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The impact of El Niño on stock returns and trading volume of developing countries

Can profits be earned through a climate cycle?

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Abstract

This thesis investigates the relation between the strongest inter-annual natural climate change: El Niño and stock returns and trading volume of ten developing countries in Latin America, the Pacific and South Africa. The relation will be studied for strong El Niño events, which have more impact on countries than weaker events. The results are used to implement a long-short strategy with ETFs – listed on the NYSE – on the ’15-’16 El Niño, to see if one could have earned profits. Strong El Niño events influence the stock returns of eight markets. First, a decline in returns is visible in most markets, after which an increase is observed. Trading volume tends to decrease as a consequence of strong El Niño shocks. Four different timings are examined with respect to the long-short strategy on ETFs. The ETFs are obtainable for every investor and not only for large institutional investors. The findings are that there was a strong opportunity to earn profits on the ’15-’16 El Niño. The weather phenomenon El Niño does affect the financial markets and investors should trade on it based on these results.

Keywords: El Niño, international financial markets, stock return, trading volume, investment decisions, Exchange-Traded Funds

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1. Introduction

The end of 2015 and the beginning of 2016 is characterized by a strong El Niño. This was the strongest El Niño since 1997-1998 and had high implications on the economy. In 2017, Cashin, Mohaddes and Raissi analyzed the effects of El Niño shocks on economic performance for 26 countries in the period of 1979-2013 (Cashin, Mohaddes, & Raissi, 2017). In contrast with earlier studies, Cashin et al. (2017) found that economic performance is influenced by this weather phenomenon. They showed that El Niño significantly affects growth, inflation, energy and non-fuel commodity prices of 21 countries c.q. regions in a comprehensive study. El Niño is a weather phenomenon that happens once in every 3 to 7 years (Trenberth, 1997). During these months, around Christmas, trade-winds from the East to the West of the Pacific weaken and this has all kinds of effects in the Pacific, Asia and the south of the Americas, such as draughts and heavy rains. When and how strong El Niño will be, is hard to predict. This paper contributes to the growing interest and search for a relation between climate and economic performance. By studying the effect of El Niño on stock index returns and trading volume of developing countries and emerging markets in the pacific and Latin America, as well as applying this to Exchange-Traded Funds from major stock indices of those countries, but listed on the New York Stock Exchange.

How can a meteorological phenomenon be linked to the world of finance? In 2002, Brunner found a relation between El Niño and a country's GDP. He showed that a strong El Niño can be responsible for a variation in GDP of 10-20%. As mentioned, El Niño leads to draughts or heavy rains and this can harm the primary sector. The smaller the primary sector or the more diversified an economy is, the smaller is the effect of El Niño shocks on its GDP growth (Cashin, Mohaddes, & Raissi, 2017). Another example of how El Niño influences an economy takes place in the period around Christmas, in front of the coast of Peru, Chili and Ecuador. As a result of El Nino, instead of cold fresh water which contains a lot of fish, warmer water boils up in front of the west coast of South America. As a result, these countries — who rely on the export of fish — incur a major decline in export. This does not only hit the fishing companies but their economy as a whole (Trenberth, 1997). On the contrary, the worlds commodity price of these specific fish species will rise. This will benefit those who export the same fish and have not been hit by the effects of El Niño, since the price is now higher. Therefore, the effects on GDP can be both direct and indirect but also be positive and negative. Thus, one can corroborate that there are winners and losers from an El Niño event. The question now rises whether this effect is also visible in the stock markets of developing countries c.q. emerging markets (from now on, developing countries and emerging markets will be used interchangeably). By studying this, it will open opportunities in the ever-growing interest for profitable investment strategies, which in this research will be Exchange-Traded Funds.

The performance of a stock market reflects how a country's economy is performing. On the one hand, investors can trade internationally and are not bounded by borders. On the other hand however, only one out of seven equity trades are done in a foreign market (Tesar & Werner, 1995; French & Poterba, 1991). Therefore, trades on equity markets are a good indication of economic performance.

A possible relation between El Niño and financial markets would be of interest for every investor for the following reasons. First, when an economy is hit by something like El Niño, the greatest effect is found on economies or stock markets that are less diversified. Developing countries have economies that are often focused on the abundance of resources that they possess. Peru for example, relies a lot on the export of fish. Thus, if a strong El Niño hits the fish price, Peru will be hit harder than an economy that is more diversified such as the US. Second, developed countries are studied more often because of the data availability and interest. For the developing countries and or emerging markets that are already studied, I follow the literature provided by Cashin et al. (2017). The third reason for studying developing countries is that not only stock returns are important here, but also the volume of trading. This effect has not been studied before for developing countries that are hit by El Niño. The volume increase is independent on whether a country is a 'loser' or a 'winner' upon an El Niño event, since trading volume is positively correlated with stock returns (Harris & Raviv, 1993; Karpoff, 1987). When a country is a 'loser', its economic performance will be negatively influenced, and trading volume will increase since shareholders would want to sell their shares. Similarly to 'losers', the trading volume of winners of El Niño will also increase for exactly the opposite reason. Furthermore, ETFs are cheap and liquid products that can be bought and sold by every investor (Bodie, Kane, & Marcus, 2014). Using the presented result on an investment with ETFs, will give this research a potentially strong investment strategy for every investor out there. This study will contribute to our knowledge about El Niño and stock markets but also adds the new perspective of ETFs and trading volume. Furthermore, some new countries are studied, which have never been studied before.

If a correlation can be found, investors can use this for a future trading strategy to extract profits from El Niño shocks. This contrasts with the Efficient Market Hypothesis of Basu (1977), but will later be explained more thoroughly in this thesis. The most optimal trading strategy would be to go long in winners from El Niño shocks and short in losers and not a long only strategy. Long-short strategy can lead to significant more gains if you have superior information than a long-only strategy (Grinold & Kahn, 2000). It is costly for a regular investor to go long in a whole index or to go short in an index, if already possible, but ETFs might solve this problem. The transaction costs are already low for ETFs, but especially in the American market, that is accessible for almost all investors, the transaction costs are among the lowest. The outcome of this research can be used directly by investors.

The research question is: *What is the effect of El Niño on stock returns and trading volume on stock indices of developing countries?* To answer this question the following sub-questions need to be answered:

1. What is the effect of an El Niño shock on stock returns of developing countries?
2. Is the effect on trading volume different than on stock returns for developing countries?
3. Was a long-short strategy profitable on ETFs for stock indices in the most recent strong El Niño of 2015-2016?

My expectation is that the effect of an El Niño shock will be more or less equal on stock return as well as on trading volume. According to Gallant et al. (1992), large price movements are continued by a subsequent large increases in volume. Hence, I expect that both will be affected by El Niño with equal magnitude. However, if the effect of El Niño on stock returns is large, whether positive or negative, the effect on trading volume will always be positive according to theory. Furthermore, I expect that the same effect will apply as on the countries studied by Cashin and Mohaddes (2017), which are shown in Table 1. Some countries are hit harder by this shock of nature than others. Lastly, I expect that when I find an effect for developing countries, investors will make profits on the ETF-market when losers and winners are pooled together, and a long-short strategy is applied.

Table 1: Results and expectations of strong El Niño events on stock returns
These are the results from Cashin et al. 2017 where El Niño events are regressed against GDP. I do note that GDP is not perfectly correlated with stock returns, but no further studies are found that study these countries with respect to El Niño. A (-) sign stands for a negative effect on stock returns. A (+) sign stands for a positive effect on stock returns. A plus and minus sign stand for both negative and positive but different in timing. A zero stands for no effect.

Country		
India	(-)	Weak monsoon and higher temperatures lead to small fall in growth, not significant in all quarters
Indonesia	(-)	Drought leads to less mining activities (hydropower) and withered crops. Relative large effect on GDP growth
South Korea	(+)	Few quarters increase in GDP
Malaysia	(0)	Very short upside on growth after 1 quarter normalizing again
Philippines	(0)	Extensive early warning system for ENSO events, they are warned early enough to take precautions and ENSO does not affect growth
Thailand	(+ -)	
Brazil	(+ -)	Growth in the south because of rain and drought in the north, offsets each other
Chile	(-)	Stormy winters lead to less mining and a higher copper price. No statistically significant results in GDP growth
Peru	(+ -)	More rain leads to enormous increase in GDP growth by agriculture and a smaller decrease by the decline in fish export
South Africa	(-)	Droughts lead to a small decrease in growth after 1 year

The main findings of this paper are partly corresponding with the expectations and previous studies of Cashing et al. (2017): a general tendency of a decline in stock returns up to 6 months after El Niño impact. After that a recovery of the stock market gives an increase in returns later. Trading volume decreases instead of the expected increase. The magnitudes are larger than the effects on stock returns. Large profits can be earned through the use of ETFs for the El Niño in ’15-’16. Different strategies all show positive results.

The remainder of this paper is structured as follows. First, the theoretical background is given on what El Niño is, how it evolves and more information on the weather versus stock returns. Second, the hypotheses are discussed. Third, the variables are elaborated. Fourth, the data and methodology are examined. Next, the results are presented in the regression analysis and the investment strategy is discussed. Then, the robustness of the results is checked and the discussion will shed some light on the findings.

2. Theoretical Background

Before I explain what the literature says about the direct and indirect effect of El Niño shocks on stock markets, a description is given of what El Niño exactly is, when it happens and how its strength is measured.

2.1 El Nino

El Niño is a natural phenomenon and part of the so called Southern Oscillation Cycle (Cashin, Mohaddes, & Raissi, 2017). It is the strongest natural inter-annual climate change on the planet and happens every 3 to 7 years (Timmermann, Oberhuber, Bacher, & Esch, 1999). The Southern Oscillation Cycle, in short ENSO, consists of El Niño and La Niña. El Niño is the warm phase of the ENSO and takes place around Christmas. The duration of an El Niño event is set between nine months and two years (Trenberth, 1997). El Niño means' the boy Christ-child' in Spanish and La Niña means 'the girl'. La Niña includes the cold phase of the SOI. El Niño covers a multitude of events that are happening at the same time. Trenberth (1997) points out that there has been some debate about all the meanings of El Niño, but summarizes them as follows: El Niño stands for the replacing of cold nutrient water for warmer less nutrient water in front of the Peruvian coast, the warming of the sea level water temperature in the central and eastern Pacific and warming of the sea level atmospheric pressure in the western Pacific.

During 'normal years', high pressure air gathers over the Southern American coast near Peru and a low pressure area develops around Australia. Because of this, trade-winds flow from the east to the west over the pacific and cold water rises up for the west coast of South America. Cold water contains a lot of nutrients for fish (Cashin, Mohaddes, & Raissi, 2017). In abnormal years, when there is an El Niño event, the air pressure drops above South America resulting in a weaker trade-wind between East and West. This results in a warmer temperature of the water before the coast of eastern South America with less nutritious water. Other effects are overall droughts in the western Pacific, such as Australia, India, Indonesia and Malaysia, a lot of rain in South America and storms and hurricanes to the center of the Pacific. Figure 1 presents an overview of how El Niño influences different areas with respect to rainfall and drought. This is to give the reader a better understanding of what is happening and why El Niño has such large consequences.

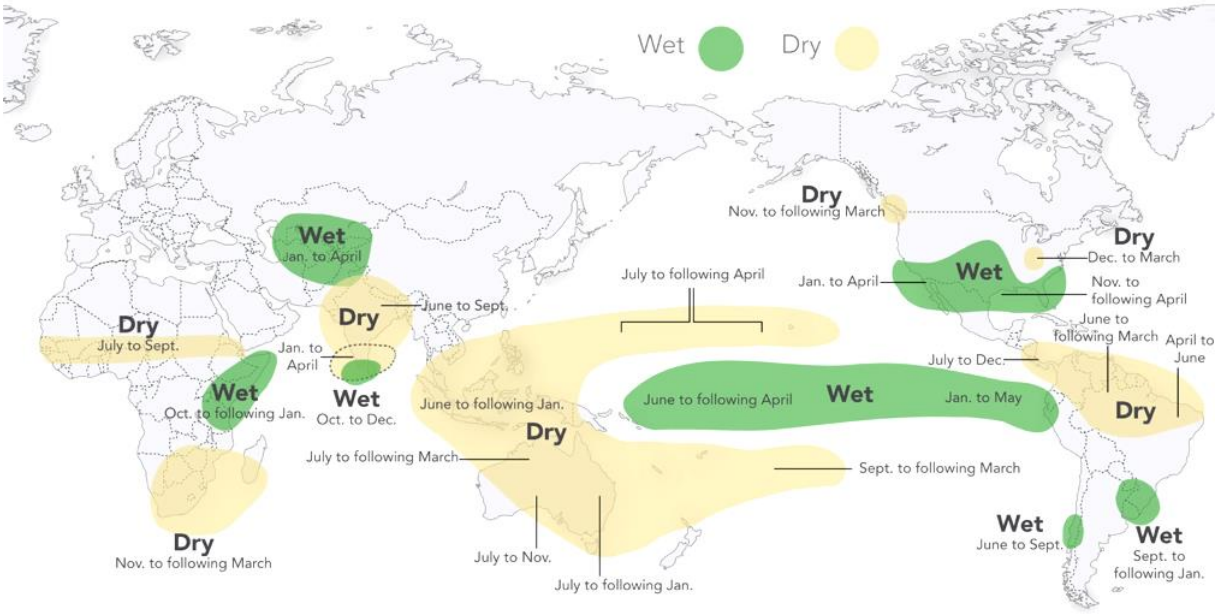

Figure 1: Rainfall and drought during an El Niño event
Consequences during an El Niño event with respect to rainfall. This is a generalization on previous El Niño events (Becker, 2016) .

Over the years, people have discovered the signs of a future El Niño, but as with most weather forecasts, predicting it right is not easy. In a study on the predictability of El Niño by Fedorov et al. (2003), a period of 8 months was enough to predict El Niño based on wind power (Fedorov, Harper, Philander, Winter, & Wittenberg, 2003). Nonetheless, this result should be put in perspective. They conclude that in the very strong El Niño of '97-'98, not a single statistical and dynamic model from the 12 models available was able to predict its duration and its intensity correctly. Therefore, they did not have a conclusive answer to the timing either. Overall, Fedorov et al. (2003) concludes that the intensity is the most uncertain aspect and is difficult to predict. For investors, the uncertainty has great implications. First of all, there are several models which predict El Niño and every time a different model could be correct. But which model can be trusted when? Secondly, the Efficient Market Hypotheses teaches us that when information is available for everyone, the effect is already in the price. This would implicate that there is not a profitable investment strategy possible for trading on El Niño. However, the credibility of these models should be taken into account. One can trust a prediction but there is still a large risk involved. Is an investor willing to take that risk to earn returns? Lastly, if one day there will be a model that predicts the timing and the intensity of El Niño correctly, the effects on stock markets will still differ every time, even when an El Niño has the same magnitude as before. On the contrary, the nearer an ENSO event, the more accurate ENSO can and will be predicted correctly. Thus in conclusion, if a model becomes more certain and precise on its strength and magnitude of the event, more investors will apply a long-short strategy when an effect on stock markets can be found.

Table 2: List of abbreviations and their full names as clarification for the reader

Abbreviation	Full name
ENSO	El Niño-Southern Oscillation
SOI	Southern Oscillation Index
ESOI	Equatorial Southern Oscillation Index
SST	Sea Surface Temperature
ONI	Oceanic Niño Index

Southern Oscillation Index

El Niño covers a multitude of events involving both sea surface temperature and air pressure. That is why there are multiple time series indices available that measure and track ENSO events. The benefit of this is that all events are combined in 1 number, indicating its strength. The Southern Oscillation Index, in short SOI, is one of them and measures differences in air pressure at sea level between Tahiti and Darwin at the 'Niño3.4' region in the pacific. During an El Niño event, the air pressure becomes lower than normal in Tahiti and higher than normal in Darwin (Barnston, 2015). This results in a negative value. For La Niña this is the other way around.

The SOI index is given monthly, indicating whether an ENSO event is about to happen. Generally, this solves the problem of day to day fluctuations due to other events than ENSO. However, Tahiti and Darwin are located south of the equator, 18°S and 12°S respectively. As El Niño is an equatorial event, the Equatorial SOI, in short ESOI, is constructed from two regions much closer to the equator. Figure 2 shows the areas used for the SOI index and the region above Indonesia and one region before the East Coast of Latin America for measures of ESOI. The SOI index is actually calculated (NOAA, Southern Oscillation Index (SOI), 2017) through a formula.[1]

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[1]

$$SOI = \frac{Standardized\ Tahiti - Standardized\ Darwin}{MSD}$$

Where

$$\text{Standardized Tahiti} = \frac{(\text{Actual Tahiti SLP} - \text{Mean Tahiti SLP})}{\sigma_{\text{Tahiti}}}$$

Where

$$\sigma_{\text{Tahiti}} = \sqrt{\sum \frac{(\text{Actual Tahiti SLP} - \text{Mean Tahiti SLP})^2}{\text{N}}}$$

And

$$\text{Standardized Darwin} = \frac{(\text{Actual Darwin SLP} - \text{Mean Darwin SLP})}{\sigma_{\text{Darwin}}}$$

Where

For the normal SOI, an index number of minus eight indicates an El Niño phase and an index number of plus eight indicates a La Niña phase. The formula above gives the standardized SOI, where the normal anomaly is divided by the mean standard deviation. This converts all La Niña months to have a value of +1 and all El Niño months -1.

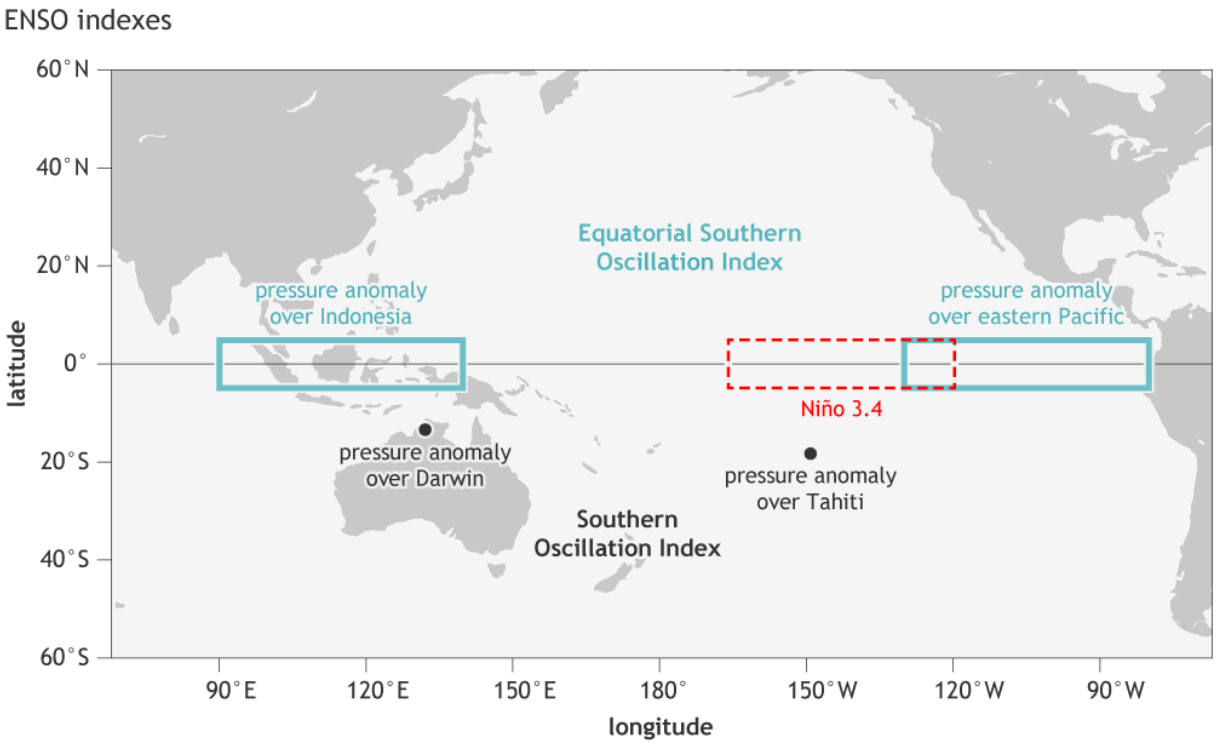

Figure 2: Locations and regions where ENSO indices are constructed from *(Barnston, 2015)*.

Oceanic Niño Index (SST)

The Oceanic Niño Index or in short ONI, measures the sea surface temperature (SST) of the east-central tropical Pacific (Dahlman, 2009). Important to note here is that ONI uses the sea surface temperature to create an index. This can be confusing for the reader. The ONI gives 3 months values of the 'Niño3.4' region, see Figure 2. An index of +0.5 for five consecutive running three-month periods means that an El Niño event is happening, an index of -0.5 mean a La Niña event.

$$\sigma_{\text{Darwin}} = \sqrt{\sum \frac{(\text{Actual Darwin SLP} - \text{Mean Darwin SLP})^2}{\text{N}}}$$

And

$$\text{MSD} = \sqrt{\sum \frac{(\text{Standardized Tahiti} - \text{Standardized Darwin})^2}{\text{M}}}$$

Where

$$\text{N} = \text{Number of months}$$

$$\text{M} = \text{Number of summed months}$$

The calculation of the index is somewhat different than the calculation of the SOI index. Here the average SST of every month is calculated and averaged with the average of the previous and next month. This is called a running three- month average and is compared with the thirty-year average. Then, the running three-month average is compared to the average temperature and this will be the deviation or index number.

Generally, measuring ENSO via SST or air pressure is fairly equal. In Table 3 the correlation between the three mentioned indices are shown. The correlation between the SOI and the equatorial SOI is high (i.e. 0.778) and positive, they are quite equal in behavior. The correlations between SOI and ONI and between ONI and ESOI are also high, -0.747 and -.859 respectively, but these are negative. Both the magnitude and sign of the correlations behave according to theory, since a higher ONI means more chance on El Niño and the SOI and ESOI indices have negative values for indicating El Niño.

For this study SOI is chosen over ONI, because it would lead to higher significance and past El Niño events relate better with SOI (Brunner A. D., 2002). Cashin et al. (2017) also use the SOI, but no further elaboration on the reason is provided. The main research will be done with the SOI values, but as a robustness check ESOI and SST indices will also be used to measure the effects of El Niño on stock returns and trading volume. Table 17 in the appendix shows the summery statistics of the ENSO indices.

Table 3: Correlation matrix between indices measuring strength of ENSO.
*, ** and *** indicate 10%, 5% and 1 % significance levels respectively

	SOI	ONI	ESOI
SOI	1		
ONI	-0.747***	1	
ESOI	0.778***	-0.859***	1

2.2 Effects of El Nino

How El Niño affects stock returns and trading volume is a question that has to be answered after the discovery of a possible effect in the first place. In regression analysis it is difficult to separate the direct and indirect effect of El Niño on stock markets. However, earlier research has been done on the effects of weather, sunshine, clouds and temperature, in general on stock markets. I call this the direct effect. The direct effect is a term that covers everything that has to do with strictly the weather in relation to stock markets. This means it is not the company that is performing well because of a shock in nature but it is the weather or nature itself influencing investors and in turn they may show some more risk-taking behavior or see the future more bright than it is. This is explained more in section 2.2.1. The

indirect effect would be bad or good economic performance by corporations due to El Niño and in turn this affects the stock returns or trading volume. A good example of this is the change from cold nutrient water for fish to warm less nutrient water in front of the Peruvian coastline. This has wide consequences for the fishing industry (Bakun & Broad, 2003). First, I will discuss more literature on the possible direct effect and see what sunshine or clouds can do with stock returns. Subsequently, I will discuss the possible indirect effects of El Niño.

Direct effects

There has been a search for a direct effect of weather on stock markets in the past years. Semi-strong and strong Standard Efficient Market Hypotheses say that there is no effect (Basu, 1977), since everyone is aware of the weather and then the effect would be gone. However, besides known anomalies such as the January effect, momentum anomaly, size or value anomaly, there is some support for a weather anomaly. Saunders (1993) found that there is a high correlation between sunny days on the New York Stock Exchange and stock performance. This is caused by its psychological effect called mood. Mood seems to influence your investing behavior in long positions and expecting future profits to be higher than they really are. More research has been done by Hirshleifer and Shumway (2003). Hirshleifer and Shumway argued that psychological evidence and causal intuition predict that sunny weather is related to having an upbeat mood. In their study they analyze 26 countries with their leading stock exchanges in the period of 1982-1997. They measured the amount of sunshine in the morning and what the effect is on the respective stock exchange. The amount of sunshine is measured with an index called the total sky cover (SKC) where zero is a clear sky and eight is overcast. They also controlled for seasonal effects. In the winter a country often experiences less sunny hours than in the summer. This research was based on earlier research from Saunders but extended to not only sun hours but also the opposite: cloudiness. More clouds mean more trades on the sell side (Chang, Chen, Chou, & Lin, 2008). Later on, they also tried to find a relation between rain and snow and stock exchange performance but no relation was found here. An upbeat mood from sunshine does not automatically implicate a downbeat mood from rain or snow. Hirshleifer and Shumway did find the same high level of correlation between sunshine and stock returns. As an extension of these two studies, Keef and Roush (2007) investigated whether these effects are the same when latitude increases or decreases. They found that the influence on stock returns became more negative when latitude increased (Keef & Roush, 2007). Lastly, other research where mood and latitude were studied was performed by Symeonidis et al. (2010). They studied the effects of weather in the form of cloudiness, precipitation and temperature and nighttime length on stock market volatility. They found an inverse relationship between cloudiness and nighttime length and volatility (Symeonidis, Daskalakis, & Markellos, 2010). If El Niño has any effect on cloudiness or sunshine (since it can lead to

heavy rains or draughts), there might indeed be a possible effect on trading volume. As explained, one of the effects from El Niño is the fact the sea surface temperature rises. As normal temperature is negatively correlated with stock returns (Cao & Wei, 2005), this directly correlates due to apathy and aggression; There has been a search for a direct effect of weather on stock markets in the past years. Semi-strong and strong Standard Efficient Market Hypotheses say that there is no effect (Basu, 1977), since everyone is aware of the weather and then the effect would be gone. However, besides known anomalies such as the January effect, momentum anomaly, size or value anomaly, there is some support for a weather anomaly. Saunders (1993) found that there is a high correlation between sunny days on the New York Stock Exchange and stock performance. This is caused by its psychological effect called mood. Mood seems to influence your investing behavior in long positions and expecting future profits to be higher than they really are. More research has been done by Hirshleifer and Shumway (2003).an investor is willing to take more risk. This correlation also found in earlier studies from Hirshleifer and Shumway (2003). These are a few studies that do find a relation or correlation between weather and stock returns and volatility.

To extract benefits from this weather or sunshine anomaly as an investor, the transaction costs of trading have to be low. Effects of weather on stock markets are not that big that transaction costs can be neglected. For the effect of sunshine on stock markets, transaction costs have to be between 1 and 4 basis points (Hirshleifer & Shumway, 2003). One has to trade frequently on equity markets in order to make profits from a weather anomaly, so when the transaction costs are already mediocre to high, the benefits of trading disappear. For example, trades on the U.S. Market already occur for an average of 1 basis point per transaction (Hirshleifer & Shumway, 2003). Therefore, profits can be made by an investor by implementing a strategy based on weather. Due to digitalization and an increased liquidity of stocks, transaction costs are still decreasing, which is in favor of trading on weather in the future from the perspective of making costs due to trading.

There are also studies that warn for misinterpretation of the results from weather anomalies (Novy-Marx, 2014). Novy-Marx states that the size anomaly in January, when the temperature is relatively low, is related with the fact that it is cold. Cold weather can lead to aggression, which could lead to more risk-taking behavior, implicating that the weather anomaly, in any form, is already a known anomaly. In the case of El Niño most return strategies based on earnings quality come from when the east pacific is unusually warm, implicating an El Niño period (Novy-Marx, 2014). This critique on anomalies in general is that standard predictive regression analysis do not reject the H0 hypothesis that the weather in Manhatten, El Niño and the party of the US president influence these anomalies.

Indirect effects

In addition to the direct effects of weather on stock returns, the indirect effects of El Niño are clearly shown in history. In this paper, I hope to link effects of El Niño on stock returns and trading volume for developing countries to the already found effects for the stock markets. But first it is wise to discuss how these indirect effects might influence stock returns or trading volume.

As mentioned, Brunner states that variation in GDP growth and inflation of G7 economies can be explained for 10-20% because of El Niño and 20% of real commodity price movements between 1963-1997 because of ENSO (Brunner A. D., 2002). Note that these effects on G7 countries relate to an indirect effect of El Niño and Cashin et al. tries to look at these direct as well as indirect effects on countries that suffer or benefit from El Niño. Together, the 33 countries studied cover over 90% of total world GDP. There is extensive literature available on the effect of El Niño on commodity prices where you have winners and losers. Bakun & Broad (2003) describe that the opposite of El Niño, La Niña, brings a lot of fish for the coast of eastern South America, leading to economic benefits because of the increase in fish export (Bakun & Broad, 2003). Another study found a relation between the change in sea temperature because of ENSO events and the change in rice production in Indonesia, providing a tool for managing food securities in one of the world's important rice producing countries (Naylor, Falcon, Rochberg, & Wada, 2001).

One can say that the past decades, the focus of the consequences of ENSO events has been on commodity prices and economic performance. But this can indirectly relate to stock markets. A stock market is a representation of a country since it contains firms often located or originated in that specific country. That almost none of the literature talks about the relation to stock returns is because it was unlikely that a weather phenomenon could have such a big influence. Only until Cashin et al. described the effects on national level in a comprehensive research for a numerous amount of countries in 2017. Here, a causative relation is found between GDP variation, inflation and commodity prices and ENSO events. When El Niño occurred, in general a positive shock followed for the US, Europe and China and a small negative shock in the economies Australia, Chile, Indonesia, New Zealand, India, Japan and South Africa. This leads to the question whether these results are comparable when looking at the effects on the stock market. There is a possibility that the effect of El Niño is underestimated and that is why analysis on developing countries' stock markets has not been executed before.

2.3 Exchange-Traded Funds

Exchange-Traded Funds, or ETFs in short, are a cheap and easy solution to a problem that many passive investors have. A passive investor likes to track an index or put his money into a fund. But tracking an index is costly. One has to sell and buy a certain amount of stocks in order to keep his portfolio weight the same as the index that he is copying. In addition to the transaction costs, it also is time consuming.

One has to constantly monitor and watch what the index is doing. He could also put his money into a fund, knowing that he will have to pay some fee in order for the fund to exist and to make profits. ETFs offer a solution to all investors, small and big. But how do they work?

ETFs are a share, also called a claim on a trust, of a pool of specified assets (Poterba & Shoven, 2002). An authorized financial institution can give certain portfolios of assets or securities to the trustee and in return they get the ETF shares. In turn, these shares can be sold to other investors. If the price of the ETF is diverging from the underlying, also called the Net Asset Value, the holder of the trust will buy the specific securities and put them in the trust. ETFs have a couple of benefits. First, the ETF shares can be sold and bought at any moment in time, whereas with a fund, one can only buy or sell his shares at the end of the day. Secondly, an investor can go long and short with an ETF. With the new option of 'shorting an index' one can apply a long-short strategy and earn profits without a large starting capital (Poterba & Shoven, 2002). Lastly, as an investor you pay only a fraction of the transaction costs in comparison to copying an index yourself or putting your money into a fund (Bodie, Kane, & Marcus, 2014). The combination of these advantages make ETFs very popular under passive investors.

In this research ETFs are used in order to see if one can make profits from a long-short strategy. If El Niño affects a countries' stock returns negatively, the ETF will be shorted. This way, without any capital, one can make a possible profit.

3. Hypotheses development

El Niño affects an economy as a whole. Therefore, I do not look only at major stock indices of developing countries. I 'create' indices myself through Datastream and look at all shares available from one country and make indices from it. Major stock indices often only consist of the largest companies from that developing country and with this new method I expect to see a greater effect than prior research. Data is downloaded from Datastream and the created indices now consist easily of 100 companies in all layers of an economy, small and big. The reason for this is that in general smaller companies have a market that is more domestic than larger companies. Smaller companies may lose more customers if an economy is hit by an ENSO event. Hence, this research looks at not only small or large caps but all together combined, to look for the overall effect.

The magnitude of an El Niño shock differs every time it happens. There are four categories for measuring El Niño: weak, moderate, strong and very strong. For weak, moderate and strong El Niño shocks, the effect on stock returns and trading volume will be weaker than for very strong El Niño shocks. Furthermore, stock returns and trading volume are explained by countless other factors. Trying to find an effect for a weak El Niño is less relevant for this research. This research is interested in a large effect on developing countries. With this result one can apply a long-short strategy with ETFs and try to make a profit. However, due to the fact that very strong El Niño events only occurred in: 1982-1983, 1997-1998 and 2015-2016 and some data from countries start in the late '90s, this research focusses on strong and very strong El Niño. This means a SOI value of -1.5 and lower. As a robustness check, all regular El Niño events with SOI values of -1 and lower will be analyzed. To compare the difference and see whether weaker El Niño events also have less effect on stock returns and volume.

Hypothesis 1:

H0: A strong El Niño shock has effect on stock returns of developing countries

H1: A strong El Niño shock has no effect on stock returns of developing countries

When a country is a developing country, is open for debate. However, that is beyond the scope of this research. For that reason. I focus on the following developing c.q. emerging markets c.q. less developed countries following Cashin et al. (2017) in 3 regions. Asia and Pacific: India, Indonesia, Korea, Malaysia, Philippines, Thailand. South America: Brazil, Chile and Peru. Africa: South Africa.

El Niño can affect stock markets on both returns as well as volume. The volume of trades can also be affected by a shock. Large price declines are almost always followed by large increases in trading volume with respect to the day or week before. A large price incline however, is caused by an increase in volume, but after this incline the trading volume will decrease with respect to the period

before. Note that, trading volume cannot be negative. Similarly with index returns, when I speak about an increase or decrease here, I mean on a percentage basis of the day or month before. One can argue that changes in stock price lead to changes in volume and this effect is almost symmetric (Gallant, Rossi, & Tauchen, 1992). Therefore, I do not expect that the effect will be bigger on trading volume than on stock returns.

Hypothesis 2:
H0: El Niño has an equal effect on trading volume and stock returns
H1: El Niño has a bigger effect on trading volume than on stock returns

At last the effects that are found for winners and losers with the regression analysis will be applied on the ETF market. I expect that the effects found on the aggregated indices of the developing countries will also hold on the ETFs of major stock market indices for those countries. For that reason, I will apply the results found in the first two sections with the ETFs on the NYSE on the '15-'16 El Niño and see whether a long-short strategy is profitable.

Hypothesis 3:
H0: Profits can be made with ETFs using a long-short strategy
H1: No profits can be made with ETFs using a long-short strategy

The ETFs used are MSCI iShares ETFs and they are listed on the NYSE. The exchange is considered to have easy access which is important for this research. The extension on ETFs has as purpose that every investor out there can apply the long-short strategy and not only large institutional investors.

4. Variables (controls)

Searching for the effect of El Niño on stock returns and trading volume also means that one needs to select the right control variables. In a univariate regression we only look at the effect of El Niño on stock returns and trading volume, as if it is the only independent variable that influences stock returns. But there are a lot of variables and forces that explain why a stock price index is at a specific height, so controls are added. Because this research concerns processes on a macroeconomic level, I will only look for macroeconomic variables that explain stock returns, according to the literature. I duly note that microeconomics, local forces, corporation specific facts and other dynamics explain stock prices better and that, therefore, macroeconomic variables have a limited ability to explain stock prices in emerging markets and developing markets (Bilson, Brailsford, & Hooper, 2001). However, as explained, this research focusses on El Niño, an event that has macroeconomic consequences.

A high number of studies on the factors explaining stock returns is concerned with the market of the US or other developed countries. However, the countries of interest for this research are within emerging markets or developing countries. This means that literature focusing on emerging markets will be more relevant.

Trading volume

As mentioned above, trading volume is strongly positively correlated with stock returns (Gallant, Rossi, & Tauchen, 1992). This stands to reason, as the stock price will be partly responsible for the change in volume. In a study by Chen, Firth and Rui (2001), a Granger causality test is carried out for nine countries, concerning the question whether returns cause volume. The study answers this question affirmatively. However, the reverse was also studied and for some countries the results show that volume causes return as well (Chen, Firth, & Rui, 2001). For this reason, both variables, when available, will be added as a control to their regressions. In the study of Flannery & Potopapadakis (2002), the effect of seventeen macroeconomic variables on stock returns and volume is studied. Almost the same conclusions as from Chen, Firth & Rui (2001) can be drawn from the effects of macroeconomic variables on returns and volume. This study, in combination with the studies that suggest a high correlation between the two, makes a case for using the same control variables for both volume and return. Therefore, I expect similar results for both regressions.

Goods market variables (GDP and CPI)

GDP, Gross Domestic Product, is a popular variable to measure economic activity. GDP is widely used as a quantity to measure the state of the economy. No consensus has been established, however, on the relation between GDP and stock prices. The literature does not offer a conclusive answer to the

question whether GDP influences stock prices or trading volume. Primarily, a well-developed and modern stock market generally leads to a long-run positive impact on economic growth (Beck & Levine, 2004). But is this also true *vice versa*? Classical economic theory teaches us that the goods market is the fundamental determinant for stock prices. Wongbangpo & Sharma (2002) find a long-run positive relationship between GNP, Gross National Product, and the stock market of five ASEAN countries, namely: Indonesia, Malaysia, Philippines, Singapore and Thailand. But they also find strong suggestion of a reversed causality. One could argue that GDP/GNP explains fluctuations in stock prices and *vice versa* — arguments for reciprocal influence can be presented. In spite of the implication of this reverse causality, I include GDP as control variable in my research. In reference to the findings of Wongbangpo & Sharma (2002), I expect a positive relationship.

Inflation, or Consumer Price Index, is an important factor that impacts stock returns (Flannery & Protopapadakis, 2002). Inflation can be expected as well as unexpected. Unexpected inflation is considered harmful for an economy, because a sudden rise in input prices takes up some months or quarters to fully pass on to the market. But after some months the economy will be in a steady state again, with the possibility for consumers to spend more money and save less. This means that they invest less, to consume just the equal amount of goods. Whether CPI has a positive or a negative effect on stock returns depends on a number of things. First, it is consequential whether a stock is in its value or growth phase. Secondly, the magnitude of the inflation is relevant. Lastly, it matters whether an economy is in a contracting or expanding phase (Zuchhi, 2017). For the five ASEAN countries, CPI relates negatively to stock prices in the long run. Therefore, I expect a negative relationship (Wongbangpo & Sharma, 2002). Whereas Bilson et al. (2001), in a research of 20 emerging markets, did not suggest a strong relationship between CPI and equity indices on a monthly basis. Overall, the goods market is represented with GDP and CPI.

Money Market (M1 and interest rates)

The money market variables in this study consist of money supply type M1, which is the most liquid part of money supply, and interest rates. One can describe the effect of money supply on stock prices in the same way as the effect of an El Niño shock on stock prices. Money supply has a direct and indirect effect on stock prices. The direct effect produces an increase of money supply to change the portfolio of investors. Consequently, investors need a new equilibrium in their portfolio, since money has a new position with regard to the other assets, shares included (Brunner K. , 1961; Friedman, 1961). Money supply also has effect on interest rates and inflation, which are responsible for the indirect effect on stock prices (Dhakal, Kandil, & Sharma, 1993). The long-run effects described by Wongbangpo & Sharma (2002) for the five ASEAN countries are both negative and positive. In a study on macroeconomic variables and equity returns of twenty emerging markets, money supply (here: M1)

also had effect on equity returns. The findings show that the effect was for the greater part positive but for some countries the effect was negative. From this we may conclude that a positive and negative effect can be expected

Interest rates also have an effect on stock prices. Before a market 'feels' the change of interest rate by e.g. the FED or ECB, it already is reflected in stock prices. Usually a rise will lead to a decrease in stock price and *vice versa*. However, due to lack of data it is not possible to include short or long interest rates. For both variables, most countries do not have a record of data whatsoever, whereas the record of the other emerging markets/developing countries do not extend far enough back in time.

Others (exchange rate & import and export)

The exchange rate variable is the most influential macroeconomic variable according to Bilson et al. (2001). In their study with macroeconomic variables such as money supply, exchange rate, goods prices and real activity, this variable stood out as the most significant in most countries this can be explained as follows. The relationship was often negative, that is why I expect this to be a negative relationship in most countries. When a domestic currency devaluates, one's dollar denominated returns will increase (Bilson, Brailsford, & Hooper, 2001). That is why, it is a negative relationship. It is also seen as a measure of openness for foreign capital flow.

The macroeconomic level of import and export behave in the same manner as the FX-rate, since the exchange rate influences import and export of goods to a high extent. Fluctuating between being a cheap currency — allowing foreigners to purchase relatively cheap goods— and being an expensive currency, leading to a decline in export. Also, import and export do not appear very frequently in the literature.

Lagged stock return

To control for autocorrelation in a model, the 1 period lag of stock returns can be added (Akgiray, 1989). Returns of the previous period can in essence influence returns of the next period. However, in his study, Akgiray (1989) concludes that this only holds true for daily data. Significantly, the data used in this study is monthly data. This would imply that the lagged stock return does not have to be included in this model. However, when one looks at the anomaly momentum for instance, for a short investment period up to twelve months, a winner is more likely to become a winner and *vice versa*. That is why I think stock returns can predict next month's returns to a small extent and the lagged return is incorporated into the model.

5. Methodology & Data

For the selection of countries, Cashin et al. (2017) is followed. This means that the selection was based on the likelihood of a country being affected by El Niño, considering their primary sector and geographical location. All data except for ENSO indices is retrieved from Datastream. All countries except for Brazil have composite stock indices. Due to lack of data for a composite index, the large Brazil Stock Market (Bovespa) is used. Data on trading volume is missing for the countries Malaysia, Brazil, Chile and Peru. Furthermore, ENSO indices are all collected from the website of the National Oceanic and Atmospheric datacenter (NOAA, Monthly Atmospheric and SST Indices, 2017).

All downloaded indices are price indices and the following formula is used to create the percentage stock return per month.

$$R_{it} = 100 * \frac{P_{it} - P_{it-1}}{P_{it-1}} \quad (1)$$

The start of the time period coincides with the start of the first composite index of South Korea in December 1974. The latest starting index is South Africa in July 1995 (see Table 4 for the summery statistics on the return indices). Data on skewness and kurtosis are added to these statistics to show all four moments of an investment return distribution (Kamstra, Kramer, & Levi, 2003). The mean and variance, or standard deviation, are the first two and skewness and kurtosis are the third and fourth one. Firstly, skewness measures the degree of asymmetry where positive skewness is a right-tailed skewed return distribution and negative skewness is a left-tailed return distribution. Secondly, kurtosis measures if a return distribution peaks or is flat and the frequency of extreme outcomes. The "peakyness" of a distribution will result in a positive kurtosis value and a flatter distribution will show a negative kurtosis value.

Stock returns do not tend to be normally distributed (Kamstra, Kramer, & Levi, 2003). When looking at the histograms of the return distributions, they show to be superficially normal except for some outliers. The outliers can be left alone, trimmed or be winsorized. As can be seen, the number of observations is not that large. Hence, trimming them would lead to less observations and would not be an optimal solution. If they are left alone it may bias the results of the study. This is why I chose to use the option winsor at the 1st and 99th percentile after examining all histograms.

Table 4: Descriptive statistics of all created return indices for ten countries.
All indices except for Brazil are composite indices. This means that it contains all shares from that index, small and large cap companies. Brazil Bovespa is the large cap index of Brazil due the fact that a composite index was not available. Mean, median, standard deviation, max and min are all in percentages. The time interval is a month and all indices end on September 2017 and start at an individual month and year.

	Market	Mean	Median	St.Dev.	Max	Min	Skewness	Kurtosis	Obs.
India	*Nifty 500*	1.13	1.08	6.91	20.97	-19.36	0.04	4.00	413
Indonesia	*IDX composite*	1.28	1.36	7.99	23.17	-20.66	-0.09	3.57	320
South Korea	*KOSPI*	0.95	0.44	6.84	21.81	-15.74	0.46	3.89	513
Malaysia	*KLCI*	0.71	0.77	6.76	23.31	-19.89	0.09	4.69	452
Philippines	*PSEI*	1.43	1.19	8.47	37.40	-24.07	0.62	6.37	380
Thailand	*Bangkok SET*	0.90	0.74	7.69	28.47	-21.62	0.28	5.19	509
Brazil	*Bovespa*	5.33	2.03	15.71	83.33	-23.08	2.24	10.41	319
Chile	*IGPA*	1.42	0.72	5.30	17.67	-11.17	0.60	3.81	368
Peru	*IGBVL*	2.55	1.24	9.91	39.60	-19.68	1.22	5.97	320
South Africa	*FTSE/JSE*	1.11	1.05	4.99	12.84	-13.31	-0.11	3.24	267

A few things stand out. Brazil experiences on average the highest growth with 5.33%, but also the highest peak month of 83.33% even after winsorizing. When looking deeper into this data, I observe that the max and min are all in the first 4 year of data. This is due to the fact that the price index is rounded and starts very low at 0.1. After a few months of 0.1 an increase to 0.2 leads to an enormous increase in return. Winsorizing at the 1st and 99th percentile corrects this a few times, but this happens in more than 1% of the time. For this reason, the average is high — 5.33% — but the median is a fairly normal 2.03%. South Korea and Thailand are the oldest markets here and both observe the lowest average and median, which stands to reason, as they represent the most mature markets. Returns of Indonesia and Malaysia have lower mean returns than median returns. A rule of thumb is often that a lower mean than median is a negative skewed return distribution and the other way around. However, when a distribution has a long and a heavy tail — simply put: if the tails are unequal — the rule of thumb does not have to apply (Hippel, 2005). According to the rule of thumb Malaysia should have a negative skewness and South Africa should have a positive one, but this is the other way around. All other countries have a median-skewness relation according to theory. Interpreting skewness and kurtosis and the normality of these return distributions have to be done with caution.

First, for testing normality a number of tests is available. The Jarque-Bera test, which is constructed from the third and fourth higher moment, needs more observations than these return

distributions. With a lower number of observations, it is more difficult to observe a normal distribution because of the way the formula is constructed. Neither is the Kolmogorov-Smirnov test a strong test for normality. With skewness and kurtosis one can also test normality in Stata, but results have to be interpreted with caution. A H0 hypothesis can statistically be rejected in a skewness-kurtosis test, but still have very 'normal-like' properties in its histogram and distribution of returns. The skewness-kurtosis test shows that only Indonesia and South Africa are normally distributed. However, as pointed out, all other return distributions, besides from the fact that they are positive or negative skewed or have fat tails, also can have normal distribution properties. In conclusion, one should be very careful in interpreting the results from statistical tests.

Next, the statistical software, Stata, uses a formula[2] for measuring kurtosis where no kurtosis means a value of 0. Often another formula[3] is used which implicated a value of 3 when no kurtosis is measured. Brazil and Peru observe high values of kurtosis, 10.41 and 5.97 respectively. Thus, being the most 'peaky' with fat tails. It is normal for stock returns to observe kurtotic values (Kamstra, Kramer, & Levi, 2003). Lastly, Brazil is highest skewed with 2.24.

The other dependent variable of interest is trading volume. The volume data is only available for India, Indonesia, South Korea, Philippines, Thailand and South Africa. The variable is a count variable, which implies that its values increase discrete. Table 5 shows the summery statistics of the trading volume variables. A few things are worth mentioning. First of all, in all cases the variance, so standard deviation squared, is larger than the mean. This is called overdispersion. Secondly, there are no values of zero. And lastly, the variable is a count variable. After inspecting the histograms of the normal variable and taking the natural logarithm of volume, the conclusion is that a normal OLS method does not fit the distribution of the variable perfectly. In count data models such as Poisson and negative binomial are more common. Moreover, in a another study on trading volume, the negative binomial distribution is used specifically (Glaser & Weber, 2009). The negative binomial model fits this data best, because the data on trading volume meets all three conditions. Namely: Non zero values, higher variance than mean (overdispersion) and variable is count data (Lawless, 1987).

2

$$Kurtosis = \frac{\frac{\sum(x-\bar{x})^4}{n}}{\left(\frac{\sum(x-\bar{x})^2}{n}\right)^2}$$

3

$$Kurtosis = \frac{\frac{\sum(x-\bar{x})^4}{n}}{\left(\frac{\sum(x-\bar{x})^2}{n}\right)^2} - 3$$

Table 5: Descriptive statistics of trading volume.
Values are in millions. Observation time interval is monthly and all observations are winsorized at the 1st and 99th percentile.

	India	Indonesia	South Korea	Philippines	Thailand	South Africa
Mean	52187	7253274	4955	51414	40991	3655407
Median	25338	6017897	5243	35099	2500	3743925
St.Dev.	62612	5972925	4598	54423	70820	1072087
Max	283703	2.30e+07	20690	322377	323480	6489469
Min	27	75076	24	3609	.26	754878
Skewness	1.532068	.6442387	.6883254	2.74956	2.145535	.0573777
Kurtosis	5.455445	2.496638	3.023687	11.87703	7.168478	3.173156
Obs	333	272	399	369	510	182

Table 6 gives the descriptive statistics of the control variables. GDP is seasonally adjusted. CPI and money supply are not seasonally adjusted.

Table 6: Descriptive statistics of the control variables.
GDP stands for Gross Domestic Product and is shown in billions. CPI stands for Consumer Price Index where the year shown in column two shows the year that the index is 100. Money supply is type M1 and shown in billions. FX-rate stand for the exchange rate for every month that translates national currency for US dollar. Any missing countries indicate that there is no data on that specific variable. GDP and money supply are rounded to billions.

GDP

	Currency	Mean	Median	St.Dev.	Max	Min	Obs
India	*INR*	25993	25611	3304	32529	20225	73
Indonesia	*IDR*	2061931	2063263	228305	2472772	1642356	88
South Korea	*KRW*	174510	164753	113017	381456	26450	511
Malaysia	*MYR*	243808	242648	26123	291053	201921	88
Philippines	*PHP*	1.31e+09	1.27e+09	3.75e+08	2.12e+09	8.26e+08	232
Thailand	*THB*	1.72e+09	1.69e+09	4.36e+08	2.52e+09	1.04e+09	292
Brazil	*BRL*	7.55e+08	6.33e+08	4.62e+08	1.63e+09	2.00e+08	256
Chile	*CLP*	35634	35715	797	36787	34005	52
Peru	*PEN*	64789860	53773163	27305287	1.28e+08	35611554	448
South Africa	*ZAR*	1.97e+09	1.74e+09	5.93e+08	3.09e+09	1.20e+09	511

CPI

	CPI=100	Mean	Median	St.Dev.	Max	Min	Obs
India	*2012*	113.93	116.30	14.53	135.40	86.81	81
Indonesia	*2012*	73.00	72.86	32.90	129.91	19.16	261
South Korea	*2015*	56.96	57.33	28.70	102.77	9.81	514

Malaysia	*2010*	72.06	71.00	24.58	118.90	33.10	513
Philippines	*2006*	63.63	58.20	46.26	147.80	4.99	514
Thailand	*2015*	61.29	61.50	25.47	101.10	19.10	501
Brazil	*1993m12*	1615.02	1466.28	1527.30	4832.27	0.00	454
Chile	*2013*	51.11	56.20	37.23	115.20	0.24	514
Peru	*2009*	52.53	63.41	46.00	127.20	0.00	514
South Africa	*2016m12*	36.31	30.40	29.48	102.40	2.40	514

Money supply

	Currency	Mean	Median	St.Dev.	Max	Min	Obs
India	*INR*	5798	2151	7535	26931	123	513
Indonesia	*IDR*	233544	53751	330472	1237643	1073	513
South Korea	*KRW*	189959	99364	208733	791637	960	513
Malaysia	*MYR*	120358	72807	112560	387107	7243	403
Philippines	*PHP*	5.91e+08	2.32e+08	7.84e+08	3.17e+09	14800000	476
Thailand	*THB*	1004	907	468	1871	372	248
Brazil	*BRL*	96497	44308	112839	326330	0	453
Chile	*CLP*	6036	2324	8275	29825	1	514
Peru	*PEN*	19411913	6790000	23859668	75260000	0	392
South Africa	*ZAR*	3.55e+08	1.28e+08	4.41e+08	1.60e+09	4068000	513

FX-rate

	Currency	Mean	Median	St.Dev.	Max	Min	Obs
India	*INR*	32.17	35.01	18.71	67.25	7.79	513
South Korea	*KRW*	907.92	885.05	250.13	1407.50	484.00	514
Malaysia	*MYR*	3.02	2.73	0.63	4.43	2.15	514
Philippines	*PHP*	31.19	27.70	16.34	56.17	7.07	514
Thailand	*THB*	29.75	26.47	7.26	45.28	20.38	514
Brazil	*BRL*	1.84	1.90	0.99	3.88	0.00	321
Chile	*CLP*	399.53	458.28	251.57	829.18	4.05	514
Peru	*PEN*	2.61	2.85	0.99	3.58	0.00	349
South Africa	*ZAR*	5.06	4.21	3.73	14.93	0.69	513

Overall, the control variable GDP has a number of missing observations for some countries. This is due to the fact that the recording of data started late. Different sources are consulted for acquiring the appropriate data. Yet Datastream was the source with the most suitable data. GDP is given on a quarterly basis and the time interval used is monthly. To overcome this problem there are several solutions such as linear interpolation and cubic spline interpolation. The statistical software package Stata, which is used in this study, experiences problems with cubic spline interpolation, when

the sequence of observations is both ascending and descending. Therefore, Matlab is used to calculate the monthly observations from quarterly data with the cubic spline interpolation method. This method does not generate new observations, but gives an approximation on the months between the quarters. When using these estimates, systematic correlation can enter the model, because the calculated estimates are calculated systematically with Matlab. However, no auto or serial correlation was found.

This research focusses on only strong and very strong El Niño shocks. Consequently, a larger effect is expected than if the SOI index on its own would be regressed on returns and volume. A simple univariate regression is executed for stock returns, following Saunders (1993) and Hirshleifer and Shumway (2003). If only the SOI index would be the independent variable, the studied effect will be also on positive values and that may also have bearing on La Niña for instance.

This study looks at the effect of strong El Niño events on stock returns and trading volume, that is why the SOI variable includes only values lower than -1.5. To recapitulate: the SOI index, measures the difference in air pressure between Tahiti and Darwin at the 'Niño3.4' region. The stock returns use a method called Ordinary Least Squares to regress the stock returns for all countries with a simple univariate regression.

$$R_{it} = \beta_0 + \beta_1 NINOSTRONG_t + \varepsilon_t \quad (2)$$

Where NINOSTRONG stands for all values of SOI lower than and equal to -1.5. A negative value in the regression analysis means that El Niño influences stock returns positively, because El Niño is represented to all values of the SOI index lower than -1.5 in this study. Although this study is mainly focused on the effects of a strong El Niño, the effects of a regular El Niño on stock returns and trading volume is also studied. Tables are presented in the Appendix and significant differences between the two models are noted. The SOI index will have a value of lower than and equal to -1 in these tables. Trading volume is using a Generalized Linear Model that is different from OLS. Because of the overdispersion, the Poisson regression is not suited in this case. The negative binomial distribution is also a log normal relationship and can be written as:

$$V_{it} = exp(\beta_0 + \beta_1 NINOSTRONG_t + \varepsilon_t) \quad (3)$$

Keeping in mind that this can be rewritten to:

$$V_{it} = e^{\beta_0} * e^{\beta_1 NINOSTRONG_t} * e^{\varepsilon_t} \quad (4)$$

El Niño is a phenomenon that does not happen overnight. As has been explained, El Niño slowly builds up and can be active for a couple of months or a year. To study the effects on the stock markets on impact, meaning in the same month, would be incomplete. For this reason, the effects will be studied up to 4 quarters later. The losses or profits that firms possibly make are now visible on their balance sheets and investors possibly react to this. The following two regressions will investigate this effect for stock returns and trading volume.

$$R_{it} = \beta_0 + \beta_1 NINOSTRONG_t + \beta_2 NINOSTRONG_{t-3} + \beta_3 NINOSTRONG_{t-6} + \beta_4 NINOSTRONG_{t-9} + \beta_5 NINOSTRONG_{t-12} + \varepsilon_t \quad (5)$$

$$V_{it} = \exp(\beta_0 + \beta_1 NINOSTRONG_t + \beta_2 NINOSTRONG_{t-3} + \beta_3 NINOSTRONG_{t-6} + \beta_4 NINOSTRONG_{t-9} + \beta_5 NINOSTRONG_{t-12} + \varepsilon_t) \quad (6)$$

Again, the NINOSTRONG values represent SOI values of -1.5 and lower. Although these regressions are simple and do not consist of any control variables, the first indication will clarify whether El Niño has a bigger impact on returns or volume. After examining these simple relations, I will continue and add control variables for the full regression analysis with the following formulas:

$$R_{it} = \beta_0 + \beta_1 NINOSTRONG_t + \beta_2 NINOSTRONG_{t-3} + \beta_3 NINOSTRONG_{t-6} + \beta_4 NINOSTRONG_{t-9} + \beta_5 NINOSTRONG_{t-12} + \beta_{11} GDP_{it} + \beta_{12} CPI_{it} + \beta_{13} M1_{it} + \beta_{14} FXrate_{it} + \beta_{15} R_{it-1} + \varepsilon_t \quad (7)$$

$$V_{it} = exp(\beta_0 + \beta_1 NINOSTRONG_t + \beta_2 NINOSTRONG_{t-3} + \beta_3 NINOSTRONG_{t-6} + \beta_4 NINOSTRONG_{t-9} + \beta_5 NINOSTRONG_{t-12} + \beta_{11} GDP_{it} + \beta_{12} CPI_{it} + \beta_{13} M1_{it} + \beta_{14} FXrate_{it} + \beta_{15} R_{it-1} + \varepsilon_t) \quad (8)$$

After these results one will have a better view on the effects and possible relation between El Niño and stock returns and trading volume. These results will be used to distinguish 'winners' and 'losers'. After that, the portfolios of winners and losers are implemented in a long-short strategy with ETFs of the researched countries on the NYSE. Transaction costs will be accounted for to complete the strategy.

6. Results

The results of this study on El Niño will be presented following the order of the section Methodology & Data: first the simple regression, than the lagged form of the simple regression and, ultimately, the full regression with added control variables. Subsequently, the stock returns and trading volume results will be compared with each other. Table 7 gives a simple correlation matrix of the returns and volumes for the respective countries. This indicates that the earlier mentioned studies on the correlation between prices and volume is indeed true for my sample (Gallant, Rossi, & Tauchen, 1992). Therefore, I do not expect to see great differences between variables and results. However, since the two are positively correlated, I expect that a negative impact on returns will lead to an increase in shares sold, and hence s a positive effect on trading volume.

Table 7 : Simple correlation table between stock prices and trading volume.
*Trading volume corresponds with its stock return. *, ** and *** indicate 10%, 5% and 1 % significance levels respectively*

Stock Returns	India	Indonesia	South Korea	Philippines	Thailand	South Africa
Volume	0.851***	0.915***	0.878***	0.825***	0.685***	0.597***

Table 6 demonstrates that GDP has a high number of missing observations for the countries India, Indonesia, Malaysia and Chile. CPI for India as well. This is due to the fact that Datastream did not yield data on that certain period. Dealing with countries that are less developed or are not part of the modern western world comes with a number of difficulties. The data on GDP can also be downloaded on a different source, but with a time interval of a year. This study, however, had to be carried out based on data gathered on a monthly basis. Fitting a linear interpolation or cubic spline interpolation from a year to 12 months is not feasible. Cubic spline interpolation does not give new observations, it only gives approximations for the missing months. One observation versus eleven approximations is not very reliable. When the variable GDP was added to the regression of India, Indonesia, Malaysia and Chile it also caused severe multicollinearity with VIF values of over a 100 and F-tests of the model being not significant. The multicollinearity was caused by a drop of 75% in observations for some countries. Results cannot be interpreted with any certainty in these cases. Furthermore, the results are also tested for serial correlation with a Durban Watson test and for heteroskedasticity. Neither have been found.

The results will be presented in the following manner. First, I will discuss the effects of a strong El Niño with SOI values lower than and equal to -1.5 on stock returns. After that I will discuss the effects on trading volume. Secondly, every type of regression is concluded with an extra comparison between the effects of an El Niño with a SOI value of -1 and regular El Niño shocks. These tables are shown in

the appendix and will serve as a first indication of the difference between stronger and weaker El Niño events and as a robustness check for the results. After this section, the results will be discussed in the section discussion.

6.1 Regression analysis

Univariate regressions

Table 8 presents the univariate regression results of a strong El Niño on stock returns. Important to note is that a negative effect in the table means a positive effect on stock returns. These results show the effects on impact, meaning that the effect is studied within the same time interval of a month. A few things stand out. First, Brazil is the only return index that shows significant results at the 1%-level. A unit increase is less El Niño, so 1 unit decrease of SOI, which means more El Niño, leads to an increase of stock returns by 5.36%. Furthermore, every alpha is significant at least at the 5%-level. Lastly, the r-squared values of all regressions are low. This was to be expected for reasons explained earlier in chapter 4 Variables. It has, for instance, been made clear that the performance of businesses on an individual level and many more variables explain the variance of stock market indices better. It is unexpected, however, that some countries do not show any significance at all. According to theory, Peru should be hit hard by a strong El Niño. According to the semi strong EMH, a possible explanation could be that El Niño is already priced in. However, no conclusions pointing in this direction can be drawn yet from these results. The next regression will be with lagged variables to see whether El Niño impacts stock returns with some delay.

Table 8: Simple univariate regression on stock returns.
NINOSTRONG stands for the El Niño with a SOI value of lower than and equal of -1.5. The countries represent the composite stock market indices. Observations are in monthly intervals and R-squared represents the variance of stock return that is explained by the independent variables. The values are in whole percentages. A negative value for NINOSTRONG is actually an increase in returns, since El Niño is represented by all values of -1.5 and lower. Alpha is the intercept and the t-statistics are presented in parentheses. *, ** and *** indicate 10%, 5% and 1 % significance levels respectively.

	India	Indonesia	South Korea	Malaysia	Philippines
NINOSTRONG	-1.2994	-0.9722	-0.0849	-0.4307	0.3095
	(-1.54)	(-0.97)	(-0.14)	(-0.69)	(0.30)
alpha	1.0327***	1.1858***	0.9404***	0.6617**	1.4590***
	(2.99)	(2.59)	(3.04)	(2.03)	(3.28)
Obs	413	320	513	452	380
R-squared	0.006	0.003	0.000	0.001	0.000

	Thailand	Brazil	Chile	Peru	South Africa
NINOSTRONG	-0.6204	-5.3593***	-0.3684	-0.3648	-0.9056
	(-0.90)	(-2.74)	(-0.57)	(-0.29)	(-1.20)
alpha	0.8297**	4.8199***	1.3841***	2.5166***	1.0420***
	(2.38)	(5.41)	(4.90)	(4.43)	(3.35)
Obs	509	319	368	320	267
R-squared	0.002	0.023	0.001	0.000	0.005

The negative binomial regression results have to be interpreted differently. The coefficient NINOSTRONG, for instance, means: a one unit increase in SOI index leads to a difference in logs of expected counts, expected to decrease or increase by the value of the coefficient, keeping all other variables constant. The constant is similar to OLS in a sense that if all variables in the model are zero, the log for expected counts for trading volume is the value shown in units trading volume. The variable trading volume is denoted in millions. The shown pseudo r-squared is the McFadden r-squared[4] from a contribution in a book (McFadden, 1973). A McFadden r-squared between 0.2 and 0.4 can be interpreted as a great fit. The original r-squared, used in the OLS method with returns, tends to be higher in general. The z-statistic is the regression coefficient divided by its standard error. Similarly, with the t-statistic, a big negative or positive z-statistic means that the regression coefficient is not equal to zero.

Table 9 shows the results of the univariate regression on trading volume. The pseudo r-squared values are very low and based on these simple results, we cannot say that El Niño effects trading volume on impact. The alphas however, are significant on the 1%-level. To give an example of the interpretation of the coefficients of NINOSTRONG: India has a coefficient of 0.2177. All else equal, an

[4] Formula in stata is $1 - \frac{\log Likelihood(model)}{\log Likelihood(null)}$

increase of SOI by 1 unit will lead to an increase of $Exp(0.2177) = 1.24\ (i.e.\ 24\%)$ trading volume. More El Niño, a decrease in SOI, will lead to a decrease in trading volume. It has to be noted that an increase of SOI by 1 unit is a very large increase, since its scale only goes from -4 to +4. However, this coefficient is not significant, so it cannot be interpreted with any certainty.

Table 9: Simple univariate negative binomial regression on trading volume.
NINOSTRONG stands for the El Niño with a SOI value of lower than and equal of -1.5. The countries represent the number of shares traded in millions. Observations are in monthly intervals. Pseudo R-squared represents not the same as it does with OLS. It represents McFadden's pseudo R-squared where a value between 0.2 and 0.4 implicates an excellent fit. A negative value for NINOSTRONG is actually an increase in trading volume, since El Niño is represented by all values of -1.5 and lower. Alpha is the intercept and the z-statistics are presented in parentheses. *, ** and *** indicate 10%, 5% and 1 % significance levels respectively.

	India	Indonesia	South Korea	Philippines	Thailand	South Africa
NINOSTRONG	0.2177	-0.0599	0.1256	0.1171	0.1303	-0.0038
	(1.13)	(-0.35)	(0.83)	(1.15)	(0.62)	(-0.06)
alpha	10.8798***	15.7927***	8.5171***	10.8567***	10.6337***	15.1115***
	(126.66)	(252.59)	(132.84)	(239.61)	(105.78)	(635.76)
Obs	333	272	399	369	510	182
Pseudo R-squared	0.0001	0.0000	0.0001	0.0001	0.0000	0.0000

In comparing strong and normal El Niño events a few things stand out. Table 18 in the appendix presents the results for all regular El Niño shocks on stock returns with a SOI index of -1 and lower. There are no large differences. All coefficients change a bit. The significance level of the constant of Malaysia changes from the 5%-to 10%-level and El Niño on impact causes the Brazilian Bovespa to increase by 4.17% instead of 5.36% — both significant at the 1%-level. This decrease in magnitude can be explained by the fact that now weaker El Niño shocks are incorporated into the model. Weaker El Niño events have less devastating consequences than very strong shocks. Table 19 shows the results on trading volume. Now, South Korea and India show significant coefficients at the 5%-level. Possibly, this can be explained by the fact that more observations can be studied. For India, an one unit decrease in SOI leads to an decrease in volume by 44.8%, which is a high decrease. A stronger El Niño shock now means a decrease in trading volume. Also, the McFadden r-squared values are all substantially higher.

Univariate lagged regression

Table 10 shows the univariate regression for stock returns but now with lagged coefficients up to 12 months. Some significant results can be observed. Six months after a strong El Niño the effect on the reaction on the South Korean stock markets seems to be negative (sign of the coefficient is reversed if we talk about a stronger El Niño) with 1.55%. This is significant at the 5%-level. However, a quarter later, significant at the 1%-level, the market recovers again and a positive effect is observed. The same effect seems to happen at the Peruvian stock market, but now in month 3 and 9. Next, El Niño seems

to effect the Brazilian stock market still on impact with around 5% and also after 12 months. Both effects are positive on the Brazilian market. The companies that benefit with higher stock returns from El Niño, might profit from the increased rain in the south of Brazil.

Table 10: Univariate lagged regression on stock returns.
NINOSTRONG stands for the El Niño with a SOI value of lower than and equal of -1.5. Each lag represents a quarter later than impact. The countries represent the composite stock market indices. Observations are in monthly intervals and R-squared represents the variance of stock return that is explained by the independent variables. The values are in whole percentages. A negative value for NINOSTRONG is actually an increase in returns, since El Niño is represented by all values of -1.5 and lower. Alpha is the intercept and the t-statistics are presented in parentheses. *, ** and *** indicate 10%, 5% and 1 % significance levels respectively.

	India	Indonesia	South Korea	Malaysia	Philippines
NINOSTRONG	-1.3481	-1.1958	-0.5192	-0.7041	0.1712
	(-1.58)	(-1.16)	(-0.80)	(-1.05)	(0.16)
L3.NINOSTRONG	0.3667	1.1921	0.5175	0.5935	0.2057
	(0.47)	(1.14)	(0.76)	(0.84)	(0.19)
L6.NINOSTRONG	1.8947***	-0.8443	1.5469**	0.4334	2.3333**
	(2.60)	(-0.81)	(2.28)	(0.62)	(2.18)
L9.NINOSTRONG	-0.8016	0.7037	-2.1767***	-1.1263	-1.4395
	(-1.11)	(0.68)	(-3.19)	(-1.59)	(-1.35)
L12.NINOSTRONG	0.6827	-0.9350	0.2087	0.5984	-0.8383
	(1.00)	(-0.93)	(0.32)	(0.89)	(-0.80)
alpha	1.2642***	1.1703**	0.8617***	0.6883**	1.4695***
	(3.46)	(2.39)	(2.62)	(1.99)	(3.13)
Obs	413	320	502	452	380
R-squared	0.027	0.012	0.027	0.009	0.019

	Thailand	Brazil	Chile	Peru	South Africa
NINOSTRONG	-0.8625	-5.8984***	-0.6493	-1.0364	-0.9901
	(-1.17)	(-2.98)	(-0.99)	(-0.83)	(-1.29)
L3.NINOSTRONG	0.7311	1.5988	1.3019*	2.7357**	0.3535
	(0.95)	(0.80)	(1.95)	(2.14)	(0.46)
L6.NINOSTRONG	-0.1028	-1.2778	0.3557	-0.3609	-0.2228
	(-0.13)	(-0.64)	(0.53)	(-0.28)	(-0.29)
L9.NINOSTRONG	-0.8239	0.1614	-0.4237	-3.2711**	0.1006
	(-1.07)	(0.08)	(-0.63)	(-2.57)	(0.13)
L12.NINOSTRONG	0.1189	-5.7165***	-0.9576	-0.7276	-0.7647
	(0.16)	(-2.89)	(-1.45)	(-0.59)	(-1.02)
alpha	0.8268**	4.2679***	1.3837***	2.2937***	0.9895***
	(2.22)	(4.53)	(4.63)	(3.84)	(2.99)
Obs	502	319	368	320	267
R-squared	0.006	0.052	0.021	0.039	0.010

Furthermore, significant effects are observed in India and the Philippines. After adding control variables in the multivariate regression, the observed effects can be interpreted with more certainty. All r-squared values are increased.

Table 11 shows the lagged univariate results on trading volume. Where at the stock returns more significant results were observed, only one value can be interpreted with some certainty at the 5%-level. After three months El Niño affects the Philippines trading volume with 28%, which is substantial. Overall, the reason why a negative binomial regression is used, is because of the overdispersion. In all the trading volume variables a high variance is observed. Trading volume fluctuates more than stock returns and El Niño seems to affect volume more than returns in magnitude. McFadden's r-squared values here also are observed higher than in the previous regressions.

Table 11: Univariate lagged negative binomial regression on trading volume.
NINOSTRONG stands for the El Niño with a SOI value of lower than and equal of -1.5. The countries represent the number of shares traded in millions. Observations are in monthly intervals. Pseudo R-squared represents not the same as it does with OLS. It represents McFadden's pseudo R-squared where a value between 0.2 and 0.4 implicates an excellent fit. A negative value for NINOSTRONG is actually an increase in trading volume, since El Niño is represented by all values of -1.5 and lower. Alpha is the intercept and the z-statistics are presented in parentheses. *, ** and *** indicate 10%, 5% and 1 % significance levels respectively.

	India	Indonesia	South Korea	Philippines	Thailand	South Africa
NINOSTRONG	0.1886	-0.0684	0.1168	0.0988	0.1036	0.0076
	(0.96)	(-0.40)	(0.76)	(0.96)	(0.48)	(0.12)
L3.NINOSTRONG	0.1812	0.0331	0.1399	0.2444**	0.1956	-0.0966
	(0.89)	(0.20)	(0.89)	(2.14)	(0.89)	(-1.46)
L6.NINOSTRONG	0.0995	-0.0324	0.1193	0.1638	-0.0058	-0.0043
	(0.49)	(-0.20)	(0.78)	(1.40)	(-0.03)	(-0.07)
L9.NINOSTRONG	-0.0416	-0.0097	0.0580	0.0488	0.0162	-0.0611
	(-0.20)	(-0.06)	(0.38)	(0.43)	(0.07)	(-0.95)
L12.NINOSTRONG	-0.0913	-0.0266	0.1098	0.0687	0.0614	-0.0796
	(-0.45)	(-0.17)	(0.73)	(0.63)	(0.28)	(-1.23)
alpha	10.8860***	15.7888***	8.5467***	10.8920***	10.6726***	15.0948***
	(117.41)	(236.74)	(125.79)	(229.60)	(98.00)	(609.66)
Obs	333	272	399	369	502	182
Pseudo R-squared	0.0003	0.0000	0.0004	0.0012	0.0001	0.0009

Table 20 shows the results for all El Niño events with SOI values of -1 and lower on stock returns. Generally, the same effects are observed. However, the magnitudes are a bit smaller and the significance drops one star at a number of places. That the magnitudes are smaller stands to reason. Weaker El Niño events can lead to less dramatic effects on the stock markets. Peru is the only exception in this scenario. The coefficients increase, as does the significance. Now, El Niño also affects the stock

market on impact. This result may be explained by the fact that more observations are now taken into account. Further information will be shown at the multivariate regressions. Table 21 in the appendix shows almost the same results as Table 11, except for South Korea. Normal El Niño events affect stock returns in South Korea on impact and after 12 months, but these results have to be interpreted with caution, since the relation is weak, at the 10%-level.

Multivariate regression analysis

Finally, the full model is employed and control variables are added to try to take away some of the variance in stock returns in order to present as accurate an assessment as possible of the impact of strong El Niño shocks on stock returns. What stands out in Table 12 is that it is difficult to predict stock returns with macroeconomic variables. CPI, lagged returns and the FX-rate of Chile are not significant. GDP is left out of the regression four times, because of the mentioned multicollinearity and large drop in observations. The other six regression denote a value of 0.0000 for GDP. GDP is measured in billions — which is a large number— and this deflates the value to a small number. Similarly to the lagged univariate results, India', South Korea', Chile' and Peru' stock market demonstrate in the same quarters the same sign but with a slightly different magnitude.

Table 12: Multivariate lagged regression on stock returns.

NINOSTRONG stands for the El Niño with a SOI value of lower than and equal of -1.5. Each lag represents a quarter later than impact. GDP stands for Growth Domestic Product. CPI stands for Consumer Price Index. M1 stands for money supply type 1. FX-rate stands for the exchange rate of the national currency for 1 dollar. L.Return stands for stock returns of the previous month. N/A stand for not available. The countries represent the composite stock market indices. Observations are in monthly intervals and R-squared represents the variance of stock return that is explained by the independent variables. The values are in whole percentages. A negative value for NINOSTRONG is actually an increase in returns, since El Niño is represented by all values of -1.5 and lower. Alpha is the intercept and the t-statistics are presented in parentheses. *, ** and *** indicate 10%, 5% and 1 % significance levels respectively.

	India	Indonesia	South Korea	Malaysia	Philippines
NINOSTRONG	-1.1397	0.3319	-0.3745	-0.1907	-0.0153
	(-1.36)	(0.29)	(-0.57)	(-0.23)	(-0.01)
L3.NINOSTRONG	0.3401	1.0336	0.5352	1.7515**	0.5231
	(0.41)	(0.89)	(0.77)	(2.12)	(0.49)
L6.NINOSTRONG	2.0044***	-1.1439	1.6435**	0.8693	1.1375
	(2.78)	(-0.99)	(2.40)	(1.05)	(1.08)
L9.NINOSTRONG	-0.8372	0.1805	-2.0533***	-1.4504*	-2.4027**
	(-1.18)	(0.16)	(-2.99)	(-1.79)	(-2.26)
L12.NINOSTRONG	0.3778	-1.0655	0.3511	0.3282	-1.0494
	(0.56)	(-0.93)	(0.53)	(0.41)	(-1.00)
GDP	n/a	n/a	-0.0000	n/a	-0.0000
			(-0.75)		(-0.77)

CPI	n/a	0.0297	0.0419	-0.0333	0.1784
		(0.58)	(0.31)	(-0.52)	(1.29)
M1	-0.0000	-0.0000	0.0000	0.0000	0.0000
	(-0.23)	(-0.62)	(1.09)	(0.34)	(0.31)
FX-rate	0.0139	n/a	0.0027	-0.0030	0.0981
	(0.38)		(0.99)	(-0.00)	(1.07)
L.Return	0.2101***	0.0489	0.0656	0.0758	0.1126*
	(4.34)	(0.77)	(1.46)	(1.50)	(1.71)
alpha	0.5975	0.3271	-0.1758	3.0676	-6.4361
	(0.56)	(0.18)	(-0.13)	(1.06)	(-0.83)
Obs	411	260	499	397	232
R-squared	0.071	0.015	0.039	0.036	0.070

	Thailand	Brazil	Chile	Peru	South Africa
NINOSTRONG	-1.4133	-0.9654	-0.4790	-0.4538	-1.1039
	(-1.13)	(-0.79)	(-0.76)	(-0.37)	(-1.41)
L3.NINOSTRONG	2.2905*	2.6232**	1.3712**	3.2506***	0.2272
	(1.78)	(2.13)	(2.14)	(2.62)	(0.29)
L6.NINOSTRONG	-0.5069	-1.2618	0.3322	-0.2424	-0.3656
	(-0.40)	(-1.01)	(0.52)	(-0.20)	(-0.46)
L9.NINOSTRONG	-1.8234	-0.5367	-0.4553	-2.7293**	-0.0386
	(-1.45)	(-0.43)	(-0.71)	(-2.19)	(-0.05)
L12.NINOSTRONG	-0.1720	-3.2532***	-1.0021	-0.0591	-0.9319
	(-0.14)	(-2.63)	(-1.58)	(-0.05)	(-1.20)
GDP	-0.0000	-0.0000	n/a	0.0000	0.0000
	(-0.47)	(-0.97)		(1.01)	(0.34)
CPI	-0.0022	0.0036	-0.1714**	-0.3350**	0.0321
	(-0.01)	(0.90)	(-2.42)	(-2.17)	(0.21)
M1	0.0049	-0.0000	0.0000	0.0000	-0.0000
	(0.66)	(-0.14)	(0.24)	(0.20)	(-0.41)
FX-rate	0.0727	-0.1040	0.0252*	3.8092	-0.1856
	(0.51)	(-0.09)	(1.81)	(1.33)	(-0.80)
L.Return	0.0182	0.0213	0.2208***	0.1146**	-0.0308
	(0.28)	(0.34)	(4.30)	(2.05)	(-0.49)
alpha	0.7820	-0.9930	-0.5996	5.9974	-0.4895
	(0.05)	(-0.29)	(-0.23)	(1.05)	(-0.09)
Obs	246	256	367	316	263
R-squared	0.034	0.072	0.119	0.127	0.022

Brazil and Philippines show different results. El Niño now affects the Brazilian stock market not positively on impact, but negatively in the first quarter. An effect of -2.62% is observed for strong El Niño shocks in Brazil and a positive effect of 2.4% in the Philippines. R-squared values increase enormously — for Peru even to 0.127 — and are in line with comparable and earlier mentioned studies (Saunders, 1993; Chang, Chen, Chou, & Lin, 2008).

Table 13 presents the multivariate analysis results of El Niño on trading volume. Overall, the model looks strong with very high increases in pseudo r-squared values and the H0 hypothesis that coefficients equal zero can be rejected. Now the control variables are in general more often significant, which indicates that these macroeconomic variables do affect trading volume. El Niño does not affect trading volume on impact at a minimum of the 10%-level for all six markets. The strongest effects are visible on the Indian and the Filipino market. In India, El Niño has the strongest effects in the fourth quarter, where volume drops an astounding 49.9% at the 1%-level of significance. The other quarters the number of shares sold drops between 27- and 35%. In the Philippines trade seems to drops (remember a unit increase of SOI is very large and more El Niño means a unit decrease), up to 27.8% in the second quarter after impact. Furthermore, weaker relations are found for Indonesia and Thailand both in magnitude and the strength of the correlation itself. El Niño again does not seem to affect the South African stock market in volume or returns.

In comparing strong El Niño events (Table 12) to all El Niño events (Table 22) on stock returns as a robustness of the results one observes the same tendencies with the multivariate analysis as with the univariate lagged analysis. Magnitudes drop slightly and significance levels also drop a star-level. R-squared values decrease as well. Peru is again the only exception and the effect increases in magnitude. Table 23 presents the results for NINO and trading volume. Differences are observed for India and Thailand. Now the magnitude decreased and only in the fourth quarter are significant results observed. The reversed is true for Thailand where the magnitude and number of quarters that affect trading volume increases. Effects of the controls are consistent and the values for pseudo r-squared also.

Table 13: Multivariate lagged negative binomial regression on trading volume.
NINOSTRONG stands for the El Niño with a SOI value of lower than and equal of -1.5. GDP stands for Growth Domestic Product. CPI stands for Consumer Price Index. M1 stands for money supply type 1. FX-rate stands for the exchange rate of the national currency for 1 dollar. L.Return stands for stock returns of the previous month. N/A stand for not available. The countries represent the number of shares traded in millions. Observations are in monthly intervals. Pseudo R-squared represents not the same as it does with OLS. It represents McFadden's pseudo R-squared where a value between 0.2 and 0.4 implicates an excellent fit. Trading volume is noted in millions. A negative value for NINOSTRONG is actually an increase in trading volume, since El Niño is represented by all values of -1.5 and lower. Alpha is the intercept and the z-statistics are presented in parentheses. *, ** and *** indicate 10%, 5% and 1 % significance levels respectively.

	India	Indonesia	South Korea	Philippines	Thailand	South Africa
NINOSTRONG	0.1420	-0.0023	0.0035	-0.0690	0.1050	0.0427
	(1.15)	(-0.05)	(0.05)	(-0.61)	(1.52)	(0.88)
L3.NINOSTRONG	0.2436*	0.0542	0.0198	0.2453**	0.1423*	-0.0546
	(1.94)	(1.15)	(0.26)	(2.27)	(1.96)	(-1.09)
L6.NINOSTRONG	0.2514**	0.0091	0.0672	0.2266**	0.0208	0.0190
	(2.06)	(0.19)	(0.87)	(2.14)	(0.28)	(0.39)
L9.NINOSTRONG	0.3147**	0.0635	-0.0347	0.1920*	-0.0046	-0.0103
	(2.40)	(1.30)	(-0.45)	(1.79)	(-0.06)	(-0.21)
L12.NINOSTRONG	0.4046***	0.0906*	-0.0668	0.1363	0.0594	-0.0286
	(3.14)	(1.90)	(-0.86)	(1.27)	(0.82)	(-0.57)
GDP	n/a	n/a	0.0000***	0.0000***	0.0000***	0.0000***
			(3.09)	(4.44)	(9.09)	(3.24)
CPI	n/a	0.0627***	0.0068	-0.0410***	0.0221	-0.0042
		(28.22)	(0.27)	(-3.04)	(1.58)	(-0.56)
M1	0.0001***	-0.0000***	-0.0000***	-0.0000***	-0.0019***	0.0000
	(7.56)	(-14.58)	(-7.30)	(-4.64)	(-4.06)	(0.32)
FX-rate	0.1020***	n/a	0.0036***	-0.1023***	0.0680***	-0.0112
	(7.65)		(13.29)	(-10.46)	(7.43)	(-0.64)
L.Return	0.0278***	0.0141***	0.0153***	0.0154**	0.0274***	-0.0054
	(3.76)	(5.56)	(3.53)	(2.25)	(6.99)	(-1.37)
alpha	4.6051***	12.1548***	0.6302**	11.6811***	-0.4266	13.2255***
	(8.95)	(147.92)	(2.03)	(16.53)	(-0.44)	(23.78)
Obs	332	259	396	232	246	179
Pseudo R-squared	0.0455	0.0721	0.0929	0.0219	0.0779	0.0191

6.2 Investment strategy

In this section the previous results on stock returns are used to try to develop a profitable investment strategy on the ’15-’16 El Niño. The strategy used is a long-short strategy. First, some more information and details on the ’15-’16 El Niño is needed in order to make a decision on when to buy and when to sell. Next, the ETFs in combination with transaction costs are explained and the returns over time are shown. At last the presented effects are used to see if one can make a profit.

The 2015-2016 El Niño is one of the strongest El Niño shocks measured since the beginning of accurate measuring in the 1950’s (Jacox, et al., 2016). There are multiple indices which give values to its strength and these indices all measure temperature or air pressure at slightly different places. That is why one index reports the strongest El Niño up to date and others report that the ’15-’16 El Niño is in the top 3. In 2014 high SST anomalies were reported which are the first signs of a coming El Niño. This failed to develop to full strength but the temperature at the ‘Niño3.4’ region stayed higher than normal. This led to a built up and in November 2015 the warmest SST anomaly was noted (Jacox, et al., 2016). For this reason, it is difficult to set an exact date when El Niño starts and when it ends. In this study the SOI index is used to determine and establish the effects of El Niño on stock markets. For this reason, the SOI index here is used to determine the beginning and ending period from the ’15-’16 El Niño. Figure 3 shows SOI values from begin 2014 to end 2016.

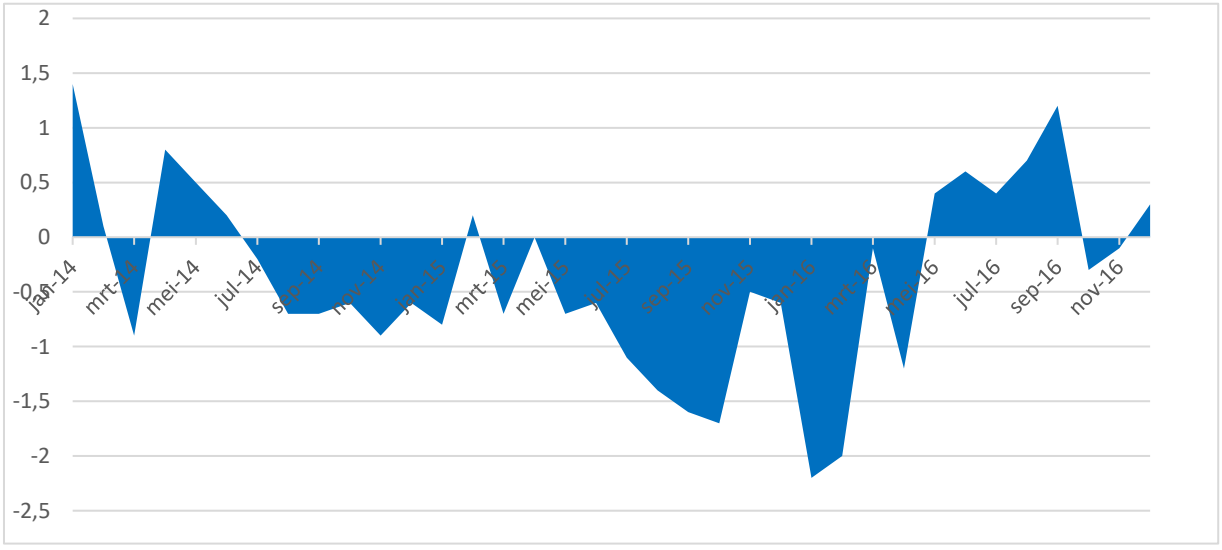

Figure 3: SOI values from 2014 to 2016
Depicts the slow build-up from 2014 to the strong El Niño of ’15-’16. Values lower than and equal to -1 are official El Niño values. Source: own creation

The data on ETFs is obtained via Datastream and contains MSCI iShares ETF funds from the studied countries. The expense ratios of the ETFs are given in their prospectus and deviate from 71 bps to 48 bps. Expense ratios are subtracted every year from your investment with this percentage. The first year this is only your initial investment, but the second year this is from your total fund amount

including accrued gains. The assumption that I make here is that this is the only cost for an investor. The fixed costs at your broker to buy this ETF is different for large and small investors and hard to account for. This cost is also very small, thus leaved out of the equation.

Earlier mentioned in the literature review is that 8 months in advance at earliest, the first prediction models give their information about the magnitude and start of a coming El Niño. However, this comes with great uncertainty and high wrong prediction rates. Even in 2014, meteorologists thought that a strong El Niño was on their doorstep. This was delayed until 2015, which was only observed early 2015. If an investor is willing to invest and implement a long-short strategy on El Niño, he has to make a trade-off: do you invest according to a prediction model with the risk of a wrong prediction, or do you wait until the ENSO indices begin to measure temperature or air-pressure anomalies. For this reason, I will investigate four possibilities with relating arguments on why this is the right moment to get on board. But first in Figure 4, all 10 ETF prices are shown from January 2014 to January 2017. This figure already shows what was expected before this research in the first place. Almost all ETFs, or indices, experience a downfall during the El Niño period from 2015-2016.

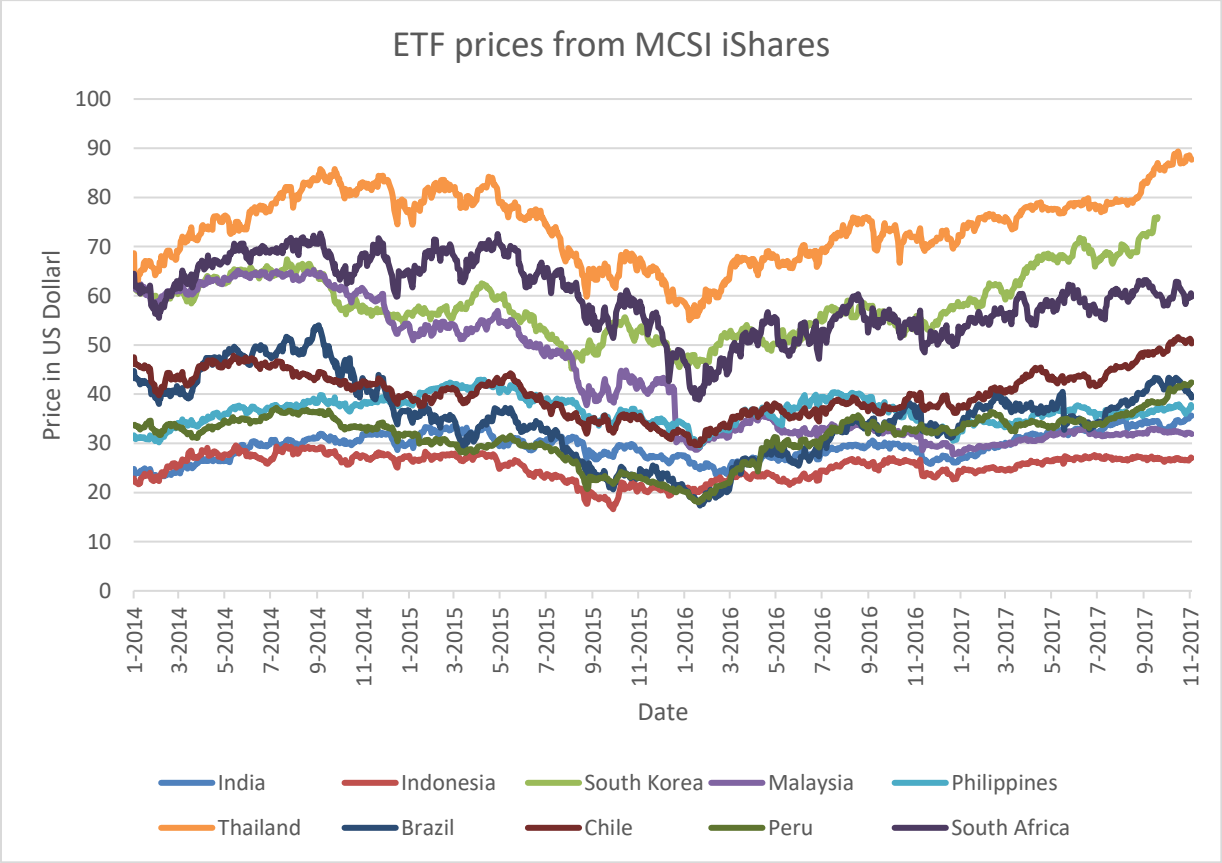

Figure 4: ETF prices from MSCI iShares
All ETFs are listed on the NYSE. The period chosen is relating to the slow build-up from the strong El Niño in '15-'16. All ETF prices are on a daily basis. Source: own creation

Table 14 shows all ETFs with corresponding long-short strategy. The strategies and timing are dependent on the results in Table 12, where no significant effects of El Niño are found in Indonesia and South Africa. Therefore, these countries are left out of the portfolio.

Table 14: ETFs with corresponding investment strategy
The expense ratios are obtained from the prospectuses of the corresponding ETFs. The timing of short and long is determined based on Table 12 of this research where the effect between strong El Niño shocks and composite stock indices are studied. All noted effects are based on at least a 10% significance-level. When no long or short strategy is noted, no effect is found.

Country	ETF	Expense ratio	Short	Long
India	iShares MSCI India ETF	0.71%	Lagged 6 months	-
South Korea	iShares MSCI South Korea Capped ETF	0.64%	Lagged 6 months	Lagged 9 months
Malaysia	iShares MSCI Malaysia ETF	0.48%	Lagged 3 months	Lagged 9 months
Philippines	iShares MSCI Philippines ETF	0.64%	-	Lagged 9 months
Thailand	iShares MSCI Thailand Capped ETF	0.63%	Lagged 3 months	-
Brazil	iShares MSCI Brazil Capped ETF	0.63%	Lagged 3 months	Lagged 12 months
Chile	iShares MSCI Chile Capped ETF	0.64%	Lagged 3 months	-
Peru	iShares MSCI All Peru Capped ETF	0.63%	Lagged 3 months	Lagged 9 months

Investors try to find the most optimal point in time to invest their capital in. The optimal timing is often different for a lot of investors, depending on their investment goals. This section will discuss 4 different moments in time to see whether one can reap benefits of El Niño with ETFs. Remember that the indices in this research are composite indices where small- and large-cap companies are all under one return index. The effects found can be different when looking at ETFs, since these track only the large capped companies on their specific exchanges. Nonetheless, Figure 4 shows that large returns could be obtained with the right strategy. The 4 strategies with respect to the start of the investment that will be investigated are: on impact, 8 months prior to impact but with lags, 8 months prior to impact and 8 months prior to the wrong predicted El Niño of 2014. At the beginning of each month, according to Table 14, after El Niño impact, the ETFs will be shorted or a long position will be held. This position will be held for exactly one month, because the study on stock returns is also run in lagged months after impact. After this month the position will close again.

First, what the impact moment of El Niño is, is determined by the SOI index. A strong El Niño has an SOI index of -1.5 and lower. The first option on impact means that the trades will be done with the corresponding lags. This means for example that the ETF for India will be shorted at the beginning of the 6^{th} month after impact and will be bought back at the end of the 6^{th} month. The second strategy is with the theory that 8 months before an El Niño there are prediction centers that will predict an El

Niño with some uncertainty of course. But the assumption is made that an investor is willing to take that risk. The next assumption is that he still looks at the significant effects of this study and will just invest 8 months prior to the previous option. For South Korea, Malaysia, Brazil and Peru, the effects were first negative and after that, the price indices of those countries seem to rebound back up again. There is a chronological time order. For this reason, the long positions after a short position are not held 8 months prior to strategy 1. Otherwise one does not profit from the rebound effect. These 4 strategies have all the same closing time of all positions, which corresponds exactly with the results that are found in this study. Philippines for example only has a long strategy and here a long position is held 8 months prior to strategy 1. For clarification, Table 24 in the appendix shows all prices and expense ratios to the corresponding dates of Table 15 on the long and short positions. Strategy 3 relates to the efficient market hypothesis. Here, all first positions are held 8 months prior to impact, instead of 8 months prior to the investment moment with lags. The theory behind it is that when information, in this case about El Niño, flows to the market, the market will react on it immediately on it. The last strategy or timing is in 2014, when a strong El Niño was predicted. If investors rely on these ENSO forecasts, there is a possibility that they might invest directly on it, the same as in strategy 3. Therefore, this option is also investigated.

At last the returns can be calculated and the long-short strategy can be implemented. But first a small note on the long-short strategy. The intention was to short losers and go long in winners at the same time. However, the results showed that El Niño affects most countries at different months. This is according to theory, therefore an investor cannot short and go long directly at the same time. When this is the case, an investor would not need any start capital and this would make the strategy applicable for every investor.[5] Nevertheless, only a small start capital is needed to apply this strategy since most countries start off with negative stock returns which imply shorting the ETF. With shorting you get money first and you buy the share back at a later point in time.

[5] Note: not every investor is allowed to short shares, or in this case ETFs. However, the assumption is made that the investor is allowed to short.

Table 15: Opening and closing dates of all long-short positions								
	India	*South Korea*	*Malaysia*	*Philip.*	*Thailand*	*Brazil*	*Chile*	*Peru*
Strategy 1 – On impact September 2015								
Open short	3-1-16	3-1-16	12-1-15		12-1-15	12-1-15	12-1-15	12-1-15
Close short	3-31-16	3-31-16	12-31-15		12-31-15	12-31-15	12-31-15	12-31-15
Open long		6-1-16	6-1-16	6-1-16		9-1-16		6-1-16
Close long		6-30-16	6-30-16	6-30-16		9-30-16		6-30-16
Strategy 2 – 8 months prior to impact September 2015 (with lags)								
Open short	7-1-15	7-1-15	4-1-15		4-1-15	4-1-15	4-1-15	4-1-15
Close short	3-31-16	3-31-16	12-31-15		12-31-15	12-31-15	12-31-15	12-31-15
Open long		6-1-16	6-1-16	10-1-15		9-1-16		6-1-16
Close long		6-30-16	6-30-16	6-30-16		9-30-16		6-30-16
Strategy 3 – 8 months prior to impact September 2015 (without lags)								
Open short	1-1-15	1-1-15	1-1-15		1-1-15	1-1-15	1-1-15	1-1-15
Close short	3-31-16	3-31-16	12-31-15		12-31-15	12-31-15	12-31-15	12-31-15
Open long		6-1-16	6-1-16	1-1-15		9-1-16		6-1-16
Close long		6-30-16	6-30-16	6-30-16		9-30-16		6-30-16
Strategy 4 – 8 months prior to expected impact November 2014								
Open short	3-3-14	3-3-14	3-3-14		3-3-14	3-3-14	3-3-14	3-3-14
Close short	3-31-16	3-31-16	12-31-15		12-31-15	12-31-15	12-31-15	12-31-15
Open long		6-1-16	6-1-16	3-3-14		9-1-16		6-1-16
Close long		6-30-16	6-30-16	6-30-16		9-30-16		6-30-16

Table 16 gives the total return for every country's ETF. The results are above my expectation. In Figure 4 one can observe that large decreases in price are visible and the timing of the downwards and upward trend looks as if it correlates with the strong El Niño of '15-'16. Every strategy is profitable in total.[6] For simplicity the assumption is made that every position, whether long or short, is done with the same amount of money. This way the returns can be added and subtracted from each other. In Malaysia and Brazil, large returns up to 52% can be earned, but also Peru is an exceptional ETF to put your money in. These returns over a period of two years are worth investing in. Table 24 in the appendix gives a full overview of the strategies. Here is shown that the short positions earn the highest returns.

[6] Only looking at the returns. Risks are not incorporated into the model.

Table 16: Total returns on long-short strategy

Returns are in whole percentages and are total returns. This means long and short position returns are added and/or subtracted. Expense ratios are also accounted for. Calculation on total returns is done in Table 24 in the appendix. Where:
Strategy 1 – On impact September 2015
Strategy 2 – 8 months prior to impact September 2015 (with lags)
Strategy 3 – 8 months prior to impact September 2015 (without lags)
Strategy 4 – 8 months prior to expected impact November 2014

	India	*South Korea*	*Malaysia*	*Philippines*	*Thailand*	*Brazil*	*Chile*	*Peru*
Strategy 1	7.89	3.23	1.5	4.23	4.07	6.3	3.46	8.3
Strategy 2	11.02	3.21	44.98	14.7	24.17	40.79	19.25	37.9
Strategy 3	8.355	9.246	45.028	1.886	20.426	47.436	16.436	43.446
Strategy 4	-14.525	16.046	51.818	15.656	11.456	52.036	22.306	45.826

The 4 different strategies are four options that an investor can have in my opinion. Strategy 1 and 2 are more short-term positions, within 1 year. Strategy 3 and 4 are positions of 1 to 2 years. Of course, with hindsight, larger returns could have been earned, but these 4 strategies cover most options on the ends of the spectrum that investors can invest on. The largest returns could have been made if an investor directly reacts on a prediction of a coming El Niño, strategy 3 and 4. The believers in an El Niño in 2014 got rewarded, because a year later one of the strongest measured yet El Niño shocks was registered. However, large losses could also have been occurred if the prediction was wrong. Therefore, the results have to be interpreted with caution. This is all with hindsight. Also, other factors in those countries could have been responsible for a decrease and increase in prices. But the tendency of a decline and increase is not bound by location as it is visible in both Latin America and the countries pacific. This gives the impression that indeed returns can be made from El Niño. Which leads to the conclusion that H0 of hypothesis 3 — that profits can be made with ETFs using a long-short strategy — cannot be rejected, since profits can be made for every strategy. This also answers sub-question 3: was a long-short strategy profitable on ETFs for stock indices in the most recent strong El Niño of 2015-2016, with yes. Yet, the magnitude differs per country, strategy 4 reports a loss in India and South Africa and Indonesia are left out of the equation at all.

7. Robustness

In order to check if the results that are suggested are robust, a two way of testing is applied. The first test is the extension towards normal El Niño events with the same ENSO index and the second test is using different ENSO indices.

The first extension is already discussed, and all tables are presented in the appendix. To summarize this shortly, the magnitudes and significance-levels mostly moved according to logical thinking. This serves as a robustness for the results on strong El Niño events. Magnitudes became a little bit smaller and often 1 star-level of significance was turned in. Peru was the only exception. Here magnitudes increased and more months were significant. The total number of SOI values of strong El Niño shocks studied is 5.1%, where normal El Niño shocks had 14% of total SOI values. This indicates that there is a substantial difference in observations between the two, which might play a role. But again, no conclusion can be drawn here, and this is a topic for future research.

The second extension is with different ENSO indices, namely: ESOI and ONI. The ESOI measures differences in air pressure but at locations at the equator and ONI measures the sea surface temperature in the 'Niño3.4' region. Earlier mentioned in the literature review, others studied the SOI index for more significant results (Brunner A. D., 2002; Cashin, Mohaddes, & Raissi, 2017). The ESOI index indeed shows very few significant results. Only Peru has results at the 1%-significance-level. Here, decreases are followed by increases with respect to stock returns. This is similar to the SOI index. Furthermore, very weak correlations are found for the Philippines and South Africa. This is surprising, since South Africa did not show any significant results with the SOI index. Now it looks like El Niño does indeed affect stock returns in South Africa. ONI presents even less significant results. Very few results can be interpreted with certainty, and only South Korea, Malaysia and Chile show significance at the 10%-level. However, also here the tendency of a downward movement and back up again is visible. This confirms the results which are found with the SOI index.

8. Discussion

In this thesis I studied the effects of El Niño events on stock returns and trading volume. The findings are a decrease in stock returns first followed up by an increase. Trading volume tends to decrease after an El Niño impact. In general, the results of El Nino on stock returns are better than expected. Previous studies showed difficulties in finding significant results linking influences of nature, such as temperature, sunshine and ENSO events, to stock returns and other performance variables such as GDP. Overall, a tendency of a strong El Niño shock that hits stock returns negatively in several quarters (1^{st}, 2^{nd} and 3^{rd} after impact) can be observed and one or two quarters later the stock market recuperates and returns are boosted up again. This holds true for South Korea, Malaysia, Brazil and Peru. Especially the two countries in Latin America show large effects. Returns of Brazil and Peru both decline the 1^{st} quarter after impact with 2.62% and 3.25% and later increases with 3.25% and 2.73% respectively.

The null hypothesis from hypothesis 1 — that a strong El Niño shock has effect on stock returns of developing countries — cannot be rejected since strong El Niño events in general affect stock returns. If countries are studied separately, no effects can be found on the South African and Indonesian stock markets. Thus, for those countries one can reject the null hypothesis that El Niño affects stock returns. A weak effect is shown for Thailand where El Niño affects the stock returns at the 10%-level after the 1^{st} quarter on impact with 2.29%.

Before hypothesis 2 can be discussed, two things are important. First, only six countries had a record on trading volume via Datastream. Therefore, the results have to be interpreted with care. Secondly, returns and volume have a different distribution, because they are two different types of variables. Trading volume is a count variable and has a negative binomial distribution where a GLM method is used to regress the effects. Stock returns uses OLS and is a continuous variable. Taking these things into account, the Philippines and India observe the biggest effects on trading volume. Trading volume decreases in the 4^{rd} quarter after impact with 49.9% in India. Also with trading volume, the Indonesian and South African markets denote the smallest or no effect when looking at the p-values. El Niño shows higher effects in percentages on trading volume, but the variance is very large thus it increases and decreases a lot. El Niño shocks affects more often stock return and can also be explained according to theory. That is why the H0 hypothesis from hypothesis 2 — that El Niño has an equal effect on trading volume and stock returns — cannot be rejected completely. The effect is bigger in magnitude, but not for the number of markets.

Regarding the research question with its sub-questions, clear answers can be provided. Sub-question 1: what is the effect of an El Niño shock on stock returns of developing countries, is answered in the results section using the multivariate analysis and shows a tendency to a decline of returns and

a recovery in later quarters. Sub-question 2: is the effect on trading volume different than on stock returns for developing countries, is clarified in the previous paragraph. Indeed, the effect of El Niño on trading volume is substantially different than on stock returns. There is a difference in magnitude and the effect is also always decreasing, where El Niño also has positive effect on stock returns. This is against expectations about trading volume. Where an increase in trading volume was expected due to a sudden rise or downfall of the stock price. Earlier stated, that no matter if a country is a 'winner' or a 'loser', trading volume increases (Gallant, Rossi, & Tauchen, 1992). Topic of future research will be why returns tend to decrease first and subsequently increase. One reason could be because of the suggested recovery of the market, but a second reason could be that companies benefit in later quarters after the impact because of the positive consequences of El Niño, such as rain. A last reason could be, that the impact of El Niño is anticipated by investors and after the impact of El Niño, the stock prices increase back to 'normal' levels again. The last and third sub-question: was a long-short strategy profitable on ETFs for stock indices in the most recent strong El Niño of 2015-2016, can be answered with yes. A long-short strategy was profitable for all 4 strategies on impact, 8 months prior to impact with lags, 8 months prior to impact and for the predicted El Niño in 2014.

In order to study whether the results from a strong El Niño hold strong when all regular El Niño events (SOI value -1.5 versus -1 and lower) are taken into account, a check was performed with tables that are shown in the appendix. The results appear to be normal and following logic. If weaker El Niño events are added to the regression equation, one would expect a result with a smaller magnitude. Weaker El Niño shocks do indeed affect countries with less intensity and less often I observe significant results with exception of Peru. Further study is needed to explain why this happens.

There are limitations to this study. First, the biggest limitation is the lack of data. The data availability on stock returns starts at very different times in history. South Korea already has data that goes back to 1974 and Indonesia for instance starts recording in 1991. Since the time unit is in months and El Niño happens every 3 to 7 years, it would benefit the results and the reliance of this study if all data on returns started in the '80s, since all the strongest El Niño events were in this time slot. That there is a big variety on when an index has available data, could be due to the fact that in this study is chosen for a composite index of all shares, located at these large exchanges. However, this tradeoff is made because the small listed companies may be affected more by strong El Niño shocks than large companies. This is due to the customer base which is more local at small companies and smaller companies might have less capital reserves to incur losses. The data on trading volume is not available for Malaysia, Brazil, Chile and Peru. It is harder to make a comparison between trading volume and returns in hypotheses 2 if there are 4 missing countries. The control variables are also subject to lack of data. As mentioned, the short and long interest rates and GDP had to be dropped in some cases due to multicollinearity. If all these cases can be fixed, one would have a better and more complete

understanding of the effects of a strong El Niño on stock returns and trading volume. This is a suggestion for further research.

Another limitation is the investment-strategy. All investors have a risk-return tradeoff, but in this thesis only the return part is studied. How these ETFs fit in one's portfolio is different for all investors. Trading blindly only on El Niño may not be a good idea, the efficient market frontier should always be kept in mind. Further research is suggested to more investment strategies to get a better idea of the possibilities for investors. A suggestion here is that Jensen's alpha in the Fama-French three-factor model can be used. Jensen's alpha measures excess returns, this implicates that it is controlled for risk. This also has to be tested on a future El Niño.

9. Conclusion

This study extends prior research on the economic effects of El Niño of Cashin et al. (2017) and Brunner (2002) with a new perspective: the world of finance. The study to the effects of El Niño on trading volume and stock return is performed for 6 and 10 countries respectively. The results are used to implement an investment opportunity for normal investors using ETFs on the NYSE. To study the effects on stock returns, a multivariate OLS method is used. The effects on trading volume are studied using a negative binomial regression analysis, which is a GLM method.

The strongest natural inter-annual climate change does affect stock returns and trading volume of 10 developing countries and emerging markets, except for Indonesia and South Africa. The effect of an El Niño shock on stock returns of developing countries can be summarized as that the shock causes both winners and losers from 1.5% up to 3.5% on a monthly basis. It is clearly visible that a market is first a 'loser' and after that it recovers. Returns are higher, and the market becomes a winner again. Stock returns differ from the effects on trading volume. The effects that are observed on volume are bigger in magnitude. 12 months after impact, the volume at the Indian market drops with 49.9%, which is the largest observed drop.

With the presented results a long-short strategy is implemented to see if profits could be made from the '15-'16 El Niño. Large returns could have been earned if investors followed the efficient market hypothesis and directly reacted to the first warnings of a possible El Niño event with strategy 3 — 8 months prior to the impact of September 2015 — and strategy 4 — 8 months prior to the expected El Niño of November 2014. The direct long-short strategy on impact of strategy 1 and the 8 months prior to impact with lags, strategy 2 are also profitable, but they result in a less higher total return. Even after controlling for the expense ratio the returns are higher than expected. This is partly due to the shorter holding period than strategy 3 and 4. The ETFs are listed on the NYSE and can be bought by anyone and based on these results, I highly recommend to do so during the coming El Niño. Since El Niño is an irregular occurring event, I expect that this suggested trading anomaly will maintain to exist. Furthermore, it is not possible yet to predict an ENSO event with a lot of certainty.

With this concluding remark, this study suggests that the weather, in the form of El Niño, affects stock returns and trading volume. Institutional and regular investors can earn profits when they trade on this large weather phenomenon.

Appendix

Table 17: Summery statistics of three indices measuring the Southern Oscillation Cycle. SOI stands for Southern Oscillation Index. ONI stands for Oceanic Niño Index and ESOI stands for Equatorial Southern Oscillation Index. Start of the indices is December 1974, with the start of the first return distribution. Time interval is in months.

	SOI	ONI	ESOI
Mean	.05	.03	-.01
Median	0	-.03	.05
St.Dev.	.98	.85	.98
Max	2.9	2.64	3
Min	-3.6	-1.85	-3.5
Obs	514	513	514

Table 18: Simple univariate regression on stock returns.
NINO stands for the El Niño with a SOI value of lower than and equal of -1. The countries represent the composite stock market indices. Observations are in monthly intervals and R-squared represents the variance of stock return that is explained by the independent variables. The values are in whole percentages. A negative value for NINOSTRONG is actually an increase in returns, since El Niño is represented by all values of -1 and lower. Alpha is the intercept and the t-statistics are presented in parentheses. *, ** and *** indicate 10%, 5% and 1 % significance levels respectively.

	India	Indonesia	South Korea	Malaysia	Philippines
NINO	-0.4007	0.1312	-0.2605	-0.4495	-0.7912
	(-0.61)	(0.16)	(-0.50)	(-0.84)	(-0.98)
alpha	1.0584***	1.3047***	0.8940***	0.6116*	1.2699***
	(2.92)	(2.73)	(2.77)	(1.80)	(2.73)
Obs	413	320	513	452	380
R-squared	0.001	0.000	0.000	0.002	0.003

	Thailand	Brazil	Chile	Peru	South Africa
NINO	-0.5275	-4.1731***	-0.2082	-1.5749	-0.5861
	(-0.90)	(-2.60)	(-0.40)	(-1.54)	(-0.95)
alpha	0.7842**	4.4937***	1.3743***	2.2359***	1.0212***
	(2.16)	(4.83)	(4.65)	(3.79)	(3.19)
Obs	509	319	368	320	267
R-squared	0.002	0.021	0.000	0.007	0.003

Table 19: Simple univariate regression on trading volume.

NINO stands for the El Niño with a SOI value of lower than and equal of -1. The countries represent the number of shares traded in millions. Observations are in monthly intervals. Pseudo R-squared represents not the same as it does with OLS. It represents McFadden's pseudo R-squared where a value between 0.2 and 0.4 implicates an excellent fit. A negative value for NINOSTRONG is actually an increase in trading volume, since El Niño is represented by all values of -1 and lower. Alpha is the intercept and the z-statistics are presented in parentheses. *, ** and *** indicate 10%, 5% and 1 % significance levels respectively.

	India	Indonesia	South Korea	Philippines	Thailand	South Africa
NINO	0.3667**	0.0471	0.2701**	0.1282	0.2643	0.0257
	(2.45)	(0.36)	(2.39)	(1.59)	(1.58)	(0.48)
alpha	10.9178***	15.8035***	8.5514***	10.8713***	10.6676***	15.1147***
	(123.22)	(245.97)	(128.63)	(229.98)	(102.44)	(624.36)
Obs	333	272	399	369	510	182
Pseudo R-squared	0.0006	0.0000	0.0007	0.0003	0.0002	0.0000

Table 20: Univariate lagged regression on stock returns.

NINO stands for the El Niño with a SOI value of lower than and equal of -1. Each lag represents a quarter later than impact. The countries represent the composite stock market indices. Observations are in monthly intervals and R-squared represents the variance of stock return that is explained by the independent variables. The values are in whole percentages. A negative value for NINOSTRONG is actually an increase in returns, since El Niño is represented by all values of -1 and lower. Alpha is the intercept and the t-statistics are presented in parentheses. *, ** and *** indicate 10%, 5% and 1 % significance levels respectively.

	India	Indonesia	South Korea	Malaysia	Philippines
NINO	-0.7554	-0.1827	-0.5497	-0.9011	-1.1784
	(-1.08)	(-0.20)	(-0.95)	(-1.51)	(-1.34)
L3.NINO	0.3950	0.5028	-0.1032	0.9407	0.5846
	(0.56)	(0.53)	(-0.17)	(1.47)	(0.63)
L6.NINO	1.3403**	0.8492	1.3813**	0.0479	0.5657
	(2.01)	(0.90)	(2.23)	(0.07)	(0.61)
L9.NINO	-0.7109	-0.6047	-1.2056*	-0.4493	0.1535
	(-1.07)	(-0.64)	(-1.94)	(-0.70)	(0.17)
L12.NINO	0.0831	0.2659	-0.3861	-0.4260	-1.1496
	(0.14)	(0.30)	(-0.67)	(-0.72)	(-1.31)
alpha	1.2241***	1.4463***	0.7201**	0.5357	1.2219**
	(3.01)	(2.71)	(1.97)	(1.41)	(2.34)
Obs	413	320	502	452	380
R-squared	0.027	0.012	0.027	0.009	0.019

	Thailand	Brazil	Chile	Peru	South Africa
NINO	-0.9029	-4.7382***	-0.4329	-2.7815**	-0.9050
	(-1.39)	(-2.74)	(-0.77)	(-2.58)	(-1.34)
L3.NINO	1.0127	0.2796	0.2891	3.6460***	0.8027
	(1.45)	(0.15)	(0.49)	(3.21)	(1.14)

L6.NINO	-0.4326	1.4903	0.4774	-0.6757	0.0654
	(-0.62)	(0.82)	(0.82)	(-0.59)	(0.09)
L9.NINO	-0.7812	-1.6308	-0.9667*	-2.6620**	-0.1464
	(-1.12)	(-0.90)	(-1.66)	(-2.35)	(-0.21)
L12.NINO	-0.3111	-3.0918*	-0.2584	-0.4747	-0.2422
	(-0.48)	(-1.79)	(-0.47)	(-0.45)	(-0.38)
alpha	0.6222	3.7869***	1.2318***	1.9582***	1.0391***
	(1.52)	(3.67)	(3.70)	(3.04)	(2.94)
Obs	502	319	368	320	267
R-squared	0.011	0.038	0.012	0.057	0.010

Table 21: Univariate lagged negative binomial regression on trading volume.
NINO stands for the El Niño with a SOI value of lower than and equal of -1. The countries represent the number of shares traded in millions. Observations are in monthly intervals. Pseudo R-squared represents not the same as it does with OLS. It represents McFadden's pseudo R-squared where a value between 0.2 and 0.4 implicates an excellent fit. A negative value for NINOSTRONG is actually an increase in trading volume, since El Niño is represented by all values of -1 and lower. Alpha is the intercept and the z-statistics are presented in parentheses. *, ** and *** indicate 10%, 5% and 1 % significance levels respectively.

	India	Indonesia	South Korea	Philippines	Thailand	South Africa
NINO	0.2678	0.0181	0.2264*	0.0431	0.2183	0.0322
	(1.60)	(0.13)	(1.90)	(0.50)	(1.20)	(0.57)
L3.NINO	0.2325	0.0961	0.1627	0.2010**	0.2786	-0.0397
	(1.30)	(0.68)	(1.28)	(2.07)	(1.45)	(-0.72)
L6.NINO	0.1162	0.0533	0.1818	0.1566	-0.0096	0.0016
	(0.65)	(0.40)	(1.48)	(1.62)	(-0.05)	(0.03)
L9.NINO	-0.0261	0.0757	0.1172	0.0149	0.0510	-0.0420
	(-0.15)	(0.56)	(0.94)	(0.15)	(0.26)	(-0.77)
L12.NINO	0.0307	0.0546	0.2104*	0.1233	0.1888	-0.0340
	(0.18)	(0.42)	(1.75)	(1.41)	(1.02)	(-0.63)
alpha	10.9588***	15.8428***	8.6515***	10.9441***	10.7675***	15.1000***
	(110.50)	(222.83)	(117.27)	(210.17)	(92.10)	(570.47)
Obs	333	272	399	369	502	182
Pseudo R-squared	0.0010	0.0002	0.0022	0.0019	0.0006	0.0004

Table 22: Multivariate lagged regression on stock returns.

NINO stands for the El Niño with a SOI value of lower than and equal of -1. Each lag represents a quarter later than impact. GDP stands for Growth Domestic Product. CPI stands for Consumer Price Index. M1 stands for money supply type 1. FX-rate stands for the exchange rate of the national currency for 1 dollar. L.Return stands for stock returns of the previous month. N/A stand for not available. The countries represent the composite stock market indices. Observations are in monthly intervals and R-squared represents the variance of stock return that is explained by the independent variables. The values are in whole percentages. A negative value for NINOSTRONG is actually an increase in returns, since El Niño is represented by all values of -1 and lower. Alpha is the intercept and the t-statistics are presented in parentheses. *, ** and *** indicate 10%, 5% and 1 % significance levels respectively.

	India	Indonesia	South Korea	Malaysia	Philippines
NINO	-0.7602	0.5208	-0.4404	-1.0195	0.2180
	(-1.09)	(0.51)	(-0.75)	(-1.52)	(0.20)
L3.NINO	0.3284	0.8711	-0.0869	2.1469***	0.4255
	(0.46)	(0.83)	(-0.14)	(3.01)	(0.43)
L6.NINO	1.2282*	-0.3725	1.4167**	0.0414	0.5506
	(1.87)	(-0.35)	(2.27)	(0.06)	(0.56)
L9.NINO	-0.5955	-0.6157	-1.0567*	-0.5155	-1.3172
	(-0.91)	(-0.59)	(-1.68)	(-0.73)	(-1.34)
L12.NINO	-0.1517	-0.2955	-0.2726	-0.9788	-0.9531
	(-0.25)	(-0.29)	(-0.46)	(-1.46)	(-1.02)
GDP	n/a	n/a	-0.0000	n/a	-0.0000
			(-0.53)		(-0.88)
CPI	n/a	0.0247	0.0129	-0.0250	0.2016
		(0.48)	(0.10)	(-0.39)	(1.41)
M1	-0.0000	-0.0000	0.0000	0.0000	0.0000
	(-0.30)	(-0.52)	(0.94)	(0.25)	(0.41)
FX-rate	0.0189	n/a	0.0030	-0.1578	0.1128
	(0.51)		(1.09)	(-0.17)	(1.21)
L.Return	0.2092***	0.0487	0.0634	0.0829*	0.1270*
	(4.30)	(0.77)	(1.40)	(1.65)	(1.90)
alpha	0.3613	0.5596	-0.2282	2.8222	-7.1208
	(0.33)	(0.29)	(-0.16)	(0.96)	(-0.90)
Obs	411	260	499	397	232
R-squared	0.059	0.012	0.027	0.047	0.053

	Thailand	Brazil	Chile	Peru	South Africa
NINO	0.4584	-1.0570	-0.2250	-1.9219*	-0.9277
	(0.41)	(-0.97)	(-0.41)	(-1.81)	(-1.35)
L3.NINO	2.6223**	2.1313*	0.5671	4.0401***	0.7727
	(2.27)	(1.89)	(1.01)	(3.65)	(1.08)
L6.NINO	-0.5189	-1.0892	0.3031	-0.7347	0.0198
	(-0.45)	(-0.96)	(0.54)	(-0.66)	(0.03)

L9.NINO	-1.0135	-0.4505	-0.8334	-2.1341*	-0.2059
	(-0.89)	(-0.40)	(-1.49)	(-1.93)	(-0.29)
L12.NINO	-0.2376	-1.4552	-0.3038	0.1426	-0.2964
	(-0.22)	(-1.33)	(-0.57)	(0.13)	(-0.43)
GDP	-0.0000	-0.0000	n/a	0.0000	0.0000
	(-0.36)	(-0.90)		(1.14)	(0.19)
CPI	-0.0908	0.0036	-0.1824**	-0.3522**	0.0209
	(-0.39)	(0.89)	(-2.57)	(-2.31)	(0.13)
M1	0.0063	-0.0000	0.0000	0.0000	-0.0000
	(0.86)	(-0.21)	(0.10)	(0.13)	(-0.23)
FX-rate	0.0991	-0.0558	0.0278**	4.1020	-0.1787
	(0.69)	(-0.05)	(2.01)	(1.46)	(-0.77)
L.Return	0.0175	0.0209	0.2195***	0.1052*	-0.0310
	(0.27)	(0.33)	(4.21)	(1.89)	(-0.49)
alpha	4.2382	-1.2031	-1.2568	5.1802	0.6746
	(0.28)	(-0.35)	(-0.48)	(0.90)	(0.12)
Obs	246	256	367	316	263
R-squared	0.038	0.048	0.107	0.139	0.019

Table 23: Multivariate lagged negative binomial regression on trading volume.

NINO stands for the El Niño with a SOI value of lower than and equal of -1. GDP stands for Growth Domestic Product. CPI stands for Consumer Price Index. M1 stands for money supply type 1. FX-rate stands for the exchange rate of the national currency for 1 dollar. L.Return stands for stock returns of the previous month. N/A stand for not available. The countries represent the number of shares traded in millions. Observations are in monthly intervals. Pseudo R-squared represents not the same as it does with OLS. It represents McFadden's pseudo R-squared where a value between 0.2 and 0.4 implicates an excellent fit. A negative value for NINOSTRONG is actually an increase in trading volume, since El Niño is represented by all values of -1 and lower. Alpha is the intercept and the z-statistics are presented in parentheses. *, ** and *** indicate 10%, 5% and 1 % significance levels respectively.

	India	Indonesia	South Korea	Philippines	Thailand	South Africa
NINO	0.1374	0.0076	0.0283	-0.0368	0.1420**	0.0191
	(1.20)	(0.18)	(0.46)	(-0.38)	(2.46)	(0.45)
L3.NINO	0.0970	0.0614	0.0059	0.2540***	0.1984***	-0.0241
	(0.78)	(1.45)	(0.09)	(2.64)	(3.22)	(-0.57)
L6.NINO	0.1327	0.0173	0.1156*	0.1373	0.0413	0.0071
	(1.12)	(0.41)	(1.85)	(1.42)	(0.64)	(0.17)
L9.NINO	0.1369	0.0605	0.0279	0.1677*	-0.0128	-0.0235
	(1.11)	(1.38)	(0.45)	(1.71)	(-0.19)	(-0.56)
L12.NINO	0.2605**	0.0345	-0.0463	0.1342	0.0130	-0.0104
	(2.22)	(0.81)	(-0.73)	(1.47)	(0.20)	(-0.25)
GDP	n/a	n/a	0.0000***	0.0000***	0.0000***	0.0000***
			(2.86)	(4.88)	(9.55)	(3.20)
CPI	n/a	0.0622***	0.0135	-0.0485***	0.0165	-0.0041
		(27.59)	(0.55)	(-3.53)	(1.18)	(-0.55)
M1	0.0001***	-0.0000***	-0.0000***	-0.0000***	-0.0018***	0.0000
	(7.40)	(-14.29)	(-7.07)	(-5.02)	(-4.06)	(0.30)
FX-rate	0.0956***	n/a	0.0035***	-0.1032***	0.0688***	-0.0115
	(7.04)		(13.21)	(-10.59)	(7.68)	(-0.64)
L.Return	0.0284***	0.0142***	0.0148***	0.0175**	0.0257***	-0.0055
	(3.83)	(5.61)	(3.46)	(2.55)	(6.77)	(-1.41)
alpha	4.9182***	12.1894***	0.6398**	11.6008***	-0.1793	13.2166***
	(9.25)	(143.22)	(2.09)	(16.46)	(-0.19)	(23.33)
Obs	332	259	396	232	246	179
Pseudo R-squared	0.0443	0.0723	0.0933	0.0227	0.0803	0.0189

Table 24: Calculation of returns on the long and short position.

The opening and closing price are in US Dollar, since all ETFs are listed on the NYSE. All positions are closed in the months according to results in Table 12. The opening variates per strategy. Returns and expense ratio are in whole percentages. The calculation on returns is ((close-open)/open)*100%. Expense ratios in strategy 3 and 4 are compounded for 2 years, because these strategies will have a horizon between 1 and 2 years.

Strategy 1 – On impact

Impact El Niño according to SOI index is September 2015. All positions are held exactly 1 month. At which month after impact the position is taken, depends on the number in the rows: long and short. Expense ratios are from the prospectus and total returns is returns minus expense ratio.

	India	*South Korea*	*Malaysia*	*Philippines*	*Thailand*	*Brazil*	*Chile*	*Peru*
Short	L6	L6	L3		L3	L3	L3	L3
Open	25.21	52.77	30.96		58.64	20.68	31.92	20.18
Close	27.02	52.48	32		60.66	19.88	32.82	19.59
Long		L9	L9	L9		L12		L9
Open		52.94	31.44	37.58		33.63		29.27
Close		54.70	33.12	39.41		34.66		31.03
Returns	-7.18	0.55 + 3.32	-3.36 + 5.34	4.87	-3.44	3.87 + 3.06	-2.82	2.92 + 6.01
Ex. Ratio	-0.71	-0.64	-0.48	-0.64	-0.63	-0.63	-0.64	-0.63
Total	**7.89**	**3.23**	**1.5**	**4.23**	**4.07**	**6.3**	**3.46**	**8.3**

Strategy 2 – 8 months prior to impact (with lags)

Impact El Niño according to SOI index is September 2015. All positions are held exactly 1 month. Positions are taken 8 months prior to strategy 1. With exception for the long positions of South Korea, Malaysia, Brazil and Peru due to the rebound effect. Expense ratios are from the prospectus and total returns is returns minus expense ratio.

Short	L6	L6	L3		L3	L3	L3	L3
Open	30.61	52.76	53.44		80.66	32.25	40.97	29.03
Close	27.02	52.48	32		60.66	19.88	32.82	19.59
Long		L9	L9	L9		L12		L9
Open		52.94	31.44	34.17		33.63		29.27
Close		54.70	33.12	39.41		34.66		31.03
Returns	11.73	0.53 + 3.32	40.12 + 5.34	15.34	24.8	38.36 + 3.06	19.89	32.52 + 6.01
Ex. Ratio	-0.71	-0.64	-0.48	-0.64	-0.63	-0.63	-0.64	-0.63
Total	**11.02**	**3.21**	**44.98**	**14.7**	**24.17**	**40.79**	**19.25**	**37.9**

Strategy 3 – 8 months prior to impact (without lags)

Impact El Niño according to SOI index is September 2015. All positions are held exactly 1 month. Positions are taken 8 months prior to impact. With exception for the long positions of South Korea, Malaysia, Brazil and

Peru due to the rebound effect. Expense ratios are from the prospectus and total returns is returns minus expense ratio.								
Short	L6	L6	L3		L3	L3	L3	L3
Open	29.95	56.56	53.92		77.46	36.57	39.89	31.96
Close	27.02	52.48	32		60.66	19.88	32.82	19.59
Long		L9	L9	L9		L12		L9
Open		52.94	31.44	38.2		33.63		29.27
Close		54.70	33.12	39.41		34.66		31.03
Returns	9.78	7.21 + 3.32	40.65 + 5.34	3.17	21.69	45.64 + 3.06	17.72	38.7 + 6.01
Ex. Ratio	-1.425	-1.284	-0.962	-1.284	-1.264	-1.264	-1.284	-1.264
Total	**8.355**	**9.246**	**45.028**	**1.886**	**20.426**	**47.436**	**16.436**	**43.446**
Strategy 4 – 8 months prior to expected impact 2014 Expected impact El Niño was November 2014. All positions are held exactly 1 month. Positions are taken 8 months prior to impact. With exception for the long positions of South Korea, Malaysia, Brazil and Peru due to the rebound effect. Expense ratios are from the prospectus and total returns is returns minus expense ratio.								
Short	L6	L6	L3		L3	L3	L3	L3
Open	23.89	61.03	60.88		69.50	39.95	42.95	33.25
Close	27.02	52.48	32		60.66	19.88	32.82	19.59
Long		L9	L9	L9		L12		L9
Open		52.94	31.44	33.7		33.63		29.27
Close		54.70	33.12	39.41		34.66		31.03
Returns	-13.1	14.01 + 3.32	47.44 + 5.34	16.94	12.72	50.24 + 3.06	23.59	41.08 + 6.01
Ex. Ratio	-1.425	-1.284	-0.962	-1.284	-1.264	-1.264	-1.284	-1.264
Total	**-14.525**	**16.046**	**51.818**	**15.656**	**11.456**	**52.036**	**22.306**	**45.826**

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