 1971	0.040	0.707	1.219	-11.350	14.173

To provide a better overview Table 4 shows the summary statistics of the SOI variable. This is the difference between Tahiti and Darwin in the air pressure anomaly. This variable is measured monthly and therefore has fewer differences in observations that the stock market index variables. Values that are bigger than -1 indicate an El Niño episode.

Table 4. Summary Statistics SOI.

Table 4 displays summary statistics for the SOI anomalies. Column 1 provides the starting date and the ending date is March 2016. This variable is the difference in air pressure anomaly between Tahiti and Darwin and is measured monthly. Values below -1 indicate an El Niño episode Further columns describe the mean, median, standard deviation, minimum value and maximum value

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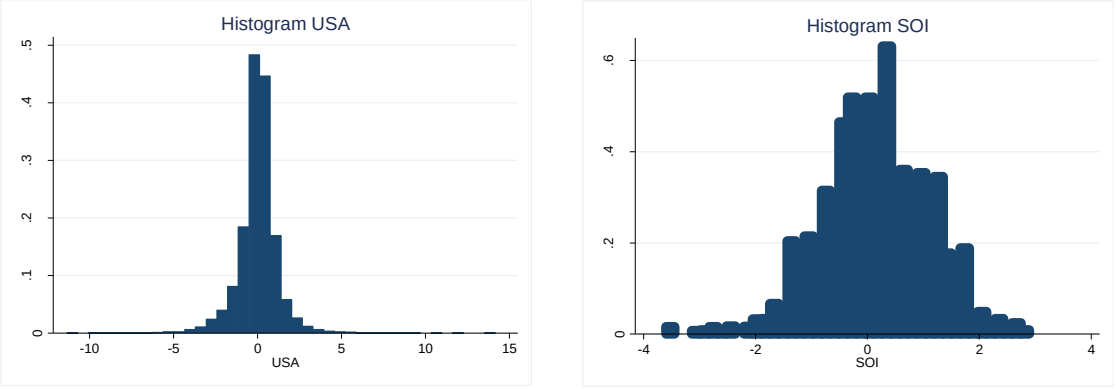
Begin Date	**Mean**	**Median**	**St. Dev.**	**Min.**	**Max.**
January 1951	0.123	0.1	0.950	-3.6	2.9

To show that there are no problems with the data, histograms of USA and SOI have been made. Figure 1 shows the histogram of the USA and the histogram of SOI. Both histograms show indications of a normal distribution (after applying a proper width), so there is no need to make adjustments to the data.

Figure 1 Histogram.

Figure 1 shows the histograms of the USA stock returns and SOI to show that these are not problematic and follow a normal distribution.

.



4.2. Ordinary least squares

To keep it simple, I start with a simple OLS regression with SOI as the independent variable and without any control variables. A negative (lower than -1) independent variable indicates an El Niño episode. Therefore a negative coefficient indicates that El Niño has a positive effect on the stock market returns. In this regression there are four significant coefficients, namely Canada, Chile, Peru and U.S. An SOI value of -1 or more, indicates for Peru an increase in the stock market returns of 0.065% or more on a daily basis (depending on the value SOI takes). Furthermore, all coefficients (except Japan) are negative, which implies a positive effect of El Niño on the stock market.

Table 5. OLS regression.

*Table 5 shows the results of the OLS regression with SOI as the independent variable and the return of the stock market in country x as the dependent variable. When SOI is -1 or larger, one speaks of an El Niño episode. Therefore a negative coefficient means a positive effect. Values reported between parentheses show the t-statistic. * indicates a 10% confidence level, ** a 5% confidence level and *** indicate a 1% confidence level.*

Country	Obs.	Coefficient	R-squared
Australia	6,218	-0.009	0.0001
		(-0.73)	
Canada	12,327	-0.022***	0.0006
		(-2.67)	
Chile	7,629	-0.020**	0.0005
		(-2.04)	
France	7,478	-0.0004	0
		(-0.02)	
Germany	13.369	-0.009	0.0001
		(-0.85)	
India	6,586	-0.031	0.0004
		(-1.61)	
Japan	17,023	0.017	0
		(0.61)	
Mexico	7,368	-0.012	0.0001
		(-0.67)	
Netherlands	8,673	-0.017	0.0002
		(-1.16)	
Peru	6,586	-0.065***	0.0019
		(-3.58)	
South Africa	5,413	-0.008	0.0001
		(-0.52)	
UK	8,413	-0.006	0
		(-0.46)	
USA	11,763	-0.024**	0.0004
		(-2.17)	

To check the robustness of the results, the control variables for January and Monday are included into the regression. Significant results are similar to Table 5, since here Canada, Chile, Peru and U.S are also the significant coefficients. Chile, is the only one of these four, that has changed with -0.001, which means the returns are slightly more positive when controlled for January and Monday. The only thing that really does change is the R-squared, which increased, with the highest R-squared being 0.0049 for Chile. 0.0049 is not particularly high for the variation of the dependent variable that the independent variable explains. The coefficients for January deny the January effect, since most of the coefficients, particularly the significant ones, are positive. Finally the significant, negative results for the Monday coefficient show that the Monday effect exists.

Table 6. OLS regression with control variables.

Table 6 shows the results of the OLS regression with SOI as the independent variable and the return of the stock market in country x as the dependent variable. When SOI is -1 or larger, one speaks of an El Niño episode. Therefore a negative coefficient means a positive effect. Furthermore control variables for January and Monday are included. Values reported between parentheses show the t-statistic. indicates a 10% confidence level, ** a 5% confidence level and *** indicate a 1% confidence level.*

		SOI	**January**	**Monday**	
Country	**Obs.**	**Coefficient**	**Coefficient**	**Coefficient**	**R-squared**
Australia	6,218	-0.009	-0.024	-0.0120	0.0002
		(-0.71)	(-0.56)	(-0.66)	
Canada	12,327	-0.022***	0.037	-0.105***	0.0028
		(-2.66)	(1.25)	(-5.14)	
Chile	7,629	-0.021**	0.065*	-0.135***	0.0049
		(-2.08)	(1.86)	(-5.49)	
France	7,478	-0.0004	-0.010	-0.104***	0.0009
		(-0.03)	(-0.18)	(-2.61)	
Germany	13,369	-0.009	0.039	-0.102***	0.0013
		(-0.85)	(1.04)	(-3.87)	
India	6,586	-0.031	-0.020	0.007	0.0004
		(-1.60)	(-0.30)	(0.16)	
Japan	17,023	-0.003	0.084***	-0.035	0.0005
		(-0.29)	(2.60)	(-1.55)	
Mexico	7,368	-0.012	-0.014	-0.176***	0.0022
		(-0.68)	(-0.23)	(-3.96)	
Netherlands	8,673	-0.017	0.009	-0.057	0.0005
		(-1.16)	(0.17)	(-1.60)	
Peru	6,586	-0.065***	-0.048	-0.057	0.0023
		(-3.58)	(-0.75)	(-1.25)	

South Africa	5,413	-0.009	0.028	0.042	0.0003
		(-0.53)	(0.48)	(1.03)	
UK	8,413	-0.006	-0.005	-0.069**	0.0007
		(-0.46)	(-0.11)	(-2.32)	
USA	11,763	-0.024**	0.070*	-0.175***	0.0040
		(-2.19)	(1.74)	(-6.24	

Concluding, the OLS regressions show that hypotheses 1 can be rejected, El Niño does have an effect on the returns on the stock market. Hypotheses 2 can also be rejected, since almost every country shows positive effects. Table 7 shows the expected and found signs of SOI on the stock market. Japan is the only country that didn't show a negative sign in both regressions. For Chile and Peru a negative effect was expected, but the regression shows a positive effect of El Niño on the stock market in both countries. This might be explained by the fact that there are higher returns, because the prices are higher due to a shortage in supply, which could be one of the reasons. There might also be other unknown reasons who explain this effect. Small effects should not be seen as troublesome, since El Niño is one of the many factors that have an effect on the stock market in a country. The low r-squared indicates that a lot of variation in the dependent variable can be explained by other factors than El Niño.

Table 7. Expected versus found effects (signs) of SOI.

A negative sign implies a positive effect of SOI on the stock market in a country.

Country	**Expected effect of SOI**	**Found effect of SOI**
Australia	+	-
Canada	-	**-*** **
Chile	+	**-** **
France	-	-
Germany	-	-
India	+	-
Japan	+	-/+
Mexico	-	-
Netherlands	-	-
Peru	+	-***
South Africa	+	-
UK	-	-
USA	-	-**

4.3. Volatility

The second regression tests the effect of El Niño on the stock market by a volatility regression. The significant results are the same countries as in the Ordinary Least Squares Regression; Canada, Chile, Peru and the USA. Here the implication is a bit different; when SOI is -1 or larger, the stock market volatility is 0.044% higher per day in Peru. The negative coefficients imply that during an El Niño episode the volatility is higher than normal.

Table 8. Volatility regression.

*Table 8 shows the results of the OLS regression with SOI as the independent variable and the volatility of stock market in country x as the dependent variable. When SOI is -1 or larger, one speaks of an El Niño episode. Therefore a negative coefficient means a positive effect. Values reported between parentheses show the t-statistic. * indicates a 10% confidence level, ** a 5% confidence level and *** indicate a 1% confidence level.*

Country	Obs.	Coefficient	R-squared
Australia	6,218	-0.009	0.0001
		(-0.73)	
Canada	12,327	-0.024***	0.0006
		(-2.67)	
Chile	7,629	-0.024**	0.0005
		(-2.04)	
France	7,478	-0.0002	0
		(-0.02)	
Germany	13.369	-0.007	0.0001
		(-0.85)	
India	6,586	-0.020	0.0004
		(-1.61)	
Japan	17,023	-0.003	0
		(-0.32)	
Mexico	7,368	-0.008	0.0001
		(-0.67)	
Netherlands	8,673	-0.013	0.0002
		(-1.16)	
Peru	6,586	-0.044***	0.0019
		(-3.58)	
South Africa	5,413	-0.007	0.0001
		(-0.52)	
UK	8,413	-0.005	0
		(-0.46)	
USA	11,763	-0.020**	0.0004
		(-2.17)	

To test the robustness of the results, the control variables are included. This leads to higher R-squared's, but the same significant results for SOI. These results show that during an El Niño episode volatility is larger than during a normal period and that these results are not affected by the control variables. The control variables show no indication of the presence of a January effect. The Monday effect is present, indicated by the significant coefficients, which indicates more volatility on a Monday.

Table 9. Volatility regression with control variables.

*Table 9 shows the results of the OLS regression with SOI as the independent variable and volatility as the dependent variable. Values reported between parentheses show the t-statistic. When SOI is -1 or larger, one speaks of an El Niño episode. Therefore a negative coefficient means a positive effect. Furthermore control variables for January and Monday are included. Values reported between parentheses show the t-statistic * indicates a 10% confidence level, ** a 5% confidence level and *** indicate a 1% confidence level.*

		SOI	**January**	**Monday**	
Country	**Obs.**	**Coefficient**	**Coefficient**	**Coefficient**	**R-squared**
Australia	6,218	-0.009	-0.025	-0.020	0.0002
		(-0.71)	(-0.56)	(-0.66)	
Canada	12,327	-0.024***	0.040	-0.115***	0.0028
		(-2.66)	(1.25)	(-5.14)	
Chile	7,629	-0.024**	0.076*	-0.157***	0.0049
		(-2.08)	(1.86)	(-5.49)	
France	7,478	-0.0003	-0.007	-0.075***	0.0009
		(-0.03)	(-0.18)	(-2.61)	
Germany	13,369	-0.007	0.032	-0.084***	0.0013
		(-0.85)	(1.04)	(-3.87)	
India	6,586	-0.020	-0.013	0.005	0.0004
		(-1.60)	(-0.30)	(0.16)	
Japan	17,023	-0.002	0.071***	-0.030	0.0005
		(-0.29)	(2.60)	(-1.55)	
Mexico	7,368	-0.008	-0.009	-0.115***	0.0022
		(-0.68)	(-0.23)	(-3.96)	
Netherlands	8,673	-0.013	0.007	0.043	0.0005
		(-1.16)	(0.17)	(-1.60)	
Peru	6,586	-0.044***	-0.033	-0.038	0.0023
		(-3.58)	(-0.75)	(-1.25)	
South Africa	5,413	-0.007	0.023	0.035	0.0003
		(-0.53)	(0.48)	(1.03)	
UK	8.413	-0.005	-0.004	-0.063**	0.0007
		(-0.46)	(-0.11)	(-2.32)	
USA	11,763	-0.020**	0.058*	-0.144***	0.0040
		(-2.19)	(1.74)	(-6.24)	

The found results show that hypothesis 5 can be rejected. Results indicate that El Niño has an effect on the volatility of the stock market and that this effect is positive. The higher volatility might explain the higher returns. The higher returns during El Niño found in the Ordinary Least Squares Regression can therefore be related to El Niño or a higher volatility.

4.4. Abnormal returns

Abnormal returns are the returns that are different from the average returns, in this case over the last 30 days. This would lead to an elimination of sudden shocks and trends in the data. Table 10 shows the results for the OLS regression with the abnormal returns as the dependent variable. No results are significant and no R-squared is higher than 0.0001, which indicates that El Niño doesn't really have an influence on the abnormal returns.

Table 10. OLS regression.

*Table 10 shows the results of the OLS regression with SOI as the independent variable and the abnormal returns as dependent variable. When SOI is -1 or larger, one speaks of an El Niño episode. Therefore a negative coefficient means a positive effect. Values reported between parentheses show the t-statistic. * indicates a 10% confidence level, ** a 5% confidence level and *** indicate a 1% confidence level.*

Country	Obs.	Coefficient	R-squared
Australia	6,217	0.002	0
		(0.16)	
Canada	12,326	-0.005	0
		(-0.65)	
Chile	7,628	0.0003	0
		(0.03)	
France	7,477	0.001	0
		(0.06)	
Germany	13,368	-0.003	0
		(-0.32)	
India	6,585	0.006	0
		(0.330	
Japan	17,022	0.003	0
		(0.29)	
Mexico	7,367	0.010	0
		(0.55)	
Netherlands	8,672	0.002	0
		(0.13)	
Peru	6,585	0.013	0.0001
		(0.70)	
South Africa	5,412	0.004	0
		(0.02)	
UK	8,412	0.003	0
		(0.26)	
USA	11,762	-0.002	0
		(-0.21)	

Table 11 shows the results of the abnormal returns regression with control variables for the January and Monday effect. Just as in the regression without control variables no coefficient of SOI is significant. The control variables show significant results in this abnormal returns regression. The Netherlands shows a significant, negative effect of January on the abnormal returns, while Canada, Chile, France, Germany, Mexico, UK and the USA show significant, negative abnormal returns for Mondays. These results probably leaded to the increased R-sqaured's in this regression. Therefore one cannot say that the control variables do not influence the abnormal returns, it is just that El Niño doesn't have an effect on these abnormal returns.

Table 11. OLS regression with control variables.

Table 11 shows the results of the OLS regression with SOI as the independent variable and the abnormal returns as dependent variable. When SOI is -1 or larger, one speaks of an El Niño episode. Therefore a negative coefficient means a positive effect. Furthermore control variables for January and Monday are included. Values reported between parentheses show the t-statistic. indicates a 10% confidence level, ** a 5% confidence level and *** indicate a 1% confidence level.*

		SOI	**January**	**Monday**	
Country	**Obs.**	**Coefficient**	**Coefficient**	**Coefficient**	**R-squared**
Australia	6,217	0.003	-0.071	-0.020	0.0005
		(0.20)	(-1.60)	(-0.64)	
Canada	12,326	-0.006	-0.047	-0.107***	0.0023
		(-0.67)	(-1.58)	(-5.11)	
Chile	7,628	0.0004	-0.040	-0.137***	0.0041
		(0.04)	(-1.14)	(-5.50)	
France	7,477	0.001	-0.060	-0.106***	0.0010
		(0.07)	(-1.02)	(-2.59)	
Germany	13,368	-0.004	-0.024	-0.103***	0.0011
		(-0.73)	(-0.61)	(-3.83)	
India	6,585	0.007	-0.104	0.007	0.0004
		(0.34)	(-1.51)	(0.15)	
Japan	17,022	0.003	0.021	-0.035	0.0002
		(0.30)	(0.63)	(-1.53)	
Mexico	7,367	0.010	0.026	-0.179***	0.0022
		(0.54)	(0.40)	(-3.96)	
Netherlands	8,672	0.002	-0.088*	-0.057	0.0006
		(0.12)	(-1.70)	(-1.58)	
Peru	6,585	0.013	-0.070	-0.061	0.0005
		(0.71)	(-1.08)	(-1.32)	
South Africa	5,412	0.0008	0.059	0.043	0.0004
		(0.05)	(-0.99)	(1.02)	

UK	8,412	0.004	-0.063	-0.070**	0.0009
		(0.28)	(-1.44)	(-2.31)	
USA	11,762	-0.003	-0.016	-0.177***	0.0032
		(-0.22)	(-0.39)	(-6.17)	

No significant results have been found for the effect of El Niño on the abnormal returns. This indicates that the previously found effects might be due to sudden shocks or trends. The implications of El Niño, such as storms, are also sudden shocks, this might lead to finding no significant effects in a regression with abnormal returns. Therefore there are no conclusions that can be drawn from this regression.

4.5. Vector auto regression

To control for the lags and to see if it gives different implications, a vector auto regression has been done as fourth regression, results can be seen in Table 12. The SOI variable is significant at the 10% level for Canada and Germany and significant at the 1% level for Peru. Germany was not significant in the previous regressions. Implication is similar: when SOI is -1 or larger, Germany's stock returns are 0,023% larger on a daily basis. Further implications are that some of the lags have a significant influence on the stock market of a country. For example when Chile's return of the day before is 1% larger, the return of today will increase by 0.262%. This make sense, since it seems logical that the return yesterday influences the return today. Yesterday's returns are one of the factors that influence stock market returns besides El Niño. The R-squared increased but the influence of yesterday, the day before and El Niño on the stock market does not explain more than 0.0706 (Peru) of the variation in the stock price.

Table 12. Vector Auto Regression with an exogenous variable.

*Table 12 shows the results of the vector auto regression. C.. SOI is the coefficient of SOI, C. L1 and C. L2 are the first and second lag of the dependent variable, respectively. When SOI is -1 or larger, one speaks of an El Niño episode. Therefore a negative coefficient means a positive effect. Values reported between parentheses show the z-statistic. * indicates a 10% confidence level, ** a 5% confidence level and *** indicate a 1% confidence level.*

Country	Obs.	C. SOI	C. L1	C. L2	R-squared
Australia	3,730	-0.004	0.004	-0.006	0.0001
		(-0.27)	(0.26)	(-0.39)	
Canada	7,395	-0.020*	0.080***	-0.022**	0.0079
		(-1.93)	(7.21)	(-2.01)	
Chile	4,577	-0.019	0.262***	-0.019	0.0703
		(-1.55)	(18.11)	(-1.34)	
France	4,486	-0.009	0.005	-0.028**	0.0009
		(-0.43)	(0.36)	(-1.97)	
Germany	8,021	-0.023*	0.023**	-0.028***	0.0019
		(-1.78)	(2.11)	(-2.69)	
India	3,950	-0.010	0.072***	-0.033**	0.0062
		(-0.41)	(4.48)	(-2.25)	
Japan	10,213	0.0006	0.006	-0.12	0.0002
		(0.05)	(0.61)	(-1.32)	
Mexico	4,420	0.002	0.155***	-0.039***	0.0275
		(-0.11)	(11.04)	(-2.94)	
Netherlands	5,203	-0.029	0.015	-0.027**	0.0016
		(-1.62)	(1.11)	(-2.06)	

Peru	3,950	-0.064***	0.259***	-0.063***	0.0706
		(-2.98)	(16.99)	(-4.30)	
South Africa	3,247	-0.015	0.067***	0.022	0.0055
		(-0.72)	(3.92)	(1.29)	
UK	5,047	-0.014	-0.011	-0.025*	0.0009
		(-0.89)	(-0.78)	(-1.86)	
USA	7,057	-0.021	0.033***	-0.009	0.0016
		(-1.53)	(2.90)	(-0.78)	

These results show more evidence that hypothesis 1 and 2 can be rejected, El Niño has an effect and it is positive.

4.6. Differences

To test hypotheses 3 and 4 one has to look at the differences between countries. This is done in a regression where the dependent variable is the difference in country *x* and country *y*. Table 13 shows the results of this regression. Significant results are found for the difference where country *x* is Peru and country *y* is either Chile, Japan, Germany, USA or Canada. As before a negative sign means a positive effect, because of the interpretation of the SOI variable. All difference are positive, which implicates that the returns in Chile during an El Niño are higher than the previously mentioned countries.. Example: The return in Peru is 0.068% higher than the return in Japan during El Niño on a daily basis.

Table 13. Differences regression.

*Table 13 shows the results of the OLS regression with SOI as the independent variable and the difference between country x and y as the dependent variable. When SOI is -1 or larger, one speaks of an El Niño episode. Therefore a negative coefficient means a positive effect. Values reported between parentheses show the t-statistic. * indicates a 10% confidence level, ** a 5% confidence level and *** indicate a 1% confidence level.*

X	***Y***	**Obs.**	**Coefficient**	**R-squared**
USA	Australia	6,218	-0.004	0
			(-0.19)	
USA	Chile	7,629	0.008	0
			(0.48)	
USA	India	6,586	0.016	0.0001
			(0.66)	
USA	Japan	11,763	-0.019	0.0001
			(-1.29)	
USA	South Africa	5,413	-0.005	0
			(-0.22)	
USA	Germany	11,763	-0.013	0.0001
			(-1.04)	
Canada	Australia	6,218	-0.006	0
			(-0.36)	
Canada	Chile	7,629	0.010	0.0001
			(0.84)	
Canada	India	6,586	0.019	0.0001
			(0.92)	
Canada	Japan	12,327	-0.017	0.0001
			(-1.33)	
Canada	South Africa	5,413	-0.006	0
			(-0.32)	
Canada	Germany	12,327	-0.009	0.0001
			(-0.87)	

Chile	Australia	6,218	-0.006	0
			(-0.42)	
Chile	India	6,586	0.012	0.0001
			(0.58)	
Chile	Japan	7,629	-0.030	0.0003
			(-1.63)	
Chile	Germany	7,629	-0.016	0.0001
			(-0.96)	
Germany	Australia	6,218	-0.0005	0
			(-0.03)	
Germany	India	6,586	0.021	0.0001
			(0.90)	
Germany	Japan	13,369	-0.001	0
			(-0.10)	
Germany	South Africa	5,413	0.002	0
			(0.10)	
Australia	India	6,218	-0.002	0
			(-0.12)	
Australia	Japan	5,413	-0.004	0
			(-0.22)	
Australia	South Africa	5,413	0.0008	0
			(0.05)	
India	Japan	6,586	-0.033	0.0003
			(-1.40)	
India	South Africa	5,413	-0.015	0.0001
			(-0.64)	
Japan	South Africa	5,413	0.001	0
			(0.06)	
Peru	Australia	6,218	-0.033	0.0004
			(-1.64)	
Peru	Chile	6,586	-0.046***	0.0010
			(-2.61)	
Peru	India	6,586	-0.034	0.0003
			(-1.43)	
Peru	Japan	6,586	-0.068***	0.0012
			(-2.86)	
Peru	South Africa	5,413	-0.001	0
			(-0.07)	
Peru	Germany	6,586	-0.055***	0.0010
			(-2.60)	
Peru	USA	6,586	-0.051**	0.0008
			(-2.26)	
Peru	Canada	6,586	-0.054***	0.0013
			(-2.97)	

Just as in the previous regressions I control for the January and Monday effect. This changes one coefficient into a significant coefficient at 10%, namely the difference between Chile and Japan. The already found difference between Peru and Chile, Japan, Germany, USA and Canada remain significant and change by not more than 0,0001. It is also possible to make a distinction between countries, Chile also has higher returns than Japan and combined with the already mentioned differences, this implies that the countries in South America have higher returns during an El Niño episode. Differences in January are never significant, which doesn't deny the presence of the January effect, it just shows that the difference in January among countries is not significant. On the contrary differences on Monday are significant. For example for the regressions of USA it can be interpreted as follows; on Mondays Japan, South Africa and Germany perform better than the USA. This also indicates that the Monday effect is larger in the USA. Adding these control variables keeps the R-squared low, which indicates that still not much of the variation in the stock market returns is explained by the SOI value.

Table 14. Differences regression with control variables.

*Table 14 shows the results of the OLS regression with SOI as the independent variable and the difference between country x and y as the dependent variable. Furthermore, control variables for January and Monday are added. When SOI is -1 or larger, one speaks of an El Niño episode. Therefore a negative coefficient means a positive effect. Values reported between parentheses show the t-statistic. * indicates a 10% confidence level, ** a 5% confidence level and *** indicate a 1% confidence level.*

			SOI	**January**	**Monday**	
X	***Y***	**Obs.**	**Coefficient**	**Coefficient**	**Coefficient**	**R-squared**
USA	Australia	6,218	-0.004	0.030	-0.071	0.0003
			(-0.20)	(0.39)	(-1.33)	
USA	Chile	7,629	0.008	-0.025	0.018	0.0001
			(0.49)	(-0.43)	(0.43)	
USA	India	6,586	0.016	0.047	-0.101*	0.0005
			(0.65)	(0.54)	(-1.65)	
USA	Japan	11,763	-0.020	0.042	-0.127***	0.0012
			(-1.30)	(0.78)	(-3.36)	
USA	South Africa	5,413	-0.005	-0.028	-0.140**	0.0011
			(-0.22)	(-0.34)	(-2.42)	
USA	Germany	11,763	-0.013	0.060	-0.098***	0.0011
			(-1.06)	(1.38)	(-3.21)	
Canada	Australia	6,218	-0.006	0.037	-0.030	0.0002
			(-0.38)	(0.65)	(-0.76)	

Canada	Chile	7,629	0.010	-0.045	0.073**	0.0010
			(0.85)	(-1.02)	(2.39)	
Canada	India	6,586	0.019	0.036	-0.055	0.0003
			(0.91)	(0.48)	(-1.06)	
Canada	Japan	12,327	-0.017	0.002	-0.078**	0.0006
			(-1.33)	(0.05)	(-2.43)	
Canada	South Africa	5,413	-0.006	-0.007	-0.094**	0.0009
			(-0.32)	(-0.11)	(-2.19)	
Canada	Germany	12,327	-0.009	0.014	-0.017	0.0001
			(-0.87)	(0.35)	(-0.64)	
Chile	Australia	6,218	-0.007	0.069	-0.119***	0.0023
			(-0.47)	(1.42)	(-3.52)	
Chile	India	6,586	0.011	0.059	-0.157***	0.0017
			(0.57)	(0.83)	(-3.14)	
Chile	Japan	7,629	-0.030*	0.062	-0.035	0.0005
			(-1.65)	(0.96)	(-0.77)	
Chile	Germany	7,629	-0.016	0.103*	-0.121***	0.0017
			(-0.99)	(1.78)	(-2.97)	
Germany	Australia	6,218	-0.0004	-0.005	0.061	0.0003
			(-0.02)	(-0.07)	(1.30)	
Germany	India	6,586	0.021	0.008	0.009	0.0001
			(0.90)	(0.10)	(0.17)	
Germany	Japan	13,369	-0.001	0.001	-0.074**	0.0004
			(-0.10)	(0.04)	(-2.25)	
Germany	South Africa	5,413	0.002	-0.044	-0.005	0.0001
			(0.12)	(-0.67)	(-0.12)	
Australia	India	6,218	-0.003	0.022	-0.028	0.0001
			(-0.13)	(0.31)	(-0.58)	
Australia	Japan	5,413	-0.004	-0.010	0.052	0.0003
			(-0.22)	(-0.17)	(1.25)	
Australia	South Africa	5,413	0.001	-0.054	-0.053	0.0005
			(0.07)	(-0.94)	(-1.33)	
India	Japan	6,586	-0.033	0.0009	0.099*	0.0007
			(-1.40)	(0.01)	(1.68)	
India	South Africa	5,413	-0.014	-0.103	-0.039	0.0005
			(-0.61)	(-1.31)	(-0.70)	
Japan	South Africa	5,413	0.002	-0.073	-0.076	0.0005
			(0.08)	(-0.96)	(-1.43)	
Peru	Australia	6,218	-0.033	0.003	-0.032	0.0005
			(-1.64)	(0.04)	(-0.66)	
Peru	Chile	6,586	-0.046***	-0.087	0.093**	0.0020
			(-2.59)	(-1.39)	(-2.12)	
Peru	India	6,586	-0.034	-0.028	-0.064	0.0005
			(-1.43)	(-0.33)	(-1.07)	
Peru	Japan	6,586	-0.067***	-0.027	0.035	0.0013

			(-2.86)	(-0.32)	(0.59)	
Peru	South Africa	5,413	-0.002	0.028	-0.125**	0.0012
			(-0.09)	(0.40)	(-2.53)	
Peru	Germany	6,586	-0.055***	-0.036	-0.074	0.0014
			(-2.60)	(-0.48)	(-1.40)	
Peru	USA	6,586	-0.050**	-0.075	0.037	0.0010
			(-2.25)	(-0.95)	(0.67)	
Peru	Canada	6,586	-0.053***	-0.064	-0.009	0.0015
			(-2.96)	(-1.00)	(-0.19)	

Similar results as Cashin, Mohaddes & Raissi (2015) with respect to differences in countries are not found. There is no evidence that the United States and Europe perform better than Australia, Chile, India, Japan and South Africa during an El Niño episode. Therefore, Hypothesis 3 can be accepted, since there are no differences in returns. But there can be made a distinction between South America and the rest of the world, countries in South America (Chile and Peru) perform significantly better during an El Niño episode than Japan, Germany, USA and Canada. This outperformance might be related to the relation between Peru and Chile to one of the most important locations for of an El Niño episode, which is Peru. Hypotheses 4 is more complicated. Overall most countries show positive effects of El Niño on the stock market, therefore there are no losers. By the means that there are no losers, one cannot determine whether the overall gain is positive or negative. Hypothesis 4 can therefore also be accepted since the losses and gains show no difference and are similair.

5. Robustness Checks

To check the robustness of the results, robustness checks are performed. This to see if the results are the same if the dependent variables are changed. Price indexes for the sectors airline, farming and fishery, financials, general industries, marine transport, mining, technology, and utilities for developed markets have been obtained from DataStream. Per sector it differs which firms, how many firms and also which countries are included into the index. This differences make the results more robust. The choices of sector are based on the expected effect of El Niño on certain sectors. Therefore sectors are included on which more effect is expected and sectors on which no effect is expected. To see the results the same has been done to these price indexes as to the stock market indexes, namely using $d = \frac{P_t - P_{t-1}}{P_{t-1}} * 100$. Summary statistics of these dependent variables can be seen in Table 15. Mean values are pretty similar and there are no strange observations. Because of the aim of this research I do not find it necessary to control for outliers.

Table 15 Summary Statistics for the robustness checks.

Table 15 display summary statistics that describe the sample of price indexes for the robustness checks. These variables are daily observations. Column 1 describes the sector and the second column describes the beginning date. Further columns describe the mean, median, standard deviation, minimum value and maximum value.

Sector	Begin Date	Mean	Median	St. Dev.	Min.	Max.
Airline	2 January 1973	0.030	0.012	1.172	-16.389	9.953
Farming and Fishery	2 January 1973	0.028	-0.008	1.387	-17.010	16.482
Financials	2 January 1973	0.028	0.036	0.985	-12.668	10.927
General Industries	2 January 1973	0.025	0.040	0.983	-12.771	8.435
Marine Transport	2 January 1973	0.027	0.013	1.201	-13.909	10.433
Mining	2 January 1973	0.028	0.030	1.438	-22.579	16.390
Technology	2 January 1973	0.035	0.038	**1.**302	-13.544	11.159
Utilities	2 January 1973	0.023	0.016	0.811	-7.699	12.653

First a robustness check has been done without control variables. Results can be seen in Table 16. The sectors Airline, Financials, General Industries, Marine Transport and Technology show significant, positive effects of El Niño on the sector. Mining and Farming & Fishery are according to literature also expected to experience the influence of an El Niño episode, the results indicate otherwise. R-squared is still low, but this is not strange, since it is indicated that a lot of things influence the stock market. The findings show that the results are not

related to a specific sector, but that the effects are also present in, on the first eye, unrelated sectors such as Financials and Technology.

Table 16. Robustness Check.

*Table 16 shows the results of the robustness check with SOI as the independent variable and the dependent variable is the index of sector x. When SOI is -1 or larger, one speaks of an El Niño episode. Therefore a negative coefficient means a positive effect. Values reported between parentheses show the t-statistic. * indicates a 10% confidence level, ** a 5% confidence level and *** indicate a 1% confidence level.*

Sector	Obs.	Coefficient	R-squared
Airline	11,282	-0.025**	0.0005
		(-2.30)	
Farming and Fishery	11,281	-0.014	0.0001
		(-1.10)	
Financials	11,282	-0.022**	0.0005
		(-2.42)	
General Industries	11,281	-0.019**	0.0004
		(-2.06)	
Marine Transport	11,281	-0.019*	0.0002
		(-1.66)	
Mining	11,281	-0.008	0
		(-0.58)	
Technology	11,282	-0.027**	0.0004
		(-2.24)	
Utilities	11,282	-0.012	0.0002
		(-1.97)	

Furthermore to test the robustness of the robustness check control variables have been added, results can be seen in Table 17. By including control variables the sectors Airline, General Industries, Financials, Marine Transport and Technology stay significant by the same amount. This is a stronger indication that our results are robust and El Niño does have an effect on the stock market. It is surprising that in this regression there is not necessarily a significant, negative Monday effect, but in some circumstances a significant, positive effect. The effect of Financials and Technology are not expected, but according to the regression a significant, positive effect is found. The found effects on the sectors Airline, General Industries and Marine Transport are not surprising, since these sectors are all influenced by the weather.

Table 17. Robustness check with control variables.

*Table 17 displays the results of the robustness check with SOI as the independent variable the dependent variable is the index of sector when SOI is -1 or larger, one speaks of an El Niño episode. Therefore a negative coefficient means a positive effect. Furthermore control variables for January and Monday are included. Values reported between parentheses show the t-statistic. * indicates a 10% confidence level, ** a 5% confidence level and *** indicate a 1% confidence level.*

		SOI	January	Monday	
Sector	**Obs.**	**Coefficient**	**Coefficient**	**Coefficient**	**R-squared**
Airline	11,282	-0.025**	0.025	-0.117***	0.0021
		(-2.31)	(0.62)	(-4.23)	
Farming and Fishery	11,281	-0.014	-0.020	-0.074**	0.0006
		(-1.10)	(-0.42)	(-2.28)	
Financials	11,282	-0.022**	0.006	-0.100***	0.0022
		(-2.43)	(0.18)	(-4.33)	
General Industries	11,281	-0.019**	-0.025	0.016	0.0005
		(-2.06)	(-0.76)	(0.68)	
Marine Transport	11,281	-0.019*	0.020	0.054**	0.0006
		(-1.66)	(0.51)	(1.91)	
Mining	11,281	-0.008	0.045	0.092***	0.0008
		(-0.58)	(0.94)	(2.71)	
Technology	11,282	-0.027**	0.071	-0.012	0.0007
		(-2.25)	(1.63)	(-0.40)	
Utilities	11,282	-0.012	-0.024	-0.052***	0.0009
		(-1.57)	(-0.88)	(-2.71)	

The robustness checks indicate that the results found are robust; El Niño does have an effect on the stock market. It is odd that some sectors show no significant effects. One would expect that Farming and Fishery experience effects of El Niño by the change in weather. Furthermore, that there is no effect on Mining sector is contrary to the literature, which states that mining is affected by a disrupted supply. That the Utilities sector does not experience an effect is not strange, since literature indicates that it only had an effect on Venezuela, which is not incorporated in the sector indexes. In interpreting the results of these robustness checks it is important to note that the index is of the developed markets, so one might find other implications when looking at different countries. Due to the difference among countries and number of firms between the sectors the results add more reliability to the found robustness. Concluding, results show that the found effects are robust to changing circumstances.

6. Discussion

Caution has to be taken when looking at the results. Although significant and robust effects have been found, this effect could be related to numerous other things. As discussed in the literature review weather has a significant effect on mood. El Niño has an effect on weather, so the effect seen in the results might be more related to the weather than specific to an El Niño episode. El Niño weather in Northern America leads to milder winters and in South America to heavier weather (storms and rain). Due to this contrast the effects found are expected to go in different directions. This is not the case, Canada, Chile, Germany, Peru and the USA all show a positive effect of El Niño on the stock market, even though the implications of El Niño weather are different. Expectation would be a negative effect in Chile and Peru. Concluding one can say that the effect found is related to El Niño specific and not the weather.

Furthermore it was found that better weather leads to more optimistic people, which in turn leads to a positive effect on the stock market. Since again the effect of El Niño has both positive and negative implications different reactions would be expected in different countries. This is, as earlier said, not that the case. Therefore one can say that El Niño has no effect on mood that in turn affects the stock market.

Weather and mood are not the only things that might impact the found effect. El Niño has through it impact on weather also an effect on commodity prices. On average prices rise during an El Niño year, because of below normal yields. A price rise is negative, therefore one would expect negative effects of El Niño on stock market returns. However, the USA shows significant, positive effects, while the NASDAQ is more robust to changes in commodity prices since it is mainly comprised out of technology stock. Due to these findings one can say that the effect of El Niño is not predetermined by commodity prices.

The robustness check and this discussion canceled out most other things that might have an impact on the effect of El Niño on the stock market and related the effect found to El Niño only. It is also important to keep in mind that all things that affect the stock market returns are small and that there are infinite other things that also have an impact. Therefore, El Niño has an impact but it should be handled with care.

7. Conclusion

This research provides an answer to the research question; Does El Niño have an effect on stock markets? Found results indicate that the answer to the question is yes. Significant effects are found for Canada, Chile, Germany, Peru and the USA, which mostly lie in the East Pacific. This indicates that El Niño has the most influence on this part of the Pacific. Other countries show no significant effects of El Niño on the stock market.

First, an Ordinary Least Squares regression has been done, which resulted in positive, significant results for Canada, Chile, Peru and USA. The second regression tested the volatility of the stock market, which resulted in significant positive effects for the same countries. This indicates that there is a higher volatility during an El Niño episode, which rejected hypothesis 5. Third, an abnormal returns regression is performed, which showed no significant results, which might be due to the fact that implications of El Niño are partly sudden shocks/trends. Following, a vector auto regression is done to control for lags. This resulted in significant, positive results for Canada, Germany and Peru. It was also found that yesterday has an effect on today. This regression and the Ordinary Least Squares regression rejected the first two hypotheses and showed that El Niño has an effect on the stock market.

The final regression tested the differences between multiple countries. There can be made a distinction between the countries, Chile and Peru show higher returns than Japan, Germany, the USA and Canada. These differences are not similar to the differences found by Cashin, Mohaddes & Raissi (2015), so hypothesis 3 can be accepted. Since all countries show positive effects of El Niño on the stock market there are no losers, only winners. Therefore hypothesis 4 can be accepted. In the regressions Peru and Chile show positive effects, while they were expected to be negative. One explanation might be the higher volatility which leads to higher returns. Another explanation is that an El Niño episode is not perceived as negative in these countries, but is something that just happens and doesn't influence the investors, which in turn leads to no negative effects on the stock market in these countries.

This research gives a contribution to the existing knowledge, it shows that El Niño, besides the macro economy, also has an effect on the stock market. Implications of this research are that one can expect a positive increase in the stock market returns in an El Niño year, something that might be useful for investors. For investors it is also important to keep in mind the other interpretations of the effect, since these might also affect the stock market.

The effects that are found should be interpreted with caution. Robustness checks showed that El Niño not necessarily has an effect on stock markets in specific countries, but also on certain sectors such as Airline, General Industries, Financials, Marine Transport and Technology in developed markets. The robustness checks show no effect on for instance Farming and Fishery. Therefore the effects found can also be related to other things and the effect can be a coincidence, this is one of the limitations of this research.

Further research into the subject should provide more answers to see whether the effect really can be contributed to El Niño only or that other factors also have an influence on the found effect. Additional controls that should be used in further research, since there are other anomalies on the stock market, such as sunshine and rain. By adding more controls it would become clearer whether the effect can be really attributed to El Niño or whether it is just a coincidence. So, concluding, there are still a lot more questions that need answering, but there is an effect of El Niño on the stock market which deserves further elaboration.

Reference list

Brunner, A. D. (2002). El Niño and World Primary Commodity Prices: Warm Water or Hot Air? *Review of Economics and Statistics 84 (*1), 176–183.

Bansal, R., & Ochoa, M. (2012). Temperature, Aggregate Risk, and Expected Returns. Working paper. Duke University, Durham.

Cao, M., & Wei, J. (2005). Stock market returns: A note on temperature anomaly. *Journal of Banking and Finance 29* (6), 1559-1573.

Cashin, P., Mohaddes, K., & Raissi, M. (2015). Fair Weather or Foul? The Macroeconomic Effects of El Niño. IMF Working Paper, WP/15/89.

Chagnon, A. (1999). Impacts of 1997-98 El Niño Generated Weather in the United States, *Bulletin of the American Meteorological Society 80* (9), 1819-1826.

Chang, S., Chen, S., Chou, R., & Lin, Y. (2008). Weather and intraday patterns in stock returns and trading activity. *Journal of Banking & Finance 32* (9), 1754-1766

Craymer, L. (2015, 12th of October). Commodities Prices Are Heating Up on El Niño. *The Wall Street Journal.* Retrieved from http://www.wsj.com/articles/commodities-prices-are-heating-up-on-el-Niño-1444679542

Gunzberg, J. (2015, 28th of May). The Hottest El Niño yet. [blog post]. Retrieved from: http://www.indexologyblog.com/2015/05/28/the-hottest-el-nino-yet/

Hirshleifer, D., & Shumway, T. (2003). Good Day Sunshine: Stock Returns and the Weather. *Journal of Finance 58*, 1009–1032.

Howarth, E., & Hoffman, M. (1984). A multidimensional approach to the relationship between mood and weather. *British Journal Of Psychology 75*, 15-23.

Iizumi, T., Luo, J., Challinor, A., Sakurai, G., Yokozawa, M., Sakuma, H., Brown, M., & Yamagata, T. (2014). Impacts of El Niño Southern Oscillation on the Global Yields of Major Crops. *Nature Communications 5.*

Investopedia, (2016). *January Effect.* Retrieved from: http://www.investopedia.com/terms/j/januaryeffect.asp

Kang, S., Jiang, Z., Lee, Y., & Yoon, S. (2010). Weather effects of return and volatility of the Shanghai stock market. *Physica A 09* (10), 91-99.

KNMI, (2016). Uitleg over El Niño. Retrieved from https://www.knmi.nl/kennis-en-datacentrum/uitleg/el-Niño-21037ceb-3f08-4654-b08e-2ebfd5bdc2e3

Novy-Marx, R. (2014). Predicting anomaly performance with politics, the weather, global warming, sunspots, and the stars. *Journal of Financial Economics 112* (2), 137-146.

National Ocean Service (2016). What are El Niño and La Niña? Retrieved from: http://oceanservice.noaa.gov/facts/Niñonina.html

National Weather Service: Climate Prediction Centre (2016). The Southern Oscillation Index (SOI). Retrieved from: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensocycle/soi.shtml

Pidwirny, M. (2006). El Niño, La Niña and the Southern Oscillation. *Fundamentals of Physical Geography. 2nd Edition* Retrieved from: http://www.physicalgeography.net/fundamentals/7z.html

Rasmussen, E., & Wallace, J. (1983). Meteorological Aspects of the El Niño/Southern Oscillation. *Science Volume 222*, 1195-1202.

Reuters. (2016, 9th of May) Venezuela extends two-day workweek for state employees to save energy. Retrieved from: http://www.reuters.com/article/us-venezuela-workers-idUSKCN0Y1000

Smyth, J., & Terazono, E. (2016, 18th of April). El Niño: Feeling the heat. *Financial Times.* Retrieved from http://www.ft.com/intl/cms/s/0/30d7bdac-fbf5-11e5-b3f6-11d5706b613b.html#axzz49Il9Ksgc

Sanders J., & Brizzolara, M. (1982). Relationships between Weather and Mood, *The Journal of General Psychology, 107* (1), 155-156.

Saunders, E. (1993). Stock Prices and Wall Street Weather. *American Economic Review 83* (5), 1337-1345.

Symeonidis, L., Daskalakis, G., & Markellos R. (2010). *Finance Research Letters 7* (4), 214-223.

Terazono, E, (2015, 5th of November) El Niño phenomenon hits food prices. *Financial Times.* Retrieved from: http://www.ft.com/intl/cms/s/0/79a42688-83c8-11e5-8095-ed1a37d1e096.html#axzz49Il9Ksgc

The Economist, (2015, 18th of June). How El Niño affects commodity prices. [youtube movie] Retrieved from: https://www.youtube.com/watch?v=J8oDlYAP_XU

The Economist, (2016, 21st of January). The hottest year on record: 2015. Retrieved from http://www.economist.com/blogs/graphicdetail/2016/01/climate-change

Trombley, M. (1997). Stock Prices and Wall Street Weather: Additional Evidence. *Quarterly Journal of Business & Economics. 36* (3), 11-20.

World Meteorological Association (2015). *El Niño Expected to Strengthen Further: High Impacts, Unprecedented Preparation.* Retrieved from: https://www.wmo.int/media/content/el-niño-expected-strengthen-further-high-impacts-unprecedented-preparation

Wright, W., & Bower, G. (1992). Mood Effects on Subjective Probability Assessment. *Organizational Behavior And Human Decisions Processes 52,* 276-291.

Yoon, S., & Kang, S. (2009). Weather effects on returns: Evidence from the Korean stock market. *Physica A 11 (*17), 682-690.