The effect of El Nino on stock market: The evidence for thirteen U.S. industry markets and twenty-two international markets

Master Thesis

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Contents

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ABSTRACT

This thesis investigates the effect of El Nino on the return of thirteen U.S. industry markets and twenty-two international markets. First, the results show that El Nino positively influences the American consumer goods industry, Austria, Belgium, Netherland and Switzerland country indices. In contrast, El Nino episodes have a negative impact on Indonesia market index. Second, I find that the impact of El Nino is significant across worldwide markets with a 6 to 9 months delay after controlling for January effect, one–month lagged return and Halloween indicator. In the end, the long/short strategy is used to obtain excess return by buying a long in indices that are positively affected by the El Nino and selling a short in indices that are negatively affected by the El Nino.

Keywords: El Nino; stock excess returns; weather anomalies; SOI

1. Introduction

Climate is an important and urgent issue that affects our life in all aspects. In this paper, I will investigate the effect of the El Niño-Southern Oscillation (ENSO) events, or called El Niño, on the U.S. stock market, U.S. industries and international markets. Recent years, the acceleration of the globe warming dresses lots of concerns. Climate change has a significant and rising macroeconomic influence, such as development, innovation, demography and public finance (Stern 2006). When estimate the economic influence of the global warming, Bansal et al. (2016) find that the temperature fluctuations negatively influent the aggregate wealth and there is also a negative correlation between equity price and temperature risk. Consistent with this negative elasticity of stock value to global warming, Bansal et al. (2016) also find the continues rising temperature around the world lowers the proportion of current wealth consumption and leads to a positive risk exposure. Although there is no proved and certain evidence that shows the relevance between the rising temperature and more frequent El Nino events recent decades, some models do simulate an increase in intensity of ENSO (Latif and Keenlyside, 2008). Due to the rising temperature all around the world, more and more researchers focus on the impacts of global warming as well as other related weather changing on economics. The El Nino event is one of them. Although a growing number of scholars focus on the impacts of the El Nino episodes, as my best knowledge, there are no relevant researches that are related to the effects of El Nino on the equity market. In this research, I will try my best to bridge this gap.

El Niño/Southern Oscillation (ENSO) results from the periodic abnormal sea surface temperature in the central and eastern tropical Pacific Ocean as well as the periodic abnormal air pressure around the equator in the Pacific Ocean. ENSO events usually arrive fully in the end of year, so the early Christian habitants call this weather phenomenon as El Niño (the Christ Child known in Spanish) in order to celebrate the birth of Jesus (NOAA 2017).[1]

Previous researches indicate that El Nino brings various influences across the world. Cashin et al. (2017) find that El Nino contributes to real growth for Canada and the United State due to warmer winter during El Nino episodes. After the El Nino shock, there is an increase in real GDP growth of 0.32% and 0.21% in Canada and the U.S. respectively. In other researches, scholars find similar evidence .For example, the fewer land falling hurricanes in the U.S. likewise save large amount of government expense during the El Nino phase (Bove et al. 1998) and the reduced expenditure for heating oil, a boost retail sales and construction benefit the northern states in U.S. (Changnon, 1999). For Mexico, a country that relies heavily on the oil income (8% of GDP), El Niño year brings stability to the oil sector and a rising export volume. During the El Nino events, there is also an indirect benefit for Europe. The rising demand of the U.S. during the El Nino year mainly benefits the shipping industry in Europe, accounting for a 0.24% rising in real GDP growth (Cashin et al. 2017).

On the other hand, El Nino events also bring negative impacts in Australia, Indonesia, New Zealand and South Africa for example. This is mainly because an El Niño cycle usually causes severe droughts or rising wildfires in such areas. El Nino events also bring heavy rains and flooding to Peru, and it affects the fishing industry in Peru considerably.

[1] See the detail definition from NOAA website.

https://www.ncdc.noaa.gov/teleconnections/enso/enso-tech.php

Besides the macro economy, the El Nino influents commodity price as well. Brunner (2002) indicates that ENSO effect can explain about 20% of commodity price inflation and also accounts for 10-20% consumer price index and economic activity. Consistent with Brunner, Cashin et al. (2017) also find a slight increase in consumer price index and a rising oil price.

How the influences of weather anomalies transfer to the stock market? In other words, how weather anomalies affect the stock price? For the past several decades, there are a lot of researchers who investigate the impact of weather anomalies on the equity market. Weather can affect the mood of investors and then indirectly affect the behaviors or the investment decisions beyond the individuals (Saunders, 1993). Sunny days usually lead to an upbeat mood whereas lower temperature cause aggressions, which force the investors to bear larger volatility and get higher abnormal return (Cao and Wei 2005; Hirshleifer and Shumway 2003).

There also exist some disagreements with the significant weather effect. Loughran and Schultz (2004) figure out that the weather influence is offset by the transaction cost.

Since there are various El Nino macroeconomic outcomes across the world, the inconsistent of the weather impacts on equity market, and the not fully rational market participators, it is difficult to predict the effect of El Nino episodes on stock. Combining with previous research and findings, I will mainly investigate the El Nino effect on the U.S. market/industries and international market (Australia, Indonesia, New Zealand, Canada, Chile, Peru, and developed European countries[2]), whose macro economies are certainly affected by the El Nino. Another goal of this study is to find that whether there exists a delay effect of El Nino or does the market underreact the climate changing.

The main results of this study show that El Nino has significant delay effect on the agriculture industry, the construction materials industry, the insurance industry, the consumer goods industry and the retail industry in the U.S. market. Besides the delay impact of El Nino on U.S., El Nino also influences the international markets. The results show that El Nino episodes have a negative impact on Indonesia market index, and a unit reduction in SOI index lower a 1.36% monthly excess return in the Indonesian market. In contrast, there are positive impacts of El Nino across European area. The equity price in the international market likewise underreacts the El Nino event. El Nino has a significantly negative delay effect on Australia and Malaysia, and El Nino has a significantly positive delay effect on France, Italy, Sweden, UK, Peru, and Singapore. Depending on the results of this study, I apply the long/short strategy to make a portfolio that consists of winner and loser index. The abnormal excess return can be obtained through this strategy. But the lower R-square in the regressions shows that the El Nino events can only be a small effect to explain the excess return across different market.

In the remaining part, Section 2 will show a band of the literature linked to the El Nino and investigate several opinions on the El Nino and its effect on the real economy. Section 3

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[2] European countries include: Belgium, Finland, France, Germany, Italy, Netherlands, Austria, Norway, Spain, Sweden, Switzerland, and UK.

describes the data, which will be used in this paper, including different data in the U.S. market, the U.S. industries and the international market. Section 4 discusses the models and the hypothesis that will be used in this paper, and mainly forces on the SOI standardize anomalies as El Nino measurement. Section 5 shows the results and tests the hypotheses that are discussed in this methodology part, and the long/short strategy is also discussed in this part. The final section discusses the shortcomings of this paper and the possible future study, as well as a summary of this study.

2. Literature Review

This section will show a band of the literature linked to the El Nino and investigate several opinions on the El Nino and its effect on the real economy. This section will divide into several subparts. First, it will provide a short introduction about the El Nino phenomenon and its influence. Second, it will investigate how the climatic factors exert an influence on to the equity market and the impact link to the stock performance. As my best knowledge, although there has not been much research on the relation between the El Nino phenomenon and equity market performance, in the end, this section will try to give an insight on the macroeconomic effects caused by El Nino and show the potential effects in the stock market.

2.1 The introduction of the El Nino and weather impact of the El Nino

El Nino is one of the three phases of El Niño-Southern Oscillation. The other two periods are La Nina and "normal conditions". El Nino is the period during which the temperatures of the sea surface in the central and eastern tropical Pacific Ocean are higher than average. In this warming period, the increasing release of heat from the surface of the ocean attributes to the unstable interactions between the atmosphere and the tropical Pacific Ocean (Philander 1985). The decreasing of the rainfall over Indonesia and the increasing of the rainfall over the tropical Pacific Ocean lead to low-level surface winds, changing winds blowing direction normally from east to west along the equator to the opposite direction west to east (Heureux 2014b).

El Nino period has various impacts across the global area. Cashin et al. (2017) use a country-by-country analysis and investigate the El Nino shock across the globe. They find that there are positive effects of El Nino on real growth for Canada and the United State because of the warmer weather in Canada and the more rain in the South and California and the fewer hurricanes activities in the East Coast. In contrast, during the El Nino episodes there is negative weather impact on Australia, Indonesia, New Zealand and South Africa due to drought or the increasing wildfire and bush fire. Fishing industry in Peru suffered considerably during the El Nino years (Society 1975). Since Europe is in remote regions, the influence of El Nino may vary from countries. The weather conditions over central Europe are wetter and there are colder temperatures over northern Europe. The increased wind from South-Western Europe blows into northern Europe and reduces gradually (Merkel and Latif, 2002). Iizumi et al. (2014) map the impact of the ENSO on yield and find El Nino likely increase the global-mean soybean yield by around 2.1-5.1% but reduced the yields of maize, rice and wheat by about -4.1-+0.8% in most of the regions.

According to the research on the impact of El Nino in the United States, El Nino conditions normally across the nation. During 1997-1998, which is the El Nino period, even there were heavily storm in Southern nation, the higher mean temperature in Northern states lead to more human lives saved and there are net economic gains around $15.1-$15.7 billion mainly due to the decrease of heating expense and the increase of the sales. Those net economic benefits are surprising and sizeable and less government expense was needed (Changnon, 1999; Chiodi and Harrison, 2013).Because the warmer than normal surface temperature during the El Nino, there is likewise a significantly higher expected corn crop yields and a significant reduction hurricane strike in the United States (Bove et al. 1998; Handler and Hander 1983).

2.2 Different measurements of the El Nino

There are several measurements of the El Nino. Two commonly used measures of the intensity of El Nino episodes are Southern Oscillation Index (SOI) and Sea surface temperature indexes (SST). Those two indexes both are time-series index, usually monthly continuous measured.

2.2.1 Southern Oscillation Index (SOI)

Southern Oscillation Index (SOI), which is the oldest indicator of the ENSO measurement, measures the difference of air pressure at sea level between Tahiti and Darwin. The SOI is based on the air pressure at different place. It may affect by shorter-term fluctuations, which are uncorrelated with the El Nino period. To overcome this problem, usually the average monthly or seasonal value is used (Barnston 2015). Standardized[3] and smoothed data usually are used to reflect the air change in the sea surface. NOAA[4] defines that the negative values of the SOI represent the above-normal warm temperature at eastern tropical Pacific. Continuous SOI values below -1 indicate the arriving of the El Nino period(Cashin et al. 2017).

Another sea level pressure index over two regions along the equator named Equatorial Southern Oscillation Index is also used. Compare to the Southern Oscillation Index (SOI), which measures the stations located in the North of the equator, Equatorial SOI can be a better measure of the ENSO. However, only limited data is available for this index, and the SOI can

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3 The SOI values were standardized by subtracting the monthly mean and dividing by the monthly standard deviation

4 Received from NOAA Center for Weather and Climate Prediction http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensocycle/soi.shtml

go back to the 1800s (Barnston 2015).

2.2.2 Sea surface temperature indexes (SST)

Sea surface temperature indexes (SST) are the deviation between sea surface temperature in the certain region and historical average temperature. SST data is increasing used and dominated by the El Nino episodes (Rasmusson and Carpenter 1982).Bamston, Chelliah, and Goldenberg (1997) found that region Niño3.4[5] (5°North-5°South) (170-120°West) is more correlated with the ENSO phenomenon and is stronger representativeness than the other regions and encouraged that general SST indexes are used the data in Nino 3.4 region.

At National Oceanic and Atmospheric Administration (NOAA), Oceanic Niño Index (ONI), which is based on the SST, is the official indicator of the El Niño. ONI is calculated by 3-month moving average sea surface temperature indexes. In fact, ONI estimates other "noise" introduced by uncorrelated weather pattern, which exists in SST indexes (Heureux 2014a).

Relate to the arriving of the El Nino period, NOAA[6] announced that the threshold for El Nino is 3-month sea surface temperature anomalies moving average in the Niño 3.4 region greater than or equal in magnitude to 0.5 degrees C and at least five 3-month moving average anomalies above 0.5.

When uses the both index and combined them to the economic variables, Brunner (2002) find that the SOI index is more significant than SST anomalies value.

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[5] In this paper Niño 3.4 region refers to the region (5°North-5°South) (170-120°West).

[6] NOAA. (2015). *Historical El Nino/ La Nina episodes (1950-present).* http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml

2.3 The impact of the climate factors on stock markets

Weather as one of the anomalies factor in equity market not only affects the real economy but also affects the mood and behavior of the investor. Roll (1984) investigates the impact of weather in the central Florida region, and how this exogenous determinant of value affects the orange market and the orange juice futures. He finds that the weather affects the supply of the orange, and further affects companies that produce the orange juice substitutes. Firms' equities commove positively and significantly with the orange juice price. In the early studies, Saunders (1993) forces on the correlation between the weather and the stock price, he finds that weather has an effect on mood and because of different mood for cloudy and sunny days, investors psychologically influence the price of assets. Consistent with Saunders, Hirshleifer and Shumway (2003) also find there is a strong significant correlation between the sunny days and stock performance, which is led by an upbeat mood in the sunshine city. In the very low transaction cost level, weather can be a significant strategy for the investor to affect their stock return but there is a modest improvement to contribute the whole portfolio sharp ratio. Cao and Wei (2005) figure out that the mood changes in turns cause behavioral changes. The research demonstrates that temperature and stock return correlated negatively, for instance, lower temperature will cause more aggressive behavior and the investor would accept higher risk in order for the higher return. When investigate the weather effect on the Shanghai stock market, Kang et al. (2010) find that the domestic investors are more sensitive than the foreign investor to weather factor and the weather does have an effect on the volatility and the return of the stock.

In a nutshell, the stock performance is better in sunny days than in cloudy days (Chang et al. 2008; Hirshleifer and Shumway 2003; Saunders 1993).

Temperature is also a risk factor relate to the global equity market. Bansal and Ochoa (2011) showed that the temperature adversely affects the global capital market, as well as the countries' GDP growth. They conclude that there is compensation needed for temperature risk, i.e., temperature beta. Countries that located closed to the equator have a larger temperature risk exposure, usually because those countries rely much more heavily on the agriculture industry. Hong et al. (2016) focus on the risk of drought, and find the poor return for a portfolio of food industry in prolonged drought countries. Unfortunately, stock market cannot react efficiently, and there exists long-short strategy for excess return.

Inconsistent with the argument about the significant weather effect, Loughran and Schultz (2004) figure out that the weather influence is too slight to be a profitable arbitrage strategy. Even the small profits were offset by the corresponding trading cost. Novy-Marx (2014) supports the idea that the expected return was difficult to measure. He includes several anomalies variable such as the globe warming, El Nino, sunspots or the conjunctions of the planet, and found that the general regression fails to reject those variables. He states the weather factor is not the right determination of the return but can enhance the anomalies factors in the regression.

Although there are some disagreements with the weather effects on the equity market, a large amount of the research show that the weather factor can influence the stock market through the real economy or investors' behavior. That is also the reason that there exists a weather derivative market for companies to use this instrument to against the potential loss related to weather surprises(Campbell and Diebold 2005).

2.4 The macroeconomic effects caused by El Nino

The macroeconomic effects caused by El Nino vary among different geographical regions.

Changnon (1999) investigates the El Nino impacts during 1997-1998 in the United State, the major economic benefits are the decrease in cost for natural gas and heating oil due to the warmer winter, the reduced expenditure in highway-based and airline transportation, improved seasonal retail product sales and the reconstruction level. And during this period, no national loss happens from major Atlantic hurricanes. There exist net positive economic effect due to the El Nino episodes, even some losses in the Southern states.

Brunner (2002) looks into ENSO effect on world non-oil primary commodity price as well as the G-7[7] country consumer price inflation (CPI) and the growth of GDP. He finds that the ENSO effect can explain about 20% of commodity price inflation and also account for 10-20% CPI and world economic activity. Cashin et al. (2017) also find that El Nino period has a short-live negative effect for Australia, Chile, Indonesia, India, Japan, New Zealand and South Africa. As for other countries, there exists growth-increasing effect. During El Nino period, warmer weather in Canada leads to a higher return for the fishing industry. For Mexico, the decreasing tornadoes activity on the East Coast boosts exports and stabilizes the Oil sector. There is likewise a positive spillover in the United States GDP growth due to the warm winter. China can indirectly benefit from the trade with major economics, mainly with

[7] G-7 countries consist of the United States, the United Kingdom, Canada, France, Germany, Italy, and Japan.

the U.S. Increase demand in U.S. also leads an increase in the shipping industry, which slightly increases the GDP growth in Europe and Singapore, 0.24% and 0.48% respectively.

As my best knowledge, there are merely literatures, which investigate the El Nino effect in the equity market. El Nino does have an effect on the real economy, and the effect may be transferred to the stock market. Base on previous study, this thesis is intended to investigate more detail by examining the effect in U.S market and U.S. industries, as well as some developed countries.

3. Data

This section describes the data, which will be used in this paper. In section 3.1, it gives a brief introduction about the data on the different measurement of the El Nino intensity. Section 3.2 introduces the different data in the U.S. market and the U.S. industries. Section 3.3 describes the data in the international market.

3.1 Data on the El Nino intensity

Two commonly used measures of the intensity of the El Nino period are Southern Oscillation Index (SOI) and Sea Surface Temperature Indexes (SST). Barnston (2015) suggests that Equatorial Southern Oscillation Index will be a better measure of the El Nino comparing to the Southern Oscillation Index (SOI), because the Equatorial Southern Oscillation Index measures the difference between the stations located in the line of the equator, in which are more close related to the ENSO phenomenon. The data on the El Niño-Southern Oscillation (ENSO) are obtained from NOAA Center for Weather and Climate Prediction[8]. The SOI index data are available back to 1800s. Because of the World War II and lots of missing data, the data prior to 1950 are not often reliable and are not comparable to recent decades data (Brunner 2002). When investigate impacts of El Nino, Cashin et al. (2017) also use the El Nino data from 1950 due to the reliability. Before 1950, the data are only available for SOI. SST does not have any record before 1950. There are few missing data during that period for SOI. Following the same time period which Brunner (2002) and Cashin

8 National Oceanic and Atmospheric Administration

http://www.cpc.ncep.noaa.gov/data/indices/

et al. (2017) use in their paper, in this paper the El Nino measures data are from 1950 to 2017. In the research by Cashin et al. (2017) , they use SOI raw anomalies. In contrast, I use the standardized anomalies data□, which are standardized by monthly standard deviation. The SOI anomalies measures are same as the measures that are used in the research by Brunner (2002). The standardized anomalies data are smoother, and it corresponds very well with the El Nino period[9].

The Figure 1A shows the standardized of SOI and the Equatorial SOI and the Figure 1 B shows the Sea surface temperature indexes (SST) and Oceanic Niño Index（ONI）, which is constructed from the 3-month moving average SST.

Both of the figures indicate that the 1982-1983 and 1997-1998 El Nino periods are heavy as well as the latest 2015-2016 El Niño cycle. Brunner (2002) shows that the effects of those two 1982-1983 and 1997-1998 El Nino are across lots of the region of the world. During past 60 years there are around 20 mild or severe El Nino episodes in the records.

As we can see from the Figure 1A, the Equatorial Southern Oscillation Index is highly correlated with the Southern Oscillation Index, but it has lower volatility. Continues negative SOI represents the El Nino episodes, while the positive SST indicates the El Nino periods.

The table 1 shows the correlation matrix among those four measures. The SOI and Equatorial SOI are highly correlated with each other with the correlation of 0.7484. Consistent with their prediction of the El Nino, the SOI and SST are highly negatively

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9 Source: National Oceanic and Atmospheric Administration

https://www.ncdc.noaa.gov/teleconnections/enso/indicators/soi/

correlated with the correlation of -0.7216.

Figure 1A: The Standardized Southern Oscillation Index and Equatorial Southern Oscillation Index

Notes: (1) The lower red line indicates the thresholds for the El Nino events.
(2) Source: Author's construction according to the data from the U.S. National Oceanic and Atmospheric Administration's Center for Weather and Climate Prediction.

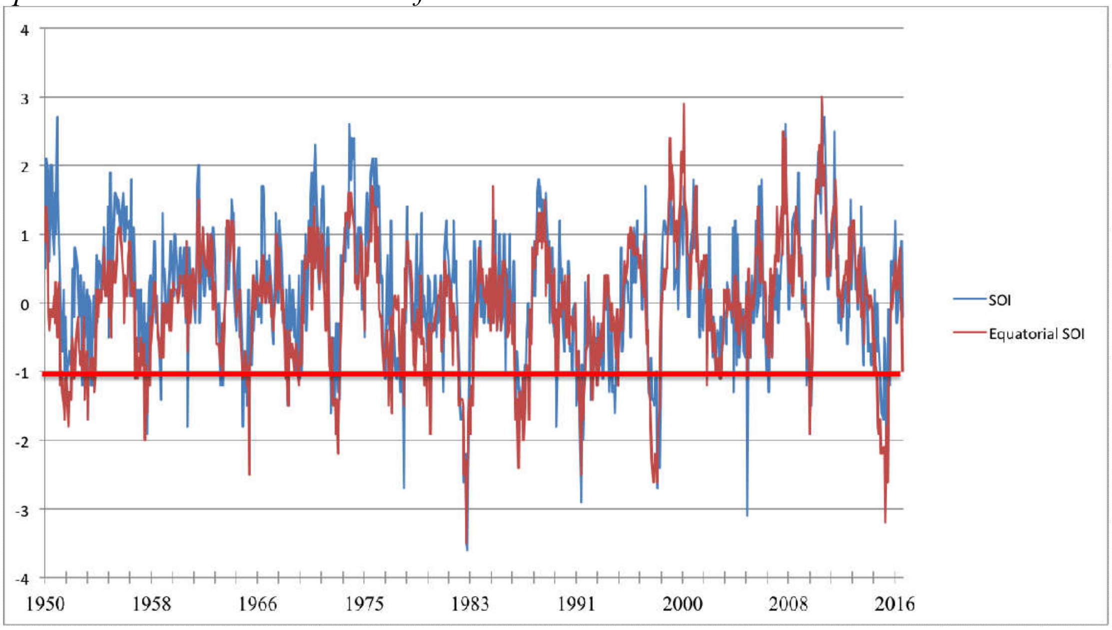

Figure 1B: The Sea Surface Temperature Indexes (SST) and the Oceanic Niño Index (ONI) on El Niño 3.4

Notes: (1) The upper red line indicates the thresholds for the El Nino events. ONI values higher than 0.5 for five continuous months indicates the arriving of the El Nino period.
(2) Date Source: Author's construction according to the data from the U.S. National Oceanic and Atmospheric Administration's Center for Weather and Climate Prediction.

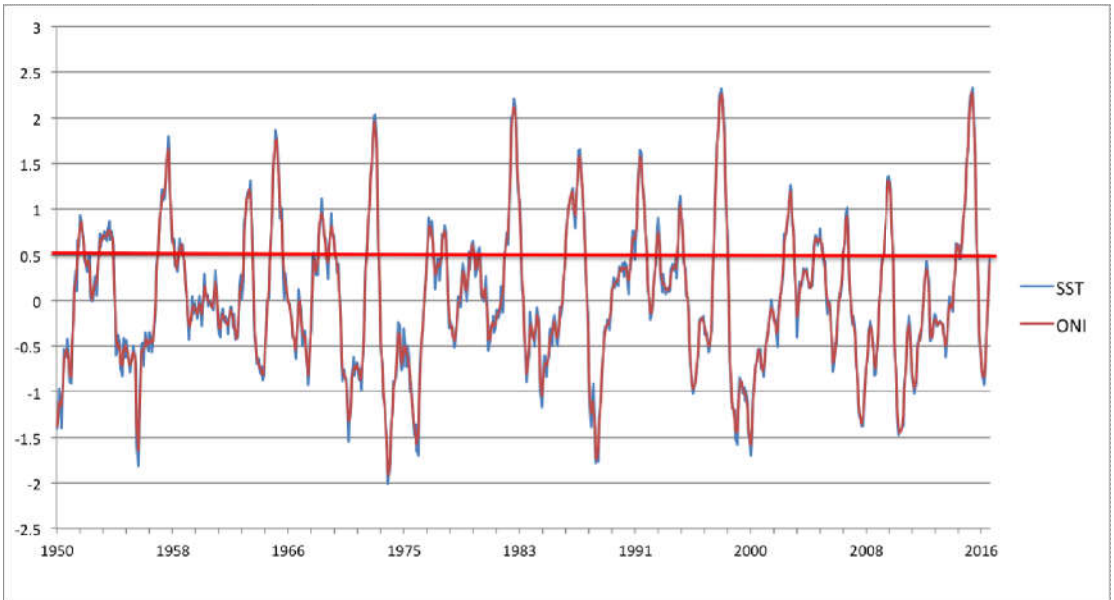

Table 1: The Correlation Matrix of Four Measures of the El Nino.
Notes: (1) The indexes are used from 1950/1/1-2017/4/1.
(2) All the indexes are monthly data.
(3) For each index, there are 808 observations.
(4) Source: data from the U.S. National Oceanic and Atmospheric Administration's Center for Weather and Climate Prediction.

	SOI	ESOI	SST	ONI
SOI	1			
ESOI	0.7484	1		
SST	-0.7216	-0.8191	1	
ONI	-0.7347	-0.8298	0.9945	1

When former researchers investigate the impacts of the El Nino episodes, they use SOI and SST as the main measurements. Brunner (2002) finds that the SOI index is more significant when it combines with the economic variables. In this paper, I will mainly focus on the SOI index[10]. In order to investigate the possible delay impacts of El Nino on the equity market, I also use lagged SOI as the measures of the El Nino intensity.

Table 2 Panel A displays the summary statistics of the SOI anomalies and the lagged SOI values. To check the multicollinearity of the independent variables, the table 2 Panel B shows the correlation matrix of the lagged variables. The highest correlation is 0.5048 between the 6-month lagged SOI and the 9-month lagged SOI. So I can draw a conclusion that there is no multicollinearity beyond the independent variables.

[10] I also use SST index do the analysis, and find the similar conclusion that SOI index is more significant than SST index.

Table 2 SOI measurements

Note: (1) SOIt-3, SOIt-6, SOIt-9, SOIt-9 represent the 3 months, 6 months, 9 months, and 12 months lagged SOI anomalies.
(2) All the SOI measures are from the National Oceanic and Atmospheric Administration.
(3) SOI is the monthly value from 1/1/1950 to 1/4/2017.

Panel A: Summary Statistics Of the Lagged SOI Values

Variable	Observations	Mean	Std. Dev.	Min	Max
SOI	808	0.14	0.96	-3.6	2.9

Panel B: The Correlation Matrix of Lagged SOI

	SOI	SOI_{t-3}	SOI_{t-6}	SOI_{t-9}	SOI_{t-9}
SOI	1.000				
SOI_{t-3}	0.504	1.000			
SOI_{t-6}	0.304	0.505	1.000		
SOI_{t-9}	0.109	0.303	0.505	1.000	
SOI_{t-12}	-0.020	0.108	0.303	0.503	1.000

3.2 Data on the US market and US industries

My set of data for the US market and industries comes from Kenneth French's website[11]. Consistent with the time interval of the SOI, I select the U.S. benchmark from first January 1950 to first April 2017. The excess return is computed by subtracting one-month T bill rate from the value-weighted return of all the CRSP firms in the U.S. market and also the companies, which have a CRSP share code of the 10 or 11, on the NYSE, AMEX, or NASDAQ[12]. It means the excess return eliminates the non-common stock such as preferred stocks, REITs.

For the industry data, the data set comes from the Fama-French 49 industry[13] portfolios. Following the same reasons that I have discussed in the literature parts, I am interested in the

11 http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

12 See the details for the construction of the bench market excess return source. http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/f-f_factors.html

13 The 49 industries are: (1) Agriculture, (2) Food Products, (3) Candy & Soda, (4) Beer & Liquor, (5) Tobacco Products, (6) Recreation, (7) Entertainment, (8) Printing and Publishing, (9) Consumer Goods, (10) Apparel, (11) Healthcare, (12) Medical Equipment, (13) Pharmaceutical Products, (14) Chemicals, (15) Rubber and Plastic Products, (16) Textiles, (17) Construction Materials, (18)Construction,(19) Steel Works Etc,(20) Fabricated Products,(21) Machinery,(22)Electrical Equipment,(23) Automobiles and Trucks ,(24)Aircraft,(25)Shipbuilding, Railroad Equipment,(26) Defense,(27) Precious Metals,(28) Non-Metallic and Industrial Metal Mining,(29) Coal,(30) Petroleum and Natural Gas,(31) Utilities,(32) Telcm Communication,(33) PerSv Communication,(34 Business Services,(35) Computers,(36) Computer Software,(37)Electronic Equipment,(38) Measuring and Control Equipment,(39) Business Supplies,(40) Shipping Containers,(41)Transportation,(42)Wholesale,(43) Retail,(44) Restaurants, Hotels, Motels(45)Banking,(46)Insurance,(47) Real Estate,(48)Trading,(49)Almost Nothing.

agriculture industry, the food products industry, the candy and soda industry, the consumer goods industry, the rubber and plastic products industry, the construction materials industry, the construction industry, the petroleum and natural gas industry, the insurance industry, the transportation industry, the utilities industry, the retail industry and the real estate industry. Handler and Hander (1983) find that the El Nino leads to higher corn yield in the United States, which will have a direct influence to the agriculture industry and further have a potential impact on the food products industry, and the candy and soda industry. El Nino also affects the rubber production (Brunner 2002). The United States is one of the largest rubber import countries14. There will exist an indirect impact on the rubber industry in U.S. because of the increasing world price of the rubber. Droughts and the high temperature following an El Nino episode increase the demand of crude oil particularly in Asian country. The increasing demand of the oil increase the world oil price considerably (Cashin et al. 2017). The United States, which is a large oil consumer country, will be affected by the increasing oil price dramatically. The petroleum and natural gas industry may benefit from the raised oil price while the transportation industry may hurt because of the increased cost. In contrast, Changnon (1999) finds that there is fewer highway-based and airline delay due to the improved weather conditions during the El Nino period, mainly in the north of the U.S.. The warmer weather conditions bring a 3%-8% increased profits in the airline industry due to the less stress and fewer delays. El Nino events likewise show a reduction in hurricanes activities

[14] United States imported $1.5 billion (11.7%) natural rubber during 2016, ranking second in the world. Source: http://www.worldstopexports.com/natural-rubber-imports-by-country/

(Bove et al. 1998). The construction of new homes is up, leading to a $350 million extra income in the construction industry from December to February(Changnon, 1999). Due to the warmer winter during the El Nino events, the retailer likewise benefits from the sizable added sales of good, around $5.6 billion good (Changnon, 1999). Those influences of the El Nino Period attract my attention and let me investigate further in the Construction Materials industry, construction industry, Insurance industry, and Real estate industry as well as the retail industry. There are also several utilities companies that save a large amount of cost by altering their strategy to deal with El Nino(Changnon, 1999).

All the industries returns are monthly value-weighted from first January 1950 to first April 2017. I take the monthly returns and net them off with the one-month T-bill[15] rate in U.S. market to compute the monthly excess return for U.S. industries. Table 3 shows the Summary Statistics of U.S. bench market excess return and the U.S. industries excess return. The average market excess return in U.S. is 0.63% per month during the last six decades.

[15] One-month T-bill rate comes from the Kenneth French's data library.

Table 3 Summary Statistics Of U.S. Bench Market Excess Return And Thirteen U.S. Industries Excess Return.

Note:(1) The monthly return values are obtained from Kenneth French's website.

(2) The mean monthly excess return is computed by subtracting one-month U.S. T-bill rate from total monthly return.

(3) The monthly returns for Candy and Soda industries are from July 1963 to April 2017, while the other monthly returns are from January 1950 to April 2017.

Dependent Variable	Obs	Mean	Std. Dev.	Min	Max
Market excess return	808	0.63	4.25	-23.24	16.1
Agriculture	808	0.57	6.40	-29.39	28.45
Food Products	808	0.73	4.16	-18.48	18.98
Candy and Soda	646	0.77	6.33	-27.07	37.95
Rubber and Plastic Products	808	0.81	5.84	-31.17	31.94
Oil	808	0.74	5.24	-18.96	23.70
Insurance	808	0.66	5.62	-26.54	26.33
Real Estate	808	0.49	7.37	-37.81	59.59
Consumer Goods	808	0.66	4.62	-22.24	18.22
Utilities	808	0.57	3.81	-12.94	18.26
Retail	808	0.72	5.04	-29.77	26.49
Construction Materials	808	0.71	5.79	-30.75	35.50
Construction	808	0.64	6.91	-31.7	23.42
Transportation	808	0.68	5.60	-28.5	18.51

3.3 Data on the international market

I obtain equity indices for international countries from DataStream. Following the research results that are got by Cashin et al. (2017) , This paper mainly focuses on the countries that are unambiguously affected by the El Nino period and also try to investigate the countries that are ambiguously affected by the El Nino period such as Japan, Singapore and Malaysia. There are certain negative El Nino effects in Australia, Indonesia and New Zealand mainly due to the drought weather conditions. Because of the storming winter and cold waves, Chile and Peru are slightly negatively and ambiguously affect by the El Nino events. In contrast, Canada can benefit from this weather cycle due to the warmer weather during El Nino period. I also obtain the data for the developed country in Europe. Europe countries include: Austria, Belgium, Finland, France, Germany, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom. First I obtain the total return index in local currency provided by DataStream and then convert the total return index in U.S. dollar currency by using the formula build into DataStream. Then I compute stock return in U.S. dollar currency. For the U.S. local investors, if they invest in the international equity market, they also should subtract the U.S. risk-free rate to get the excess return. Considering it, I compute excess return for international market by subtracting one-month U.S. T-bill rate from monthly stock return. The all monthly stock returns are measured in U.S. dollar. One obvious disadvantage of using US dollar returns is that for international investors, they more concern about their excess return based on their own countries benchmark and the purchase power of their local currency. This paper mainly focuses on U.S. local investors, if they invest in the international equity market, they also should subtract the U.S. risk-free rate to get the excess return.

Table 4 shows the Summary Statistics of international market. The developing countries such as Indonesia, Chile, Mexico and Peru show a higher average monthly excess return and a higher standard deviation. For the develop countries, their mean excess returns are quite stable around 5%-8% per month.

Table 4 Summary Statistics for the international stock market
Note: (1) All the values are percentage terms.
(2) All the data are MSCI country index obtained from Datastream.
(3) Excess return is subtracting one-month U.S.T-bill rate from total monthly return.

Country	Obs.	Begin Date	Mean	St. Dev.	Min	Max
Australia	567	February1970	0.58	6.96	-43.90	25.24
Indonesia	351	February1988	1.39	13.45	-41.79	94.09
New Zealand	351	February1988	0.51	6.74	-23.84	26.73
Canada	567	February1970	0.52	5.75	-25.80	23.29
Austria	567	February1970	0.48	6.89	-34.29	32.66
Belgium	567	February1970	0.69	5.97	-35.58	25.81
Finland	351	February1988	0.84	9.06	-30.33	34.27
France	567	February1970	0.60	6.57	-25.11	26.24
Germany	567	February1970	0.58	6.40	-22.03	23.69
Italy	567	February1970	0.29	7.43	-22.60	30.47
Netherlands	567	February1970	0.72	5.67	-24.65	25.41
Norway	567	February1970	0.74	7.91	-30.77	26.66
Spain	567	February1970	0.52	6.81	-27.60	26.70
Sweden	567	February1970	0.87	6.94	-22.75	23.13
Switzerland	567	February1970	0.64	5.33	-17.06	22.90
UK	567	February1970	0.57	6.36	-20.69	56.39
Chile	351	February1988	1.11	7.06	-29.59	24.08
Peru	291	February1993	1.33	9.17	-34.08	40.30
Japan	567	February1970	0.52	6.11	-20.17	22.07
Mexico	351	February1988	1.45	8.85	-33.69	28.79
Singapore	567	February1970	0.77	8.09	-40.87	48.61
Malaysia	351	February1988	0.62	7.98	-31.38	49.12

4. Methodology and hypothesis

This section will discuss the models and the hypothesis that will be used in this paper. The SOI variable is used as the main independent variable. For the U.S. market, the time series analysis will focus on the period of first January 1950 to first April 2017. For the international market, the time series will focus on the period of first February 1970 to first April 2017.

4.1 Regressions for the U.S. equity market and thirteen U.S. industries.

I will investigate El Nino effect by starting with the simple model, which is used by Saunders (1993) and Hirshleifer and Shumway (2003). Both of them use the Ordinary Least Squares Regression to investigate the weather effect on the stock market. The independent variable is SOI values and the dependent variable is the excess return in the U.S. market. The negative value SOI represents the El Nino intensity, which means that the smaller of the SOI value represents the more severe El Nino event. There is no control variable in the first regression. The first regression as following:

$$R_t^x = \alpha_0 + \alpha_1 SOI_t + e_t \quad (1)$$

, where R_t^x is the monthly excess return of U.S. benchmark and thirteen U.S. industries. α_0 is the intercept of this regression. SOI is the measures of the El Nino intensity in month t. e_t is the error term in this regression. α_1 measures the relation between the SOI and excess return in month t. The negative value of the α_1 shows a positive impact of the El Nino event.

The first hypothesis is that:

Hypothesis$_0$ 1: El Nino has no significant effect on U.S. stock market.

Hypothesis$_1$ 1: El Nino has a significant effect on U.S. stock market.

Hong, Torous, and Valkanov (2005) find that market information diffuses gradually across the stock market, so the market price can only react the true industry fundamental value of a delay. The investors are likewise unable to react rationally with the market information and might not extract valuable information from the market. Most of the investors only focus on the areas what they are specialized in. According to it, I make an assumption that the impact of the El Nino on equity market may have a delay, which means the market underreact the influence of the El Nino. To test this potential effect of the El Nino, I assume the second regression:

$$R_t^x=\alpha_0+\alpha_1 SOI_t+\alpha_2 SOI_{t-3} +\alpha_3 SOI_{t-6}+\alpha_4 SOI_{t-9}+\alpha_5 SOI_{t-12}+e_t \qquad (2)$$

Where SOIt-3, SOIt-6, SOIt-9, and SOIt-12 represent the 3-months, 6-months, 9-month, and 12-month lagged SOI anomalies respectively. α1, α2, α3, α4, and α5 show a 3-month, 6-months, 9-month, and 12-month delay impact of the El Nino. When a multiple regression model is used, the high correlation of the independent variables will reduce the predictive power and reliability of the independent variables. The correlation matrix should be used to check the potential multicollinearity of independent variables.

As I have discussed in the data part, lagged SOI index are not highly correlated with each other, so it is necessary to keep all the seasonal lagged SOI values in the regression.

The second hypothesis is that:

Hypothesis$_0$ *2: El Nino has no significant delay effect on U.S. stock market.*

Hypothesis$_1$ *2: El Nino has a significant delay effect on U.S. stock market.*

Many researchers find that there is a significant effect in the January, called January effect. The return in January appears to be abnormal high comparing to the return in other months of the year. Institutional investors usually sell "loss" portfolio and buy "win" portfolio to improve the performance (Haug and Hirschey 2016; Keim 1983; Moller and Zilca 2008) . Because all the excess return data that I use in the regression is monthly data, I include January effect variable as one of the control variables to eliminate the "noise" effect. When investigate the weather effect on the equity market, it is important to control for residual autocorrelation. Cao and Wei (2005), Kamstra et al. (2003), and Saunders (1993) use lagged return as one of the control variable to investigate the weather impact on equity market and they find there exist significant effect of the lagged return. Although in their sample, they analyze daily effect of weather on the stock market, while this paper mainly focuses on the monthly effect. I assume that the lagged one-month excess return may also affect the next month excess return. I include this lagged one-month excess return as the second control variable in third regression. Another control variable is Halloween Indicator. Bouman and Jacobsen (2002) find that the stock returns are lower during the summer from May to October comparing to the stock returns during the rest of the year. This Sell in May effect is significant in 36 out of 37 equity market sample. In contrast, Dichtl and Drobetz (2014) find that even this Halloween Indicator effect is statistically significant and persistent, this strategy can not be used to obtain excess return and this effect vanish gradually recent year .Due to the strongly significant Halloween Indicator impact in European countries and U.S. equity market and the long time period data sample , I also should include this effect in my third regression to rule out the noise effect. The third regression as following:

$$R_t^x=\alpha_0+\alpha_1 SOI_t+\alpha_2 SOI_{t-3}+\alpha_3 SOI_{t-6}+\alpha_4 SOI_{t-9}+\alpha_5 SOI_{t-12}+\alpha_6 D_t^{Jan}+\alpha_7 R_{t-1}^x+\alpha_8 D_t^H+e_t \quad (3)$$

D_t^{Jan} is the dummy variable, which measures the January effect. D_t^{Jan} equals to 1 if t is January otherwise D_t^{Jan} equal to 0. Rt-1 is the one-month lagged excess return in the U.S.

stock market. D_t^H is the dummy variable, which measures the Halloween Indicator impact. D_t^H equals to 1 if t equal to 4,5,6,7,8,9 or 10 otherwise D_t^H equal to 0.

This regression test is same as the second hypothesis but it is a different implementation with three control variables. It tests whether El Nino has significant effect on U.S. stock market after controlling for three control variables and lagged SOI variables.

4.2 Regressions for the international market

The excess return of the international market is not directly available in DataStream.

First, I use the total return index, which is available in DataStream, to calculate the monthly return of the different market indices by using: $R_t^x = \frac{P_t - P_{t-1}}{P_{t-1}}$. To make the international return data easily comparable with the U.S. monthly return, I turn the monthly return to percentage term by timing 100 to R_t^x. Then I get excess return for different international market by subtracting one-month U.S. T-bill rate.

For the international market, I do the same regressions as for the U.S. market, and also control the same control variables.

The third hypothesis is that:

Hypothesis$_0$ *3: El Nino has no significant effect on international stock market after controlling for two control variables and lagged SOI variables.*

Hypothesis$_1$ *3: El Nino has a significant effect on international stock market after controlling for two control variables and lagged SOI variables.*

As I have reviewed in the literature part, the El Nino effect may differ in the different regions. When there exist significant effects of El Nino on the international market, one should long the "winner" indices that are positively affected by the El Nino and short the "loser" indices that are negatively affected by the El Nino to obtain the excess return. So investors should use the information on the SOI index to make investment decisions and earn excess return. The monthly SOI index on NOAA website is posted at end of the month. How should investors use present useful information to buy a long or sell a short position in next few months? The next part shows that the possible strategies that investors can use to obtain excess return.

The fourth regression as following:

$$R_t^x=\alpha_0+\alpha_1 SOI_{t-1} +e_t \qquad (4)$$

, where R_t^x is the monthly excess return of U.S. benchmark, thirteen U.S. industries and international markets. α_0 is the intercept of this regression. SOI_{t-1} is the measures of the El Nino intensity in month t-1. e_t is the error term in this regression. α_1 measures the relation between the SOI in month t-1 and excess return in month t. The negative value of the α_1 shows a positive impact of the El Nino event, and investors should use the significant results to invest in next month.

Another problem is that how long should investors take the investment position in different market indices according to SOI index.

The fifth regression as following:

$$R_T^x=\alpha_0+\alpha_1 SOI_{t-1} +e_t \qquad (4)$$

, where R_T^x is the total excess return of U.S. benchmark, thirteen U.S. industries and international markets during T months period from month t[16]. α_0 is the intercept of this regression.

[16] In this paper, I mainly focus on 3-month, 6-month, 9-month and 12-month holding period,

SOI_{t-1} is the measures of the El Nino intensity in month t-1. e_t is the error term in this regression. α_1 measures the relation between the SOI in month t-1 and total excess return in T months holding period. The negative value of the α_1 shows a positive impact of the El Nino event, and investors should use the significant results to invest in next month and hold the investment position in T-month period.

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which means that T equal to 3, 6, 9 or 12.

5. Results

This section will show the results and test the hypotheses that are discussed in this methodology part. Section 5.1 shows the results in the U.S. market. Section 5.2 discusses the El Nino effect on the international market. Section 5.3 tests the possible investment and long/short strategy to obtain excess return.

5.1 Results for the U.S. equity market and thirteen U.S. industries.

The first hypothesis tests the present effect of El Nino on U.S. equity market and thirteen U.S. industries. The Table 5 shows the results of the first hypothesis. As we can see from the table, the coefficient of SOI in U.S. bench market is -0.202 with the p- value 0.196. It shows that there do not exist a significant effect of El Nino on U.S. whole market. When looking at El Nino effects on U.S. industries, it should be noticed that the result of the consumer goods industry is significant 1% level. The negative coefficient (-0.453) of SOI in the consumer goods industry indicates that a unit decreases in the SOI anomalies[17] increases the monthly excess return 0.453% in the consumer goods industry. Consistent with Changnon (1999), this result appears in a significant positive effect of El Nino on the consumer goods. Because of the warmer winter in the U.S. during the El Nino episodes, the citizens have more outdoor activities and consume more goods, leading a direct effect and increasing profit in the consumer industry. Except the consumer goods industry, there do not exist a significant effect of El Nino on other twelve industries. The real estate industry with the negative coefficient

[17] Negative SOI value represents the El Nino events. A decrease in the SOI anomalies means an increase in intensity of the El Nino event.

-0.436 has a P-value 0.108, which just slightly misses the significance at 10% level.

Another interesting fact is that except the model for the consumer goods industry, the R-squared for each regression is low. A possible reason for those low R-squared is that the climate anomalies have a small impact on the stock market. And I do not include other common factors such as company size, value in those models. With the results of the Table 5, I can test the first hypothesis that: "Whether El Nino has a significant effect on U.S. stock market?" I cannot reject the null hypothesis that El Nino has no significant effect on U.S. stock market except for the consumer goods industry.

Table 5：Regression results for the U.S. market and thirteen U.S. industries

Note: (1) This table reports the regression that tests the first hypothesis ($R_t^x = \alpha_0 + \alpha_1 SOI_t + e_t$).
(2) Dependent variable Agric represents the excess return in the agriculture industry; Dependent variable Food represents the excess return in the food products industry; Dependent variable Soda represents the excess return in the candy and soda industry; Dependent variable Hshld represents the excess return in the consumer goods industry; Dependent variable Rubbr represents the excess return in the rubber and plastic products industry; Dependent variable BldMt represents the excess return in the construction materials industry; Dependent variable Cnstr represents the excess return in the construction industry; Dependent variable Oil represents the excess return in the petroleum and natural gas industry; Dependent variable Insur represents the excess return in the insurance industry; Dependent variable Trans represents the excess return in the transportation industry; Dependent variable Util represents the excess return in the utilities industry; Dependent variable Rtail represents the excess return in the retail industry; Dependent variable RlEst represents the excess return in the real estate industry .N is the number of the observation. The Southern Oscillation index (SOI_t) is the independent variable that measures the intensity of El Nino from 1/1/1950 to 1/4/2017.
(3) The coefficients of the variables are displayed in the table with corresponding P-value (in brackets) below the coefficients.
(4) In the last two rows the R-squared and Adjust R^2 for each regression are showed.
** Indicate statistical significance at the 10% level*
***Indicate statistical significance at the 5% level*
**** Indicate statistical significance at the 1% level*

Variable	U.S.	Agric	Food	Soda	Hshld	Rubbr	BldMt
α_0	0.662***	0.579**	0.756***	0.787***	0.724***	0.843***	0.751***
	(0.000)	(0.011)	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)
SOI_t	-0.202	-0.0565	-0.155	-0.189	-0.453***	-0.241	-0.291
	(0.196)	(0.81)	(0.311)	(0.457)	(0.008)	(0.262)	(0.171)
N	808	808	808	646	808	808	808
R-squared	0.0021	0.0001	0.0013	0.0009	0.0088	0.0016	0.0023
Adjust R^2	0.0008	-0.0012	0	-0.0007	0.0076	0.0003	0.0011

Variable	Cnstr	Oil	Insur	Trans	Util	Rtail	RlEst
α_0	0.662**	0.720***	0.707***	0.687***	0.601***	0.748***	0.553**
	(0.007)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.035)
SOI_t	-0.18	0.143	-0.303	-0.1	-0.221	-0.203	-0.436
	(0.479)	(0.458)	(0.143)	(0.626)	(0.114)	(0.274)	(0.108)
N	808	808	808	808	808	808	808
R-squared	0.0006	0.0007	0.0027	0.0003	0.0031	0.0015	0.0032
Adjust R^2	-0.0006	-0.0006	0.0014	-0.0009	0.0019	0.0002	0.002

It is possible that the stock market underreacts the El Nino events, so the second hypothesis tests whether El Nino has a significant delay effect on U.S. stock market. The table 6 shows the results of the second hypothesis. When I include the lagged variable of SOI, there exists a 6-month lagged significant effect of El Nino on U.S. bench market at the 10% level. Jegadeesh and Titman (1993) find that momentum effect is persistent over 3 months to 12 months, and there exist lagged equity price reaction to firm risk factors. They mostly focus on 6-month return, and the results indicate that the behaviors of the investors cause the market inefficient. One possible explanation of 6-month lagged significant effect of El Nino on U.S is that the investors need time to incorporate the market information, and the equity market cannot reflect the El Nino impacts immediately. Inconsistent with previous researchers(Cashin et al. 2017; Changnon 1999), which find that the El Nino has a positive impact on the real economy, Table 6 displays a slightly negative delay impact on the U.S. equity market with a 0.337 positive coefficient of SOI_{t-6}. It should be noticed that although the present impact of El Nino on excess return in the consumer goods industry is significantly positive with a -0.581 negative coefficient of SOI, the lagged 6-month SOI shows there a negative delay impact of El Nino in the consumer goods industry. One possible explanation is that due to the warmer winter in U.S., citizens have more outdoor activities and choose to consume more goods now but consume less in the future because of the limited budget. The behaviors of the consumers lead a reverse impact of El Nino in the consumer goods industry. Besides the delay effect in the consumer goods industry, Table 6 likewise displays a lagged slightly negative impact of El Nino in the agriculture industry (0.518), the construction materials industry (0.559), the insurance industry (0.453), and the retail industry (0.421) at the

10% significant level. The 6-month lagged SOI shows that the U.S. industry market underreacts the impact of the El Nino, and the market needs time to transfer the influence of the climate anomalies to the stock price. Consistent with Changnon (1999) who find that the El Nino lead to a seasonal sales of house record, I also find El Nino have a positively significant influence in the real estate industry with a -0.551 negative coefficient of SOI at the 10% significant level . Besides the impacts that mentioned above, El Nino also has a positive influence in the food industry at 10% significant level with a -0.371 negative coefficient, and it is consistent with the findings that higher expected corn crop yields in the U.S. and fewer flood damages during El Nino periods (Changnon 1999; Handler and Hander 1983).

With the results of Table 6, I can test the second hypothesis that: "Whether El Nino has a significant delay effect on U.S. stock market?" For the U.S. market, the agriculture industry, the construction materials industry, the insurance industry, the consumer goods industry and the retail industry, I can reject the null hypothesis that El Nino has no significant delay effect on U.S. stock market. The second test shows that the market cannot react efficiently respond to the El Nino events. The delay impact exists across the majority of the U.S. industries.

Table 6: Regression results for the U.S. market and thirteen U.S. industries (Including the delay effects of SOI)

Note: (1) This table reports the regression that tests the second hypothesis (R_t^x=α_0+α1SOIt+α2SOIt-3 +α3SOIt-6+α4SOIt-9+α5SOIt-12+et).
(2) Independent variable SOIt-3, SOIt-6, SOIt-9, and SOIt-12 represent the 3-months, 6-months, 9-month, and 12-month lagged SOI anomalies respectively. Dependent variables are same as in the table5. N is the number of the observation. SOIt is the independent variable that measures the intensity of El Nino from 1/1/1950 to 1/4/2017.
(3) The coefficients of the variables are displayed in the table with corresponding P-value (in brackets) below the coefficients.
(4) In the last two rows the R-squared and Adjust R2 for each regression are showed.
** indicates statistical significance at the 10% level*
*** indicates statistical significance at the 5% level*
**** indicates statistical significance at the 1% level*

Variable	U.S.	Agric	Food	Soda	Hshld	Rubbr	BldMt
α_0	0.658***	0.616**	0.740***	0.767***	0.711***	0.816***	0.754***
	(0.000)	(0.008)	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)
SOI_t	-0.279	-0.241	-0.317*	-0.423	-0.581***	-0.314	-0.362
	(0.127)	(0.379)	(0.076)	(0.159)	(0.003)	(0.212)	(0.146)
SOI_{t-3}	-0.0158	0.164	0.197	0.436	-0.1	-0.103	-0.117
	(0.938)	(0.588)	(0.318)	(0.192)	(0.644)	(0.71)	(0.67)
SOI_{t-6}	0.337*	0.518*	0.207	0.202	0.656***	0.438	0.559**
	(0.096)	(0.088)	(0.297)	(0.546)	(0.003)	(0.115)	(0.043)
SOI_{t-9}	-0.169	-0.551*	-0.0208	-0.461	-0.216	-0.0767	-0.372
	(0.401)	(0.069)	(0.916)	(0.167)	(0.319)	(0.781)	(0.174)
SOI_{t-12}	-0.0485	-0.231	-0.11	0.271	-0.128	0.00229	-0.0256
	(0.79)	(0.399)	(0.537)	(0.366)	(0.514)	(0.993)	(0.918)
N	808	808	808	646	808	808	808
R-squared	0.0059	0.0092	0.0058	0.0072	0.0205	0.005	0.0081
Adjust R^2	-0.0003	0.0092	-0.0004	-0.0006	0.0144	-0.0012	0.0019

Variable	Cnstr	Oil	Insur	Trans	Util	Rtail	RlEst
α_0	0.653**	0.702***	0.710***	0.692***	0.578***	0.733***	0.514
	(0.009)	(0.000)	(0.000)	0.001	(0.000)	(0.000)	(0.053)
SOI_t	-0.261	0.0734	-0.45*	-0.271	-0.262	-0.227	-0.551*
	(0.382)	(0.745)	(0.063)	(0.26)	(0.11)	(0.296)	(0.083)
SOI_{t-3}	0.0216	0.192	0.108	0.176	0.0874	-0.126	-0.0553
	(0.948)	(0.439)	(0.686)	(0.508)	(0.628)	(0.599)	(0.874)
SOI_{t-6}	0.28	-0.206	0.453*	0.297	-0.0643	0.421*	0.568
	(0.396)	(0.409)	(0.09)	(0.265)	(0.723)	(0.08)	(0.106)
SOI_{t-9}	-0.145	0.31	-0.417	-0.116	0.153	-0.343	-0.252
	(0.657)	(0.213)	(0.117)	(0.661)	(0.396)	(0.151)	(0.47)
SOI_{t-12}	-0.0132	-0.0952	-0.0315	-0.232	0.0331	0.171	0.124
	(0.965)	(0.673)	(0.896)	(0.334)	(0.839)	(0.428)	(0.694)
N	808	808	808	808	808	808	808
R-squared	0.0017	0.0037	0.0086	0.0044	0.0051	0.0068	0.0071
Adjust R^2	-0.0045	-0.0025	0.0024	-0.0018	-0.0011	0.0006	0.001

As I discussed in the methodology part, in order to rule out the possible "noise" effects in the model, the control variables are included in the second hypothesis tests that whether El Nino has a significant effect on U.S. stock market after controlling for two control variables and lagged SOI variables. The table 7 shows the results of the third hypothesis. When the control variables included in the regression, there also exists a 6-month lagged slightly significant effect of El Nino on U.S market. The one-month lagged excess return appears a significant positive impact on the present excess return across the most U.S. industries. This result is in line with earlier finding by Cao and Wei (2005), Kamstra et al. (2003), and Saunder (1993),who find there exist significant effect of the lagged return when study the weather anomalies influences on stock market . Comparing to the effect of the lagged return, January effect is less significant across the industries. January effect only displays a 1% significant level in the insurance industry and a 10% significant level in the oil industry. In line with the research by Bouman and Jacobsen (2002), Halloween Indicator impact is significant at 1% level across 12 out of 14 U.S. industry sample .After controlling for three control variables, Table 7 also displays a lagged slightly negative impact of El Nino in the agriculture industry (0.547), the construction materials industry (0.599), the insurance industry (0.498), and the retail industry (0.45) at the 10% significant level as same as the impact in the Table 6. The significance of result for the consumer goods industry remains same. But one should notice that, after adding three control variables, there exists a 6-month lagged negative impact of El Nino on the real estate industry at 10% significant level. One possible explanation is same as for the consumer goods industry. The warmer winter bring advance consumption to the U.S. citizens, which means a reverse impact of El Nino events on the excess return in the real estate industry. In line with the previous research by Brunner (2002), who find El Nino events influent the commodity price of rubber, the regression for the rubber and plastic products industry shows a 6-month negative impact (0.485) of El Nino on excess return.

With the results of Table 7, I can test the hypothesis that: "Whether El Nino has a significant delay effect on U.S. stock market after adding three control variables and lagged SOI variables?" For the U.S. market, the agriculture industry, the construction materials industry, the insurance industry, the consumer goods industry, the rubber and plastic products industry, the retail industry and the real estate industry I can reject the null hypothesis that El Nino has no significant delay effect on U.S. stock market. The third test shows that after adding three control variables, the delay impact of El Nino on U.S. stock market remains same, which means that market need 6-month to transfer the effect of El Nino to the equity price. The delay impact exists across the majority of the U.S. industries.

Table 7：Regression results for the U.S. market and thirteen U.S. industries (Including the delay effects of SOI and the control variables)

Note: (1) This table reports the regression that tests the second hypothesis (R_t^x=α0+α1SOIt+α2SOIt-3 +α3SOIt-6+α4SOIt-9+α5SOIt-12+α6DJan+R_{t-1}^x+et).
(2) Independent variable SOIt-3, SOIt-6, SOIt-9, and SOIt-12 represent the 3-months, 6-months, 9-month, and 12-month lagged SOI anomalies respectively. Dependent variables are same as in the table5. N is the number of the observation. SOIt is the independent variable that measures the intensity of El Nino from 1/1/1950 to 1/4/2017. D^{Jan} is the dummy variable that measures the January effect. If month is January, D^{Jan} equals 1otherwise equals 0. R_{t-1}^x is the one-month lagged excess return in the U.S. stock market or in the U.S. industry x. D_t^H is the dummy variable, which measures the Halloween Indicator impact.
(3) The coefficients of the variable are displayed in the table with corresponding P-value (in brackets) below the coefficients.
(4) In the last two rows the R-squared and Adjust R2 for each regression are showed.
** indicates statistical significance at the 10% level*
*** indicates statistical significance at the 5% level*
**** indicates statistical significance at the 1% level*

Variable	U.S.	Agric	Food	Soda	Hshld	Rubbr	BldMt
α_0	1.181***	1.390***	0.916***	1.559***	1.215***	1.706***	1.786***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SOI_t	-0.317*	-0.291	-0.326*	-0.464	-0.600***	-0.385	-0.432*
	(0.081)	(0.287)	(0.069)	(0.122)	(0.002)	(0.119)	(0.078)
SOI_{t-3}	0.036	0.242	0.204	0.496	-0.0603	-0.0052	-0.00883
	(0.857)	(0.421)	(0.302)	(0.137)	(0.781)	(0.985)	(0.974)
SOI_{t-6}	0.361*	0.547*	0.217	0.217	0.671***	0.485*	0.599**
	(0.073)	(0.07)	(0.272)	(0.515)	(0.002)	(0.076)	(0.027)
SOI_{t-9}	-0.214	-0.630*	-0.0228	-0.512	-0.251	-0.166	-0.47*
	(0.286)	(0.036)	(0.908)	(0.126)	(0.246)	(0.543)	(0.082)
SOI_{t-12}	-0.0422	-0.222	-0.124	0.267	-0.132	-0.00368	-0.0149
	(0.816)	(0.415)	(0.486)	(0.372)	(0.501)	(0.988)	(0.951)
D_t^{Jan}	-0.324	0.659	-0.58	-0.92	-0.887	0.392	-0.358
	(0.564)	(0.435)	(0.295)	(0.329)	(0.144)	(0.607)	(0.637)
R_{t-1}^x	0.0671	0.000537	0.057	0.0204	0.0515	0.0826**	0.0629*
	(0.056)	(0.988)	(0.107)	(0.608)	(0.141)	(0.018)	(0.072)
D_t^H	-1.082***	-1.666***	-0.338	-1.468***	-0.931***	-1.983***	-2.103***
	(0.001)	(0.000)	(0.274)	(0.005)	(0.006)	(0.000)	(0.000)
N	808	808	808	646	808	808	808
R-squared	0.0268	0.0291	0.0113	0.0202	0.0336	0.0366	0.0462
Adjust R^2	0.017	0.0194	0.0014	0.0079	0.0239	5.7307	0.0366

Variable	Cnstr	Oil	Insur	Trans	Util	Rtail	RlEst
α_0	1.440***	1.345***	1.457***	1.249***	0.684***	1.213***	1.199***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.003)
SOI_t	-0.363	0.0354	-0.479**	-0.325	-0.266	-0.265	-0.619**
	(0.216)	(0.875)	(0.046)	(0.174)	(0.106)	(0.217)	(0.047)
SOI_{t-3}	0.148	0.241	0.146	0.24	0.0958	-0.0712	0.0922
	(0.647)	(0.332)	(0.581)	(0.363)	(0.597)	(0.763)	(0.788)
SOI_{t-6}	0.339	-0.192	0.498*	0.318	-0.0492	0.45*	0.602*
	(0.294)	(0.441)	(0.06)	(0.228)	(0.786)	(0.058)	(0.08)
SOI_{t-9}	-0.237	0.271	-0.475	-0.173	0.145	-0.391*	-0.342

	(0.462)	(0.276)	(0.072)	0.511	0.423	0.098	0.318
SOI_{t-12}	-0.00804	-0.104	-0.0262	-0.218	0.0274	0.168	0.122
	(0.978)	(0.643)	(0.912)	(0.36)	(0.867)	(0.433)	(0.694)
D_t^{Jan}	1.301	-1.176*	-2.070***	0.592	0.152	-0.397	1.454
	(0.15)	(0.092)	(0.005)	(0.423)	(0.765)	(0.55)	(0.13)
R_{t-1}^x	0.105***	-0.00322	0.0882**	0.0750**	0.0472	0.115**	0.141***
	(0.003)	(0.927)	(0.012)	(0.033)	(0.183)	(0.001)	(0.000)
D_t^H	-1.941***	-1.083**	-1.271***	-1.320***	-0.296	-1.061***	-1.766***
	(0.000)	(0.005)	(0.002)	(0.002)	(0.296)	(0.004)	(0.001)
N	808	808	808	808	808	808	808
R-squared	0.0443	0.0142	0.0323	0.0291	0.0095	0.0323	0.0522
Adjust R^2	0.0347	0.0044	0.0227	0.0194	-0.0004	0.0226	0.0427

5.2 Results for the international equity market.

In order to test the effect of El Nino events across the international markets, further tests will be displayed in this section. Table 8 shows the results of the hypothesis that is same as the first hypothesis for U.S. market. Contrasting to the previous research by Cashin et al. (2017), who find that there are significant negative El Nino effects on real economy in Australia and New Zealand, Table 8 shows that there does not exist significant present impacts of El Nino events on the country indices of Australia and New Zealand. But the coefficient estimate for Indonesia market shows a consistent result with the study by Cashin et al. (2017), a unit decreases in SOI lower a 1.36% monthly excess return in Indonesian market. El Nino episodes have a negative impact on Indonesia market indices at 10% significant level. Cashin et al., (2017) also state that Europe experiences a 0.24 % points increase in the real economy due to the spillover trades with the U.S., I find the corresponding results. Positive impacts of El Nino are across European area. A unit decrease in SOI anomalies increases a

0.559%, 0.540%, -0.429%, and 0.387% monthly excess return for Austria, Belgium, Netherland and Switzerland country indices respectively. One should notice that the R-squared is low for the all the regressions, which means that the weather anomalies have only limited explanations for the excess returns. The impacts of El Nino on Chilean, Peruvian, Japanese，Mexican，Singaporean, and Malaysian markets are ambiguous.

With the results of the Table 8, I can test the hypothesis□that:“ Whether El Nino has a significant effect on international stock market?” I can reject the null hypothesis□that El Nino has no significant effect on international stock markets for Indonesia, Austria, Belgium, Netherland and Switzerland.

Table 8：Regression results for the International market

Note: (1) This table reports the regression that tests the hypothesis that is same as the first hypothesis for U.S. market. ($R_t^x = \alpha 0 + \alpha 1 SOIt + et$).
(2) The dependent variable is the excess return in the country x market index, which is obtained from MSCI Indices in DataStream. N is the number of the observation. SOI_t *is the independent variable that measures the intensity of El Nino from 1/1/1970 to 1/4/2017.*
(3) The coefficients of the variables are displayed in the table with corresponding P-value (in brackets) below the coefficients.
(4) In the last two rows the R-squared and Adjust R2 for each regression are showed.
** indicates statistical significance at the 10% level*
*** indicates statistical significance at the 5% level*
**** indicates statistical significance at the 1% level*

Variable	Australia	Indonesia	New Zealand	Canada	Austria	Belgium	Finland	France
α_0	0.616**	1.25*	0.553	0.521**	0.538*	0.743***	0.851*	0.631**
	(0.036)	(0.083)	(0.127)	(0.032)	(0.064)	(0.003)	(0.081)	(0.023)
SOI_t	-0.358	1.36*	-0.441	-0.0541	-0.559*	-0.540**	-0.141	-0.271
	(0.218)	(0.064)	(0.231)	(0.822)	(0.052)	(0.03)	(0.776)	(0.324)
N	567	351	351	567	567	567	351	567
R-squared	0.0027	0.0098	0.0041	0.0001	0.0067	0.0083	0.0002	0.0017
Adjust R^2	0.0009	0.007	0.0013	-0.0017	0.0049	0.0066	-0.0026	0

Variable	Italy	Netherlands	Norway	Spain	Sweden	Switzerland	UK	Chile
α_0	0.339	0.763**	0.756*	0.522	0.895**	0.682**	0.594*	1.141**
	(0.28)	(0.001)	(0.024)	(0.07)	(0.002)	(0.003)	(0.027)	(0.003)
SOI_t	-0.445	-0.429*	-0.168	0.00996	-0.205	-0.387*	-0.248	-0.296
	(0.151)	(0.07)	(0.612)	(0.972)	(0.479)	(0.082)	(0.35)	(0.442)
N	567	567	567	567	567	567	567	351
R-squared	0.0036	0.0058	0.0005	0	0.0009	0.0053	0.0015	0.0017
Adjust R2	0.0019	0.004	-0.0013	-0.0018	-0.0009	0.0036	-0.0002	-0.0012
Variable	Germany	Peru	Japan	Mexico	Singapore	Malaysia		
α_0	0.608**	1.402**	0.553**	1.470***	0.830**	0.598		
	(0.025)	(0.01)	(0.032)	(0.002)	(0.015)	(0.164)		
SOI_t	-0.256	-0.541	-0.288	-0.192	-0.526	0.19		
	(0.339)	(0.328)	(0.26)	(0.691)	(0.119)	(0.662)		
N	567	291	567	351	567	351		
R-squared	0.0016	0.0033	0.0022	0.0005	0.0043	0.0005		
Adjust R2	-0.0001	-0.0001	0.0005	-0.0024	0.0025	-0.0023		

Further, I test whether El Nino has significant delay effects on the international stock markets. Table 9 presents the results of the coefficient estimates across twenty-two country indices. It is interested fact that the present impacts of El Nino disappear for the Indonesia, Belgium, Netherland and Switzerland, when I include the lagged SOI anomalies. In contrast, there exists significant delay influence of El Nino on France, Italy, Sweden as well as UK. The results show that El Nino positively affects the market indices across the European area with a delay. For Australia, it appears a 3-month negative impact of El Nino events. A unit decrease in SOI lowers a 1.36% monthly excess return in Australia equity market. Peru market seems react more slowly to the El Nino events, and it shows a 9-month lagged positive impact of El Nino. There are also 9-month lagged positive impacts of El Nino on Japan and

Singapore. The results are in line with the study by Cashin et al.(2017), who find that there are a-year lagged positive impacts of El Nino on Japanese and Singaporean real economy growth. In contrast, the Table 9 shows a 3-month lagged negative impact of El Nino on Malaysia. With the results of the Table 9, I can conclude that El Nino has significant delay effects on the international stock markets.

Table 9: Regression results for the International market (Including the delay effects of SOI)

Note: (1) This table reports the regression that tests the hypothesis that is same as the second hypothesis for U.S. market. ($R_t^x = \alpha_0 + \alpha_1 SOI_t + \alpha_2 SOI_{t-3} + \alpha_3 SOI_{t-6} + \alpha_4 SOI_{t-9} + \alpha_5 SOI_{t-12} + e_t$).
(2) Independent variable SOIt-3, SOIt-6, SOIt-9, and SOIt-12 represent the 3-months, 6-months, 9-month, and 12-month lagged SOI anomalies respectively. N is the number of the observation. SOI_t is the independent variable that measures the intensity of El Nino from 1/1/1970 to 1/4/2017.
(3) The coefficients of the variables are displayed in the table with corresponding P-value (in brackets) below the coefficients.
(4) In the last two rows the R-squared and Adjust R2 for each regression are showed.
** Indicate statistical significance at the 10% level*
***Indicate statistical significance at the 5% level*
**** Indicate statistical significance at the 1% level*

Variable	Australia	Indonesia	New Zealand	Canada	Austria	Belgium	Finland	France
α_0	0.648**	1.219*	0.565	0.551**	0.547*	0.785***	0.925*	0.668**
	(0.028)	(0.092)	(0.122)	(0.025)	(0.061)	(0.002)	(0.059)	(0.017)
SOI_t	-0.501	0.092	-0.465	-0.0165	-0.688**	-0.318	-0.0501	-0.292
	(0.15)	(0.441)	(0.292)	(0.955)	(0.047)	(0.287)	(0.932)	(0.374)
SOI_{t-3}	0.764*	1.006	0.211	0.0834	0.347	-0.132	0.341	0.576
	(0.051)	(0.31)	(0.673)	(0.797)	(0.371)	(0.694)	(0.611)	(0.119)
SOI_{t-6}	-0.668*	0.974	-0.126	-0.0915	0.0698	-0.236	-0.88	-0.753**
	(0.088)	(0.327)	(0.801)	(0.778)	(0.857)	(0.481)	(0.189)	(0.042)
SOI_{t-9}	-0.45	-1.005	-0.345	-0.411	-0.61	-0.55	0.0113	-0.38
	(0.251)	(0.312)	(0.492)	(0.206)	(0.116)	(0.101)	(0.987)	(0.303)
SOI_{t-12}	0.155	-0.173	0.104	0.0651	0.222	0.264	-0.62	0.192
	(0.655)	(0.843)	(0.813)	(0.822)	(0.52)	(0.376)	(0.292)	(0.558)
N	567	351	351	567	567	567	351	567
R-squared	0.0169	0.0202	0.0067	0.0052	0.0122	0.0201	0.0145	0.0168
Adjust R^2	0.0082	0.006	-0.0076	-0.0036	0.0034	0.0113	0.0002	0.008

Variable	Italy	Netherlands	Norway	Spain	Sweden	Switzerland	UK	Chile
α_0	0.384	0.779***	0.805**	0.572**	0.911***	0.699***	0.606**	1.151***
	(0.223)	(0.001)	(0.017)	(0.049)	(0.002)	(0.002)	(0.025)	(0.003)
SOI_t	-0.533	-0.424	-0.261	0.214	-0.0487	-0.424	-0.171	-0.276
	(0.152)	(0.136)	(0.511)	(0.531)	(0.889)	(0.113)	(0.592)	(0.552)
SOI_{t-3}	0.59	0.315	0.521	-0.13	0.0756	0.352	0.0945	-0.0511
	(0.159)	(0.325)	(0.244)	(0.735)	(0.847)	(0.241)	(0.792)	(0.922)
SOI_{t-6}	-0.794*	-0.471	-0.496	-0.358	-0.67*	-0.378	-0.133	0.217
	(0.058)	(0.141)	(0.268)	(0.353)	(0.088)	(0.208)	(0.712)	(0.679)
SOI_{t-9}	0.111	-0.183	-0.28	-0.163	0.146	-0.253	-0.607*	-0.385
	(0.791)	(0.568)	(0.53)	(0.673)	(0.71)	(0.399)	(0.091)	(0.465)
SOI_{t-12}	-0.301	0.163	-0.178	-0.0804	0.139	0.132	0.449	0.0406
	(0.418)	(0.566)	(0.653)	(0.814)	(0.69)	(0.621)	(0.159)	(0.93)
N	567	567	567	567	567	567	567	351
R-squared	0.0143	0.0124	0.0083	0.0066	0.0069	0.0123	0.0092	0.0035
Adjust R^2	0.0055	0.0036	-0.0005	-0.0023	-0.002	0.0035	0.0004	-0.0109

Variable	Germany	Peru	Japan	Mexico	Singapore	Malaysia
α_0	0.610**	1.492***	0.580*	1.453**	0.827*	0.57
	(0.025)	(0.007)	(0.025)	(0.003)	(0.016)	(0.185)
SOI_t	-0.281	-0.306	-0.479	-0.578	-0.632	-0.392
	(0.383)	(0.641)	(0.117)	(0.319)	(0.118)	(0.45)
SOI_{t-3}	0.281	-0.119	0.673	0.444	0.2	1.162*
	(0.437)	(0.873)	(0.05)	(0.498)	(0.66)	(0.049)
SOI_{t-6}	-0.172	-0.0368	-0.26	0.675	0.532	0.203
	(0.634)	(0.961)	(0.448)	(0.304)	(0.242)	(0.73)
SOI_{t-9}	-0.513	-1.308*	-0.692*	-0.357	-1.253**	-0.728
	(0.156)	(0.08)	(0.044)	(0.587)	(0.006)	(0.218)
SOI_{t-12}	0.41	0.384	0.172	-0.365	0.657	0.168
	(0.202)	(0.553)	(0.573)	(0.527)	(0.104)	(0.745)
N	567	291	567	351	567	351
R-squared	0.0077	0.0193	0.0179	0.0088	0.0183	0.0178
Adjust R^2	-0.0011	0.002	0.0091	-0.0056	0.0095	0.0035

In the last test, the control variables included in the regression in order to rule out the possible "noise" effects in the model. As we can see from Table 10, the January effect and the one-month lagged excess return are significant for most of the international markets. When the control variables included, the lagged impact of El Nino remains same as the result in Table 9. Those similar results show that the lagged impacts of El Nino are stable across international market. One should notice that the Halloween Indicator impact is less significant in the international market comparing to the U.S. industry market. In conclusion, El Nino has a significant delay effect on international stock markets (Australia, France, Italy, Sweden, UK, Peru, Japan, Singapore and Malaysia) after adding three control variables and lagged SOI variable.

Table 10: Regression results for the International market (Including the delay effects of SOI and the control variables)

Note: (1) This table reports the regression that tests the hypothesis that is same as the third hypothesis for U.S. market.
(R_t^x=α0+α1SOIt+α2SOIt-3 +α3SOIt-6+α4SOIt-9+α5SOIt-12+α6DJan+R_{t-1}^x+et).
(2) Independent variable SOIt-3, SOIt-6, SOIt-9, and SOIt-12 represent the 3-months, 6-months, 9-month, and 12-month lagged SOI anomalies respectively. N is the number of the observation. SOIt is the independent variable that measures the intensity of El Nino from 1/1/1970 to 1/4/2017. DJan is the dummy variable that measures the January effect. If month is January, DJan equals 1otherwise equals 0. R_{t-1}^x is the one-month lagged excess return in the country x. D_t^H is the dummy variable, which measures the Halloween Indicator impact.
(3) The coefficients of the variables are displayed in the table with corresponding P-value (in brackets) below the coefficients.
(4) In the last two rows the R-squared and Adjust R2 for each regression are showed.
** indicates statistical significance at the 10% level*
*** indicates statistical significance at the 5% level*
**** indicates statistical significance at the 1% level*

Variable	Australia	Indonesia	New Zealand	Canada	Austria	Belgium	Finland	France
α_0	0.514	1.423	0.583	0.681	0.479	0.639	1.797**	0.922**
	(0.258)	(0.2)	(0.304)	(0.071)	(0.28)	(0.097)	(0.017)	(0.032)
SOI_t	-0.526	0.287	-0.493	-0.0682	-0.683**	-0.317	-0.156	-0.326
	(0.131)	(0.743)	(0.269)	(0.814)	(0.045)	(0.281)	(0.792)	(0.321)
SOI_{t-3}	0.791**	1.264	0.234	0.16	0.371	-0.0898	0.348	0.606
	(0.043)	(0.2)	(0.642)	(0.624)	(0.331)	(0.785)	(0.601)	(0.1)
SOI_{t-6}	-0.656	0.719	-0.135	-0.103	0.0653	-0.202	-0.704	-0.714*
	(0.093)	(0.469)	(0.788)	(0.752)	(0.864)	(0.541)	(0.293)	(0.053)
SOI_{t-9}	-0.459	-0.965	-0.342	-0.429	-0.574	-0.532	-0.0915	-0.404
	(0.24)	(0.327)	(0.497)	(0.186)	(0.133)	(0.107)	(0.891)	(0.272)
SOI_{t-12}	0.153	-0.146	0.0649	0.0683	0.187	0.272	-0.56	0.193
	(0.659)	(0.866)	(0.884)	(0.813)	(0.582)	(0.353)	(0.342)	(0.554)
D_t^{Jan}	2.523**	4.176	0.584	1.348	3.261***	2.954***	-0.0185	1.832*
	(0.023)	(0.123)	(0.673)	(0.142)	(0.003)	(0.002)	(0.992)	(0.079)
R_{t-1}^x	0.0194	0.138*	-0.0296	0.0603	0.142***	0.127**	0.114*	0.0479
	(0.644)	(0.011)	(0.585)	(0.155)	(0.001)	(0.002)	(0.035)	(0.252)
D_t^H	-0.159	-1.4	-0.0663	-0.552	-0.543	-0.393	-1.9*	-0.884
	(0.795)	(0.351)	(0.931)	(0.277)	(0.364)	(0.447)	(0.062)	(0.125)
N	567	351	351	567	567	567	351	567
R-squared	0.0281	0.0506	0.0088	0.0171	0.0532	0.0581	0.0399	0.0326
Adjust R2	0.0141	0.0284	-0.0145	0.003	0.0396	0.0446	0.0174	0.0187

Variable	Italy	Netherlands	Norway	Spain	Sweden	Switzerland	UK	Chile
α_0	0.705	0.891**	0.482	0.935**	1.556***	0.622*	0.742*	1.445**
	(0.147)	(0.016)	(0.351)	(0.037)	(0.001)	(0.074)	(0.075)	(0.016)
SOI_t	-0.546	-0.47	-0.328	0.179	-0.119	-0.443*	-0.212	-0.348
	(0.143)	(0.096)	(0.41)	(0.601)	(0.732)	(0.096)	(0.506)	(0.451)
SOI_{t-3}	0.616	0.35	0.581	-0.117	0.132	0.374	0.134	-0.0275
	(0.14)	(0.271)	(0.193)	(0.761)	(0.735)	(0.21)	(0.708)	(0.958)
SOI_{t-6}	-0.76*	-0.444	-0.519	-0.312	-0.615	-0.355	-0.0963	0.264
	(0.069)	(0.162)	(0.244)	(0.418)	(0.115)	(0.234)	(0.788)	(0.614)

SOI_{t-9}	0.0882	-0.205	-0.252	-0.177	0.1	-0.274	-0.623*	-0.363
	(0.833)	(0.518)	(0.572)	(0.646)	(0.797)	(0.359)	(0.082)	(0.487)
SOI_{t-12}	-0.295	0.148	-0.154	-0.0806	0.122	0.126	0.429	0.000972
	(0.427)	(0.6)	(0.697)	(0.814)	(0.725)	(0.635)	(0.177)	(0.998)
D_t^{Jan}	1.66	2.525***	1.68	0.527	0.93	2.532***	1.758*	1.313
	(0.16)	(0.005)	(0.183)	(0.628)	(0.399)	(0.003)	(0.082)	(0.361)
R_{t-1}^x	0.0442	-0.00143	0.110**	0.0642	0.0475	0.0417	0.0847*	0.132*
	(0.293)	(0.973)	(0.009)	(0.128)	(0.257)	(0.317)	(0.043)	(0.015)
D_t^H	-0.962	-0.616	0.19	-0.894	-1.508*	-0.307	-0.657	-1.097
	(0.142)	(0.215)	(0.786)	(0.138)	(0.014)	(0.511)	(0.241)	(0.17)
N	567	567	567	567	567	567	567	351
R-squared	0.0265	0.0348	0.0228	0.0164	0.0252	0.0345	0.0269	0.0322
Adjust R2	0.0125	0.021	0.0087	0.0023	0.0112	0.0207	0.013	0.0095

Variable	Germany	Peru	Japan	Mexico	Singapore	Malaysia
α_0	0.926*	1.969*	0.602	1.973***	0.985*	0.993
	(0.027)	(0.021)	(0.13)	(0.008)	(0.06)	(0.135)
SOI_t	-0.339	-0.4	-0.479	-0.587	-0.725	-0.539
	(0.29)	(0.547)	(0.116)	(0.31)	(0.07)	(0.298)
SOI_{t-3}	0.326	-0.185	0.683**	0.431	0.378	1.255**
	(0.363)	(0.804)	(0.046)	(0.51)	(0.402)	(0.032)
SOI_{t-6}	-0.139	0.0971	-0.242	0.729	0.469	0.203
	(0.699)	(0.897)	(0.479)	(0.268)	(0.297)	(0.73)
SOI_{t-9}	-0.54	-1.297*	-0.677*	-0.317	-1.231***	-0.748
	(0.133)	(0.085)	(0.048)	(0.627)	(0.006)	(0.202)
SOI_{t-12}	0.388	0.258	0.158	-0.376	0.603	0.121
	(0.224)	(0.695)	(0.603)	(0.513)	(0.131)	(0.814)
D_t^{Jan}	2.266**	0.0872	1.885*	-0.344	2.421*	2.614
	(0.026)	(0.966)	(0.051)	(0.848)	(0.057)	(0.105)
R_{t-1}^x	0.0135	-0.0278	0.0860*	0.0531	0.143***	0.097*
	(0.746)	(0.64)	(0.04)	(0.323)	(0.001)	(0.071)
D_t^H	-1*	-0.733	-0.443	-1.267	-0.931	-1.402
	(0.076)	(0.525)	(0.407)	(0.205)	(0.186)	(0.118)

N	567	291	567	351	567	351
R-squared	0.0284	0.0217	0.0358	0.0156	0.0518	0.0478
Adjust R2	0.0144	-0.0062	0.0219	-0.0075	0.0382	0.0255

5.3 Investment and Long/short strategy

If El Nino has significant impacts across the global market, there must be a portfolio that consists of winner market indices and loser market indices to obtain the excess return. Investors should long the market index that is positively affected by the El Nino and short the market index that is negatively affected by the El Nino. The monthly SOI index on NOAA website is posted at end of the month. How should investors use present useful information to buy a long or sell a short position in next few months?

Table 11: Regression results for the investment decisions in incoming month

Note: (1) This table reports the fourth regression.
($R_t^x = \alpha_0 + \alpha_1 SOI_{t-1} + e_t$)
(2) SOI_{t-1} *is the independent variable that measures the intensity of El Nino in previous month t-1.*
(3) The coefficients of the variables are displayed in the table with corresponding P-value (in brackets) below the coefficients.
(4) In the last two rows the R-squared and Adjust R2 for each regression are showed.
** indicates statistical significance at the 10% level*
*** indicates statistical significance at the 5% level*
**** indicates statistical significance at the 1% level*

Panel A: Summary Statistics Of US Benchmark and Thirteen U.S. Industry Markets

Variable	U.S.	Agric	Food	Soda	Hshld	Rubbr	BldMt	Cnstr
α_0	0.651***	0.601***	0.725***	0.788***	0.704***	0.841***	0.749***	0.655**
	(0.000)	(0.008)	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)	(0.008)
SOI_{t-1}	-0.122	-0.208	0.0616	-0.197	-0.316*	-0.229	-0.272	-0.134
	(0.436)	(0.378)	(0.687)	(0.439)	(0.063)	(0.287)	(0.202)	(0.599)
N	808	808	808	646	808	808	808	808
R-squared	0.0008	0.001	0.0002	0.0009	0.0043	0.0014	0.002	0.0003
Adjust R^2	-0.0005	-0.0003	-0.001	-0.0006	0.0031	0.0002	0.0008	-0.0009

Variable	Oil	Insur	Trans	Util	Rtail	RlEst
α_0	0.719***	0.704***	0.669***	0.581***	0.735***	0.551**
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.036)
SOI_{t-1}	0.152	-0.277	0.0245	-0.0825	-0.117	-0.421
	(0.43)	(0.18)	(0.905)	(0.556)	(0.528)	(0.12)
N	808	808	808	808	808	808
R-squared	0.0008	0.0022	0	0.0004	0.0005	0.003
Adjust R^2	-0.0005	0.001	-0.0012	-0.0008	-0.0007	0.0018

Panel B: Summary Statistics Of Twenty-two International Markets

Variable	Australia	Indonesia	New Zealand	Canada	Austria	Belgium	Finland	France
α_0	0.611**	1.316*	0.532	0.567**	0.524*	0.762***	0.88*	0.642**
	(0.038)	(0.069)	(0.143)	(0.019)	(0.072)	(0.002)	(0.071)	(0.021)
SOI_{t-1}	-0.315	0.714	-0.234	-0.492**	-0.431	-0.729***	-0.423	-0.374
	(0.278)	(0.331)	(0.524)	(0.04)	(0.134)	(0.003)	(0.393)	(0.172)
N	567	351	351	567	567	567	351	567
R-squared	0.0021	0.0027	0.0012	0.0075	0.004	0.0152	0.0021	0.0033
Adjust R^2	0.0003	-0.0001	-0.0017	0.0057	0.0022	0.0134	-0.0008	0.0015

Variable	Italy	Netherlands	Norway	Spain	Sweden	Switzerland	UK	Chile
α_0	0.376	0.777***	0.774**	0.555*	0.912***	0.691***	0.594**	1.155***
	(0.229)	(0.001)	(0.021)	(0.054)	(0.002)	(0.002)	(0.028)	(0.002)
SOI_{t-1}	-0.803***	-0.570**	-0.346	-0.307	-0.362	-0.479**	-0.25	-0.435
	(0.009)	(0.016)	(0.295)	(0.281)	(0.212)	(0.031)	(0.347)	(0.259)
N	567	567	567	567	567	567	567	351
R-squared	0.0119	0.0103	0.0019	0.0021	0.0028	0.0082	0.0016	0.0037
Adjust R^2	0.0101	0.0085	0.0002	0.0003	0.001	0.0064	-0.0002	0.0008

Variable	Germany	Peru	Japan	Mexico	Singapore	Malaysia
α_0	0.617*	1.398*	0.541*	1.472**	0.824*	0.562
	(0.023)	(0.01)	(0.037)	(0.002)	(0.016)	(0.19)
SOI_{t-1}	-0.349	-0.521	-0.171	-0.214	-0.477	0.549

	(0.191)	(0.346)	(0.501)	(0.658)	(0.158)	(0.207)
N	567	291	567	351	567	351
R-squared	0.003	0.0031	0.0008	0.0006	0.0035	0.0046
Adjust R^2	0.0013	-0.0004	-0.001	-0.0023	0.0018	0.0017

Table 11 shows the results for the fourth regression. Panel A shows summary statistics of US benchmark and thirteen U.S. industry markets. The results for US market are similar as in the first regression. The negative coefficient (-0.316) of SOI in the consumer goods industry indicates that a unit decreases in the SOI anomalies increases the monthly excess return 0.316% in the consumer goods industry next month. If the investors know the information that SOI index are below -1 now, they should take a long position in consumer goods industry index and earn excess return from next month. Panel B shows summary statistics of twenty-two international markets. It shows that if the investors know the information that SOI index are equal -1 now, they should take long position in Canada, Belgium, Italy, Netherlands and Switzerland. A unit decrease in SOI index increase earn excess return 0.492%, 0.729%, 0.8035, 0.570% and 0.479% respectively in the following month. In order to investigate further information about the time period that the investors should hold the positions, I test the fifth regression. Table 12 shows the results of the fifth regression. For US market, the results are not significant across almost all industries. There are only slightly significant impact of El Nino on consumer goods industry and real estate industry for 3-month holding period. For international markets, the results are more significant. Consistent with the finding in section 5.2, investors can obtain excess return by taking a long position in some European

Table 12: Regression results for the investment decisions in different holding periods

Note: (1) This table reports the fifth regression.
(R_T^x=α_0+$\alpha_1$$SOI_{t-1}$ +e_t)
(2) SOIt-1 is the independent variable that measures the intensity of El Nino in previous month t-1.T is different holding periods for investment positions. T equals to 3-month,6-month,9-month or 12-month.
(3) The coefficients of the variables are displayed in the table with corresponding P-value (in brackets) below the coefficients.
(4) In the last two rows the R-squared and Adjust R2 for each regression are showed.
** indicates statistical significance at the 10% level*
*** indicates statistical significance at the 5% level*
**** indicates statistical significance at the 1% level*

Panel A: Summary Statistics Of US Benchmark and Thirteen U.S. Industry Markets

Variable	U.S.				Agric				Food				Soda			
T	3	6	9	12	3	6	9	12	3	6	9	12	3	6	9	12
α_0	1.931***	3.785***	5.654***	7.510***	1.717***	3.395***	5.131***	6.839***	2.174***	4.352***	6.582***	8.803***	2.314***	4.570***	6.900***	9.152***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SOI_{t-1}	-0.247	-0.189	-0.305	-0.55	-0.149	-0.301	-0.897	-1.396	0.194	0.327	0.452	0.615	-0.244	-0.0034	-0.515	-0.196
	(0.381)	(0.647)	(0.551)	(0.351)	(0.715)	(0.597)	(0.188)	(0.065)	(0.479)	(0.401)	(0.348)	(0.278)	(0.581)	(0.996)	(0.498)	(0.823)
N	806	803	800	797	806	803	800	797	806	803	800	797	644	641	638	635
R-squared	0.001	0.0003	0.0004	0.0011	0.0002	0.0003	0.0022	0.0043	0.0006	0.0009	0.0011	0.0015	0.0005	0	0.0007	0.0001
Adjust R^2	-0.0003	-0.001	-0.0008	-0.0002	-0.0011	-0.0009	0.0009	0.003	-0.0006	-0.0004	-0.0001	0.0002	-0.0011	-0.0016	-0.0009	-0.0015

Variable	Hshld				Rubbr				BldMt				Cnstr			
T	3	6	9	12	3	6	9	12	3	6	9	12	3	6	9	12
α_0	2.057***	3.969***	5.899***	7.834***	2.435***	4.765***	7.123***	9.404***	2.216***	4.329***	6.466***	8.568***	1.947***	3.840***	5.747***	7.628***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SOI_{t-1}	-0.59*	-0.511	-0.35	-0.453	-0.357	-0.0723	0.141	0.61	-0.615	-0.712	-0.916	0.136	-0.374	-0.589	-0.697	-0.703
	(0.051)	(0.243)	(0.515)	(0.467)	(0.369)	(0.899)	(0.837)	(0.426)	(0.107)	(0.194)	(0.156)	(0.136)	(0.433)	(0.393)	(0.396)	(0.442)
N	806	803	800	797	806	803	800	797	806	803	800	797	806	803	800	797
R-squared	0.0047	0.0017	0.0005	0.0007	0.001	0	0.0001	0.0008	0.0032	0.0021	0.0025	0.0028	0.0008	0.0009	0.0009	0.0007
Adjust R^2	0.0035	0.0005	-0.0007	-0.0006	-0.0002	-0.0012	-0.0012	-0.0005	0.002	0.0009	0.0013	0.0015	-0.0005	-0.0003	-0.0003	-0.0005

Variable	Oil				Insur				Trans				Util			
T	3	6	9	12	3	6	9	12	3	6	9	12	3	6	9	12
α_0	2.163***	4.390***	6.551***	8.741***	2.046***	4.055***	6.076***	8.079***	1.980***	3.938***	5.910***	7.871***	1.723***	3.432***	5.145***	6.823***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SOI_{t-1}	0.53	0.652	0.899	0.729	-0.358	-0.46	-0.736	-1.232*	0.195	0.511	0.346	-0.065	-0.169	-0.434	-0.406	-0.133

	(0.111)	(0.173)	(0.131)	(0.289)	(0.328)	(0.378)	(0.241)	(0.079)	(0.603)	(0.345)	(0.602)	(0.93)	(0.492)	(0.222)	(0.365)	(0.797)
N	806	803	800	797	806	803	800	797	806	803	800	797	806	803	800	797
R-squared	0.0032	0.0023	0.0029	0.0014	0.0012	0.001	0.0017	0.0039	0.0003	0.0011	0.0003	0	0.0006	0.0019	0.001	0.0001
Adjust R^2	0.0019	0.0011	0.0016	0.0002	-0.0001	-0.0003	0.0005	0.0026	-0.0009	-0.0001	-0.0009	-0.0012	-0.0007	0.0006	-0.0002	-0.0012

Variable	Rtail				RlEst			
T	3	6	9	12	3	6	9	12
α_0	2.194***	4.335***	6.509***	8.630***	1.599**	3.040***	4.487***	5.820***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
SOI_{t-1}	-0.316	-0.336	-0.417	-0.318	-0.916*	-0.937	-0.938	-0.44
	(0.357)	(0.488)	(0.472)	(0.635)	(0.076)	(0.231)	(0.331)	(0.693)
N	806	803	800	797	806	803	800	797
R-squared	0.0011	0.0006	0.0006	0.0006	0.0039	0.0018	0.0012	0.0002
Adjust R^2	-0.0002	-0.0006	-0.0006	-0.0006	0.0027	0.0005	-0.0001	-0.0011

Panel B: Summary Statistics Of Twenty-two International Markets

Variable	Australia				Indonesia				New Zealand				Canada			
T	3	6	9	12	3	6	9	12	3	6	9	12	3	6	9	12
α_0	1.802***	3.666***	5.572***	7.460***	3.833**	7.386***	11.28***	8.878**	1.688***	3.226***	4.916***	6.619***	1.643***	3.215***	4.857***	6.429***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)	(0.000)	(0.000)	(0.000)	(0.006)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SOI_{t-1}	-0.587	-1.364*	-2.646***	-3.551***	3.110**	7.964***	9.299***	15.18***	-0.662	-0.888	-1.399	-2.253*	-0.997**	-1.062*	-1.675**	-2.217**
	(0.241)	(0.054)	(0.002)	(0.000)	(0.023)	(0.000)	(0.000)	(0.004)	(0.283)	(0.337)	(0.227)	(0.099)	(0.02)	(0.089)	(0.028)	(0.011)
N	565	562	559	556	349	346	343	340	349	346	343	340	565	562	559	556
R-squared	0.0024	0.0066	0.0172	0.0236	0.0149	0.0458	0.0375	0.0239	0.0033	0.0027	0.0043	0.0043	0.0095	0.0052	0.0087	0.0116
Adjust R^2	0.0007	0.0048	0.0154	0.0218	0.0121	0.0431	0.0346	0.021	0.0004	-0.0002	0.0014	0.0014	0.0078	0.0034	0.0069	0.0098

Variable	Austria				Belgium				Finland				France			
T	3	6	9	12	3	6	9	12	3	6	9	12	3	6	9	12
α_0	1.509**	2.933***	4.370***	5.684***	2.229***	4.452***	6.717***	8.934***	2.601**	5.257***	7.915***	10.73***	1.855***	3.794***	5.750***	7.707***
	(0.008)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

SOI_{t-1}	-0.667	-0.754	-1.578	-1.498	-1.703***	-3.177***	-4.503***	-5.307***	-0.805	-3.197*	-4.861**	-8.080***	-0.609	-1.778*	-2.830**	-3.705***
	(0.23)	(0.377)	(0.139)	(0.228)	(0.000)	(0.000)	(0.000)	(0.000)	(0.378)	(0.014)	(0.003)	(0.000)	(0.214)	(0.015)	(0.002)	(0.000)
N	565	562	559	556	565	562	559	556	349	346	343	340	565	562	559	556
R-squared	0.0026	0.0014	0.0039	0.0026	0.0229	0.0354	0.045	0.0449	0.0022	0.0174	0.0258	0.0502	0.0027	0.0106	0.0174	0.0223
Adjust R^2	0.0008	-0.0004	0.0021	0.0008	0.0212	0.0337	0.0432	0.0432	-0.0006	0.0146	0.0229	0.0474	0.001	0.0088	0.0157	0.0205

Variable	Italy				Netherlands				Norway				Spain			
T	3	6	9	12	3	6	9	12	3	6	9	12	3	6	9	12
α_0	0.979	1.950*	2.940**	3.984**	2.284***	4.548***	6.837***	9.032***	2.278***	4.551***	6.855***	9.086***	1.586**	3.207***	4.856***	6.503***
	(0.078)	(0.019)	(0.006)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)
SOI_{t-1}	-1.244*	-2.614**	-3.842***	-4.998***	-1.222**	-2.130***	-3.191***	-3.328***	-0.499	-1.055	-2.447**	-3.556***	-0.608	-1.519**	-2.611***	-3.467***
	(0.023)	(0.001)	(0.000)	(0.000)	(0.003)	(0.000)	(0.000)	(0.000)	(0.415)	(0.244)	(0.027)	(0.006)	(0.231)	(0.039)	(0.005)	(0.002)
N	565	562	559	556	565	562	559	556	565	562	559	556	565	562	559	556
R-squared	0.0091	0.018	0.0237	0.0286	0.0161	0.0237	0.0368	0.0307	0.0012	0.0024	0.0087	0.0137	0.0025	0.0076	0.0138	0.017
Adjust R^2	0.0074	0.0162	0.022	0.0269	0.0143	0.022	0.0351	0.0289	-0.0006	0.0006	0.007	0.0119	0.0008	0.0058	0.0121	0.0152

Variable	Sweden				Switzerland				UK				Chile			
T	3	6	9	12	3	6	9	12	3	6	9	12	3	6	9	12
α_0	2.744***	5.563***	8.333***	11.15***	2.006***	4.041***	6.115***	8.173***	1.783***	3.629***	5.486***	7.282***	3.327***	6.618***	9.844***	13.08***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SOI_{t-1}	-0.876*	-2.036***	-2.517***	-2.721**	-0.7	-1.346*	-1.882**	-1.916**	-0.625	-1.421**	-1.942**	-1.930*	-0.579	-0.413	-1.239	-1.875
	(0.09)	(0.008)	(0.009)	(0.014)	(0.073)	(0.017)	(0.007)	(0.02)	(0.191)	(0.039)	(0.018)	(0.041)	(0.431)	(0.697)	(0.353)	(0.241)
N	565	562	559	556	565	562	559	556	565	562	559	556	349	346	343	340
R-squared	0.0051	0.0125	0.0123	0.0108	0.0057	0.0101	0.0129	0.0098	0.003	0.0076	0.01	0.0075	0.0018	0.0004	0.0025	0.0041
Adjust R^2	0.0033	0.0107	0.0105	0.0091	0.0039	0.0083	0.0111	0.008	0.0013	0.0058	0.0082	0.0058	-0.0011	-0.0025	-0.0004	0.0011
Variable	Germany				Peru				Japan				Mexico			
T	3	6	9	12	3	6	9	12	3	6	9	12	3	6	9	12
α_0	1.818***	3.637***	5.554***	7.385***	4.316***	8.585***	12.98***	16.99***	1.599***	3.253***	5.003***	6.709***	4.095***	7.866***	11.77***	15.76***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.973)	(0.000)	(0.000)	(0.000)
SOI_{t-1}	-0.549	-0.912	-1.612	-1.345	-1.251	-2.051	-4.709**	-5.291**	-0.229	-0.685	-1.699*	-2.338*	0.0289*	2.027	3.162**	3.888**

	(0.237)	(0.178)	(0.055)	(0.165)	(0.191)	(0.14)	(0.006)	(0.007)	(0.624)	(0.332)	(0.059)	(0.033)	(0.000)	(0.105)	(0.034)	(0.028)
N	565	562	559	556	289	286	283	280	565	562	559	556	349	346	343	340
R-squared	0.0025	0.0032	0.0066	0.0035	0.006	0.0077	0.0266	0.0255	0.0004	0.0017	0.0064	0.0082	0	0.0076	0.0131	0.0142
Adjust R^2	0.0007	0.0015	0.0048	0.0017	0.0025	0.0042	0.0232	0.022	-0.0013	-0.0001	0.0046	0.0064	-0.0029	0.0048	0.0102	0.0113

Variable	Singapore				Malaysia			
T	3	6	9	12	3	6	9	12
α_0	2.441***	4.767***	7.238***	9.599***	1.655*	3.216**	4.923**	6.711***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.045)	(0.008)	(0.001)	(0.000)
SOI_{t-1}	-1.156	-1.079	-1.881*	-1.394	1.716*	3.616***	4.152***	4.574**
	(0.071)	(0.244)	(0.096)	(0.292)	(0.041)	(0.003)	(0.007)	(0.013)
N	565	562	559	556	349	346	343	340
R-squared	0.0058	0.0024	0.005	0.002	0.012	0.0251	0.0214	0.018
Adjust R^2	0.004	0.0006	0.0032	0.0002	0.0092	0.0222	0.0186	0.0151

market indices. The panel B shows that investors can buy the index in Belgium, Finland, France, Italy, Netherlands, Norway, Spain, Sweden, Switzerland and UK .An unit decrease in SOI increase the total excess return 5.307% ,8.080%, 3.705%, 4.998%, 3.328%, 3.556%, 3.467%, 2.721%, 1.916%,and 1.930% respectively in 12-month holding period. Australia, Canada Peru, and Japan also show a significantly positive El Nino impact on excess return during 12-month holding period. In contrast, when the El Nino arrives, investors should sell a short position in index of Indonesia, Mexico and Malaysia.

For the loser portfolio, based on the results in Table 12, Indonesian market, Malaysian market and Mexican market are negatively affected by the El Nino for 12-month holding period.

For the winner portfolio, based on the results in Table 12，Most of European countries (Belgium , Finland, France, Italy, Netherlands, Norway, Spain, Sweden, Switzerland and UK) , Australia, Canada Peru, and Japan are positively affected by the El Nino for the 12-month holding periods. So the strategy will be that if the SOI index is below -1 and it will continues become negative, we should take a long position in winner portfolio and take a short position in loser portfolio. But it should be noticed that the Table 12 shows the total excess return during 12-month holding time period, which mean the average monthly excess return is much smaller than the value in the table. So when we consider the strategy, we should consider the most significant value and try to obtain highest excess return.

Based on the results in Section 5.2, for the loser portfolio, Indonesian market (1.36) is negatively affected by the El Nino at 10% significant level. And a 3-month lagged El Nino likewise negatively affects the Malaysian market (1.162).

For the winner portfolio, based on the results in Section 5.2，Belgium, Austria, Netherland and Switzerland are positively affected by the El Nino. So the first strategy is that when the SOI is below -1, we need to take short position in Indonesian market index and take the long position in Belgium, Austria, Netherland and Switzerland indices.

Due to the delay impact of the El Nino across the international market, based on the results in Section 5.2, we should long or short position in Australia, France, Italy, Sweden, UK, Peru, Singapore and Malaysia in different timing. So the second strategy is that when the SOI is continuously below -1, we need to take short position in Australia and Malaysia in the third month. According to 6-month lagged impact of El Nino, the third strategy is that when the SOI is continuously below -1, we need to take long position in France and Italy in the sixth month. Lastly, the fourth strategy is that when the SOI is continuously below -1, we need take long position in UK, and Singapore.

Table 13: Long/short strategy for the International market

Note: (1) The panel A shows the average monthly excess return in different equity market during 10 times El Nino periods from 1970 to 2017.
(2) The panel B shows the monthly excess return in different equity market during1997-1998 and 2015-2016 periods.
(3) 3-month, 6-month, 9-month represent the 3-month, 6-month and 9-month lagged strategy

Panel A

Strategy	Present					3-Month				9-month	
Country	Indonesia	Belgium	Netherlands	Austria	Switzerland	Australia	Malaysia	France	Italy	UK	Singapore
Average return	-3.049	1.219	1.137	0.337	0.829	0.037	-2.335	0.986	-0.332	0.719	0.878

Panel B

Strategy	Present					3-Month		6-month		9-month	
Year	Indonesia	Belgium	Netherlands	Austria	Switzerland	Australia	Malaysia	France	Italy	UK	Singapore
199705	-3.749	1.169	-0.604	-3.770	2.549	-2.287	-10.195	-7.387	-6.211	4.555	-17.898
199706	6.998	0.215	3.984	3.019	5.433	-7.065	-31.382	1.817	1.939	6.584	25.261
199707	1.923	3.017	8.836	-0.081	8.826	5.489	-10.158	3.908	7.710	4.787	-2.046
199708	-9.605	-0.150	6.524	4.544	0.661	-13.245	-15.015	3.476	9.060	-0.599	-6.491
199709	-41.790	-7.376	-9.799	-6.114	-9.671	-4.533	-26.303	8.046	3.917	-3.373	-18.917
199710	3.897	5.584	8.558	7.105	9.767	3.483	1.328	10.467	18.814	0.183	-11.915
199711	-1.080	-1.306	-4.883	-2.986	-1.701	6.322	-10.197	3.888	-1.497	-2.553	-1.896
199712	-34.161	0.716	-1.307	-7.090	3.569	1.433	49.124	4.031	4.016	-6.881	-17.105
199801	-33.414	2.653	2.894	7.444	5.704	-0.389	-5.634	0.948	-6.186	-2.436	8.916
199802	-32.421	3.667	0.900	3.357	3.387	-1.407	-13.161	1.006	10.087	5.221	23.989
199803	11.104	4.424	9.798	6.586	9.537	-7.840	-21.531	-10.891	-13.569	4.649	14.367
199804	17.096	7.825	2.568	4.463	1.078	1.456	-20.953	-6.325	-4.472	2.682	-1.755
Total return	-115.202	20.439	27.470	16.475	39.139	-18.583	-114.075	12.983	23.607	12.819	-5.490

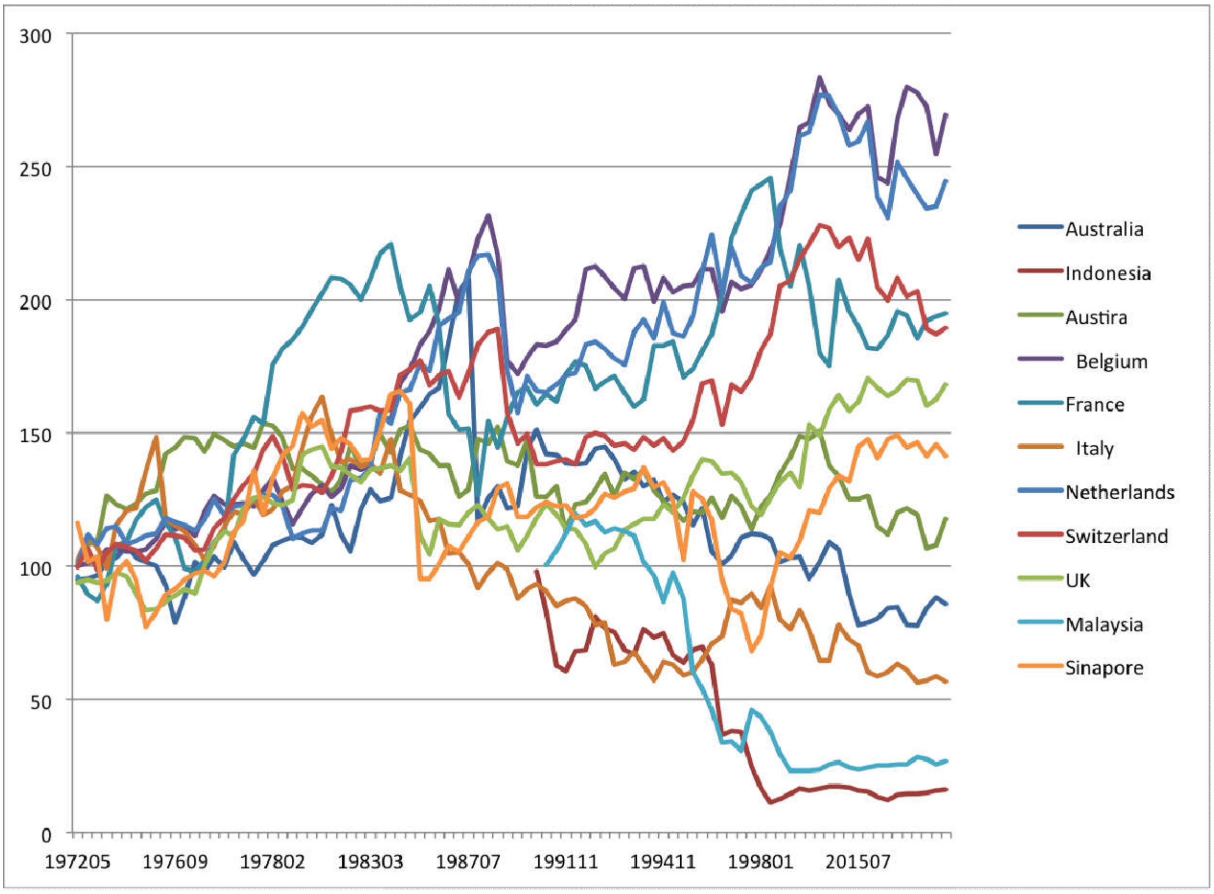
Strategy	Present					3-Month		6-month		9-month	
Year	Indonesia	Belgium	Netherlands	Austria	Switzerland	Australia	Malaysia	France	Italy	UK	Singapore
201505	-8.862	1.049	4.063	8.608	4.415	-2.197	-2.114	9.034	5.213	-5.209	-10.041
201506	2.866	-0.365	0.027	-4.409	0.770	-12.829	-14.828	-3.426	-3.592	-0.960	5.058
201507	-7.562	2.280	0.702	0.136	-3.734	0.791	-3.199	-3.034	-3.122	2.130	9.906
201508	-3.552	0.991	2.897	0.751	3.790	2.177	4.793	-4.174	-13.838	5.519	1.840
201509	-12.054	-9.704	-10.610	-8.958	-8.182	5.041	2.930	-0.215	-2.926	-2.252	-4.793
201510	-10.025	-1.026	-3.306	-2.642	-2.554	0.286	-0.655	2.829	2.829	-1.693	4.938
201511	16.361	9.944	9.008	7.435	4.471	-7.744	2.460	4.850	5.141	1.369	1.076
201512	3.142	4.485	-2.359	1.357	-3.493	-0.439	-0.249	-0.963	-3.889	2.243	-3.018
201601	0.460	-0.831	-2.491	-2.188	0.997	8.450	10.513	-4.381	-7.576	-0.017	1.395
201602	2.670	-1.761	-2.285	-10.286	-6.963	4.884	-2.344	3.633	1.474	-5.656	-3.604
201603	5.105	-6.604	0.430	0.974	-1.116	-2.898	-7.796	0.864	3.020	1.424	3.041
201604	3.999	5.752	3.927	8.918	1.364	1.723	5.053	0.569	-3.907	3.448	-3.001
Total return	-7.453	4.209	0.004	-0.304	-10.236	-2.755	-5.437	5.587	-21.172	0.348	2.797

Table 13 shows Long/short strategy for the International market. The Panel A shows the average monthly excess return in different equity market during 10 times El Nino periods from 1970 to 2017. The results are consistent with most of my strategy. El Nino has a negative impact on excess return in Indonesian market and Malaysian market. The monthly excess return in Italian market during El Nino is opposite to my prediction. It is also interesting to know that I choose 1997-1998 and 2015-2016 as the sample periods, which are severe El Nino period .The results of the Table 13 are consistent with my strategy. But we have to notice that, for example, Italy shows a negative total excess return during 2015-2016 periods, which is opposite to my strategy. One possible reason is that European crisis dominates the Italian market and the El Nino anomalies only play a small role in that time period.

In order to test my strategy better, I also run a run a simulated investment based on my strategy. The initial capital amount for each index is 100 US dollars. The figure 2 shows the results of the simulation. It is an obvious profitable investment to sell Indonesian index and Malaysian index. The long position in Belgium, Austria, Netherland and Switzerland indices also generate large excess return. There is also an interesting fact that the performances of Italian market and Australian market are opposite to my prediction. One possible explanation is that I use the monthly return to do the study, but the even average excess return will lead the loss. For example, 20% gain in this month and 20% loss in next month will lead to 4% loss in total.

Figure 2: Long/short strategy for the International market

Note: (1) The lines show the total capital amount in different equity market during 10 times El Nino periods from 1970 to 2017.



6. Conclusion

This study investigates the effect of El Nino on thirteen U.S. industry markets and twenty-two international markets. The results of this study show that El Nino has a present impact on fewer countries and only consumer goods industry in U.S. The outcome shows that a unit decrease in the SOI anomalies increases the monthly excess return 0.453% in the American consumer goods industry. In line with the research by Cashin et al., (2017), who find Europe experiences an increase in the real economy due to the spillover trades with the U.S, I find the corresponding results that El Nino positively affects European countries. A unit increase in El Nino intensity increases a 0.559%, 0.540%, 0.429%, and 0.387% monthly excess return for Austria, Belgium, Netherland and Switzerland country indices respectively. In contrast, El Nino episodes have a negative impact on Indonesia market index, and a unit reduction in SOI index lower a 1.36% monthly excess return in the Indonesian market.

The previous study shows that investors underreact market information and the stock price can only reflect the true fundamental value of a delay Hong et al.(2005). In line with the delay reaction of the equity market price, the results of this study show the similar evidence that El Nino has a significantly negative delay effect on Australia and Malaysia, and El Nino has a significantly positive delay effect on France, Italy, Sweden, UK, Peru, and Singapore. After controlling variables, such as January effect. ,one-month lagged excess return, and Halloween Indicator impact, the lagged impact of El Nino remains same across the international market. According to the results of this study, I apply the long/short strategy to obtain excess return by buying a long in indices that are positively affected by the El Nino and selling a short in indices that are negatively affected by the El Nino.

The all monthly stock excess returns in this study are measured in U.S. dollar. One shortcoming of this study is that for international investors, they are more interested in excess return based on their local risk free rate and their purchase power of local currency. This study mainly focuses on the local U.S. investors, and how they invest in global market indices and get U.S. excess return. And the low R-squares in regressions show that the El Nino events can only be a small effect to explain the excess return across different market.

Another shortcoming is that this research focuses on the different market indices. El Nino may have various impacts in different firms even in the same industry. Furthermore, compared to the developed country, developing country may have an inefficient financial system. This inefficient financial system may exist more noise effects and companies need higher cost to hedge the El Nino risk exposure. For the further researches, an idea is to investigate the El Nino effect on firm specific level in the same sector as well as investigate the strategy that different specific firm uses to hedge the climatic exposure.

In conclusion, the effect of El Nino on the stock market is significant across worldwide markets with a 6 to 9 months delay.

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