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Determining the Inflationary Effects of El Niño and La Niña in the Philippines

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Abstract

This paper investigates whether climate "shocks" (or short-term but sharp changes in climatic conditions), El Niño and La Niña, have significant impacts on inflation in the country. Using regional panel data and information from PAGASA, this study finds that both of these weather shocks have significant effects on the general price level in the Philippines, along with interest rate, foreign exchange, and unemployment rate. Further, the results also indicate that long-term changes in climatic conditions, specifically average temperature and rainfall, do not have any significant impacts on prices. These findings are consistent with the literature that point to the fact that successful adaptation to long-term changes in climatic conditions negates any potential negative impacts to the economy. The study concludes that adaptation must be expanded not only to respond to long-term changes in climatic conditions, but also to short-term but intense changes in temperature and rainfall.

Key Words: Inflation, El Niño, La Niña, climate change

JEL Codes: Q10, Q11, Q54, E00

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(Final Report)

Introduction

Among the weather anomalies and climate shocks that are known in the modern world today, perhaps the most known are the "wonder twins" El Niño and La Niña which are commonly associated with climate change. El Niño[1] is the warming of the central and eastern tropical Pacific, while its sister, La Niña[2], is the opposite, wherein instead of warming, this same area cools. Both of these climate shocks result from the El Niño Southern Oscillation (ENSO)[3]. El Niño and La Niña normally last 9 to 12 months—although it is believed that these two could actually last longer than 12 months—but manifest themselves irregularly in terms of when they occur. Because of the effects of both of these climate shocks/weather phenomena on temperature and level of precipitation, their overall impacts on the physical environment are wide and encompassing. Currently, the effects of the "wonder twins" of the

[1] El Niño is characterized by a prolonged increase in average temperature and could result in wetter-than-average conditions in some parts of North America, and drier-than-average in other areas of the world. El Niño (the little boy) was first observed by fishermen in South America in the 1600s when they experienced unusually warm water in the Pacific Ocean. Since this occurrence tended to happen around December, the fishermen coined the name *El Niño,* referring to Christ Child. (http://www.bom.gov.au/climate/enso/history/ln-2010-12/ENSO-what.shtml)

[2] As mentioned, La Niña has the effects that are opposite to those of El Niño. La Niña or *The Little Girl* is considered the anti-El Niño because it has the opposite effects to those of El Niño, and often referred to as the "cold event". The occurrence of La Niña is characterized by extended below-average sea surface temperatures across the east-central Equatorial Pacific.It was first recorded in the early part of the 20th century, during the 1900s. (http://www.bom.gov.au/climate/enso/history/ln-2010-12/ENSO-what.shtml)

[3] The ENSO cycle is the technical term referring to the fluctuations in the temperature between the ocean and the atmosphere in the east-central Equatorial Pacific. (http://www.bom.gov.au/climate/enso/history/ln-2010-12/ENSO-what.shtml)

weather world have been studied in specific countries, with most of these research efforts focusing on agriculture.

The immediate physical effects of these two weather phenomena are temporary, although they could alter the dynamics within ecosystems which, in turn, have implications in agricultural production, particularly in the production of food. The increasing awareness concerning global warming and the sharp long-term changes in climatic conditions have prompted a number of inquiries regarding the possible impacts of these changes on human welfare. The literature provides evidence and different cases and scenarios where the impacts range from health, productivity and income, to social well-being. While one might find studies that pertain to economics, most these studies have examined households and individual welfare cases, and in specific countries, and not many have delved into the macroeconomic impacts of changes in climatic conditions. This is especially true for the Philippines, where most studies on the economic impacts of climate change have focused on agriculture and income.

With these in mind, this study was conceptualized and conducted with the general objective of widening the range of research inquiries on the economic effects of long-term changes in climatic condition. The end goal is to help policy makers and economic managers plan and initiate programs and projects that have climate lens by providing a straightforward but evidence based paper that can be used as basis for policy and program creation. The specific area of interest is the impacts of climatic conditions on price level as measured in the changes in the consumper price index[4], and the economic effect of the two naturally occurring phenomena—El Niño and La Niña—on prices in the Philippines. El Niño is the

[4] The Philippine Statistics Authority defines the consumer price index or CPI, as the indicator of the movements in the average retail price of a goods and services that are commonly purchased by representative households. The CPI is normally used in determining inflation rate in the Philippines and the purchasing power of the peso. (Source: http://rsso05.psa.gov.ph/sites/default/files/Primer-on-Consumer-Price-Index.pdf)

deviation of temperature from the pattern that lasts for (at least) 3 months, and is often associated with drought. La Niña, on the other hand, is identified as having unusual precipitation patterns and intensity. Recently, the intensity of these two weather deviations has also been observed to be growing, with the current El Niño phenomenon described to be the third strongest in modern history.

As with most agriculture-based countries, agriculture is quite possibly the most affected sector in the Philippine economy by deviations in weather patterns because it is this sector that relies the heaviest on a harmonious interaction with the natural environment. The literature indicates that El Niño triggers short-run inflationary pressures because of its impacts on energy and non-fuel commodity prices, in many countries. In come countries, however, the inflationary pressure caused by El Niño is by way of food prices such as in Australia, Chile, Indonesia, India, Japan, New Zealand, and South Africa.

The long-run impacts of climate shocks such El Niño and La Niña, however, are expected to be not as strong as the short-run effects given that farmers are very likely adjust their production activities accordingly to these permanent or long-run changes in the natural environment. The findings of Arcenas (2002), for instance, indicate that Filipino peasant farmers are sensitive to changes that could affect their agricultural production, and will make the necessary adjustments in their production if they perceive that there have been changes in the pattern of the natural environment. Filipino farmers, however, are often incapable of responding immediately to "environmental shocks" as they do not have the information and the financial capacity to invest in any type of insurance. This raises the question of whether long-term changes in climatic conditions such as long-term changes in temperature and rainfall could affect agricultural production; or whether short-term changes (a climate "shock") have a greater impact than long-term ones. And since food comprises 39 percent of

the price index in the Philippines[5], it is possible that it is through the agricultural sector that the weather phenomena El Niño and La Niña could affect the general price level in the country.

There are other sectors, of course, that could be affected by long-term changes in the weather and weather shocks, but it is likely that the impact on the other sectors are not as strong; and, therefore, the impact of these sectors on the general price level would not be as statistically discernible. Among these, it is the power sector that would be affected by changes in climatic conditions, because this sector comprises almost 22 percent of the consumer price index, and almost 11 percent of the country's energy sources is from hydropower. It is unlikely, however, that long-term changes in climatic conditions (such a decline in average rainfall level) could affect the price of energy because there is sufficient time to switch to other alternative power sources—thereby diminishing the effect of a long-term decline in rainfall on hydropower supply. Alternatively, an increase in sunny days could affect the contribution of solar energy to total power usage of the country; but solar energy remains a small contributor to power generation in the Philippines and thus, it is unlikely that electricity prices would significantly be affected.

[5] This is based on the information from the Philippine Statistics Authority (PSA) as shown below:

Weights by Commodity Group for CPI (2006=100)

	Division	PHILIPPINES	NCR	AREAS OUTSIDE NCR
00.	ALL ITEMS	100.00	23.79	76.21
01	FOOD AND NON-ALCOHOLIC BEVERAGES	38.98	6.78	32.20
02	ALCOHOLIC BEVERAGES AND TOBACCO	1.99	0.33	1.66
03	CLOTHING AND FOOTWEAR	2.96	0.74	2.22
04	HOUSING, WATER, ELECTRICITY, GAS AND OTHER FUELS	22.46	6.97	15.49
05	FURNISHING, HOUSEHOLD EQUIPMENT AND ROUTINE MAINTENANCE OF THE HOUSE	3.22	0.84	2.38
06	HEALTH	2.99	0.64	2.35
07	TRANSPORT	7.81	1.86	5.95
08	COMMUNICATION	2.26	0.71	1.55
09	RECREATION AND CULTURE	1.93	0.50	1.43
10	EDUCATION	3.37	0.76	2.61
11	RESTAURANT AND MISCELENEOUS GOODS AND SERVICES	12.03	3.66	8.37

These weights were derived from the 2006 FIES.

Source: http://rsso05.psa.gov.ph/sites/default/files/Primer-on-Consumer-Price-Index.pdf.

Based on the situations discussed above, it is likely that the effect of climate change is not on the long-term changes in temperature or rainfall, but on how it changes the severity of weather anomalies, such as the "children" El Niño and La Niña, which are deviations from average temperature and average amount of precipitation respectively. The impacts of El Niño and La Niña on human welfare range quite widely, and their specific impacts on economic performance are only now being examined closely. Country-specific studies, however, are relatively scarce—especially for developing countries like the Philippines. Conducting a complete and thorough research study to ascertain all of the economic effects of climate change would take quite a bit of effort and time, especially if we monitor the long-term changes in the long-run.

In an effort to generate more pertinent information regarding this issue, this research study examines the impact of the increasing regularity and intensity of El Niño and La Niña (specifically) on inflation in the Philippines, with the specific intention of providing guidance for policy makers. This study should add to the growing evidence that shows the effect of weather anomalies (or climate shocks) on the general price level. The basic research question is straightforward: How does changes in climatic conditions impact the general price level? The answer to this question should be interesting both for the general public and the national agencies, especially the Department of Agriculture, National Economic Development Authority, and the Department of Environment and Natural Resources.

It must be noted that this study's main focus is determining the direct impacts of El Niño and La Niña on the price level. Potential indirect impacts—such as those on the price of inputs and labor—are not examined, and will be left to future research investigation. This omission is for convenience given that this study has time and resource constraints. While the objective of this study is to provide policy makers the needed and immediate information that can guide in the crafting of policy, it is likewise intended that the information generated in

this study would be used in order to ensure that the Philippines' economic policies are crafted with climate-lens.

Framework of Analysis

The movements of the general price level are normally described in the literature in terms of the drivers that affect demand or supply. Demand-side factors are typically associated with the variables that affect the ability of households to purchase, investment expansion, or the government's expenditures. To manage demand-driven inflation, fiscal and monetary policy instruments are used to influence household and/or business spending, or to augment/reduce government spending.

Supply-side factors, on the other hand, are linked with variables that impact the cost of production such as the price of raw material and labor, distribution and logistics disturbances, and trade-related issues. Price movements that are rooted on supply-side factors are challenging to manage because of the inter-variable dynamics that happen. For instance, a glut in the domestic supply of certain commodities can at times be addressed—partially or fully—by importing similar or substitute goods. Trade policy adjustments, however, cannot be imposed in a vacuum and as such, their effects in stabilizinig prices may not be happen (at least, not immediately) resulting in longer price pressures than anticipated. It is through trade that external factors can more potently affect domestic commodity prices. In effect, changes in domestic supply resulting from climate-related factors could be blunted by augmenting domestic supply with imports. Morever, economies that source essential products such as food and fuel products from international markets are susceptible to "imported inflation" or "price spillovers." A severe episode of El Niño in Vietnam and Thailand, for example, can drive global rice prices up resulting in higher inflation rates in countries that import and consume rice in large quantities.

Climate-related variables mainly affect supply; or at least, affect supply more than demand. Storms, floods, and drought can significantly dent agricultural output and destroy infrastructure vital for mobility of goods which can push the prices of both food and non-food commodities up. Even the changes in duration and timing of shifts in seasons can alter the quality and quantity of crop yield.[6] Additionally, the upsurge in sea levels can threaten the volume of harvest of aquatic material resources. As noted by Masters, Baker and Flood (2010), it is likely that as sea levels rise, the available land area for agriculture will be reduced in countries like Vietnam.

Similarly, extreme temperature does not only affect land and sea-based food provisions but also the supply and consumption of energy and water. Intense heat can cause water dam levels to drop substantially and can drag down the supply of power in areas that are reliant on hydroelectric energy. It can likewise trigger households and firms to use more electricity and water for hydration, cooling, and/or irrigation.[7] All these individually and combined, affect prices of commodities.

In a nutshell, the overarching idea in the elasticity estimation procedure is to initially establish how climate conditions affect the supply side (volume and quality of commodities

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[6] Masters, G., Baker, P. and Flood, J. in their 2010 Working Paper entitled *Climate Change and Agricultural Commodities* stated that:

"…*although the current green revolution in agricultural production has led to many technological advances such as improved varieties, genetically modified organisms, physiological improvement, seed treatment, targeted irrigation and fertilizer applications and integrated pest management, the local climate is still the greatest factor in determining how much food is produced in a given region or locality. Even with these man-made improvements, temperature and precipitation relations are major factors in determining where a crop can grow, whether there is any yield, how many crops can be grown per year and what type of crop can be grown in a certain location. Seed viability, germination and plant growth, development, stature, phenology, fruiting and seed mass are all governed by temperature, water (precipitation/soil moisture) and the interaction between these two climatic factors*."

[7] The level of income can also affect how much inflation moves. For example, Nelson, et. al. (2010) suggested that as per capita income rises consumption of rice goes down. Hence, if this finding is precise, climate-induced increase in rice prices may not have substantial impact on inflation momentum in high-income economies.

produced in an economy) and the demand side; and to examine how these changes play out in determining prices subsequently. On the supply side, the adaptation and mitigation strategies (*i.e.* the interventions) as well as the flexibility of trade flows are some of the important variables need to be factored in the model. On the demand side, the role of population growth, and changes in preferences should likewise be included. This kind of assessment typically goes two ways: by looking at the behavior of prices in the past given the changing climate conditions; and by projecting scenarios in the coming years.

Surprisingly, there are not many studies that directly quantify the impact of climate conditions on inflation although those that were reviewed for this study proved to be insightful. Cashin, Mohaddes and Raissi (2015) is one research undertaking that attempted to measure the sensitivity of inflation to climate conditions. The authors made use of a global vector autoregression model to calculate the effects of El Niño in 5 regions and 33 countries; and specified 21 country/region-specific models covering periods from the second quarter of 1979 to third quarter in 2013. The primary intention was to model the effects of El Niño within a dynamic multi-country framework, incorporating an open macroeconomic transmission dimension. Their results indicate that El Niño, whose magnitude was proxied by ENSO Index anomalies, triggered short-run inflationary pressures in the countries examined, due to the energy and non-fuel commodity prices increase. Changes in food prices also contributed 0.09-1.01 percentage points change in general price levels, depending on the weight of food in the CPI basket. The results also indicated that Asia was the most vulnerable region to inflation jumps[8] but the price effects were uneven across the sample economies, with Australia, Chile, Indonesia, India, Japan, New Zealand and South Africa registering a

[8] In Asia, food typically accounts for a huge portion of CPI basket. The weight of food in CPI is 47.6% in India, 39% in the Philippines, 33.5% in Thailand, 32.7% in Indonesia, 32.5% in China, 30.3% in Malaysia 24% in Japan (Cashin, Mohaddes and Raissi, 2015).

decline in real output during periods of El Niño; while US, China and the European region enjoyed a growth push presumably through third market effects.

The study by Nelson, et. al. (2010), on the other hand, mainly looked at potential changes in the production of key staples (*e.g*. wheat, rice and maze) under scenarios of climate conditions defined in the Millennium Ecosystem Assessment. Using the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) developed by the International Food Policy and Research Institute (IFPRI), the study partially extended the analysis to examine general price changes, but this was not the focus. Rather, the authors of the paper's objective was to project potential price movements by type of crop [9,10] , and the authors found that, between 2010-2050, the prices of the crops included in the study varied from 31 percent under the optimistic scenario, to 101 percent under the pessimistic scenario.

Another study, that of Ubilava (2014), also chose the crop-level approach and examined whether ENSO data can be a good predictor of the prices of wheat from major exporting regions (*i.e.* Argentina, Australia, Canada, Europe, and the United States). Using monthly data from January 1982 to December 2013, and following a smooth transition autoregression model that addresses nonlinear dynamics and asymmetric price transmissions in response to the climate anomalies, the study found that El Niño reduced wheat prices while La Niña did the reverse. In more precise terms, the price movement during episodes of La Niña was greater by up to 7 percentage points than the price movement during episodes of El

[9] While there is a fair amount of available literature that focus on climate conditions and food, these studies mainly analyze the relationship of climate condition on one hand, and the volume of production and flow of goods on the other. For instance, a compilation of papers of FAO in 2015 provides an in-depth analysis of the transmission of the effects of climate condition on agricultural production and trade in various context and scenarios. However, there is not much on price effects in any of the papers included in the compilation.

[10] Nelson, et. al (2010) and Elbehri, et. al. (2015), which reviewed literature on the impact of climate change on food security, highlight a common understanding among researcher that change in climate conditions will diminish productivity in the low latitude areas since as it is, these places are already, but, will increase productivity in high latitude areas as they get warmer albeit only up to a certain extent. Elbehri, et. al. (2015) also pointed out that this could "exacerbate existing imbalances between the developed and developing world."

Niño. This was a curious finding because it seemed to imply that an extended rise in temperature that characterized El Niño created a downward push on agricultural crops. Upon closer inspection, however, the findings did make sense because the study examined the experience of northern temperate countries which would have benefitted from a decline in frigid temperature as a result of El Niño. Such an occurrence would have been beneficial for crop production, which would explain the decline in prices. This would be different from the experience of tropical countries which were hit differently by El Niño, causing the already high average temperature to increase even further, and the rainfall to become scarcer.

The literature also shows that the effects of long-term changes in climatic conditions stimulate adaptation measures, which in turn soften the potential impacts of climate change. One visible example that illustrated this situation was the case of worker productivity, as reported by Arcenas (2012), who found that long-term increase in average temperature did not have a statistically significant impact on the Ilocos furniture workers' productivity. The study examined firm-level data and concluded that Ilocos furniture makers used information on climate change as an input to their planning, and responded to the increase in average temperature by installing cooling systems and changing the work schedules of the workers to reduce the impacts of the long-term change in the temperature. As a result, worker productivity and the firms' level of production did not significantly change even if the average temperature in the province rose. The study explained this occurrence as due to the fact if the change in temperature were a one time change only, and the firm would have not had time to retrofit (nor the incentive to invest in changing the technology employed by the furniture maker) its production to take into account the "shock" of a one-period temperature change. Permanent or long-term changes in climatic conditions such as the rise in average temperature, however, would be a perceived change in the environmental parameters that the furniture maker operates under. The logical move of the furniture maker if it wished to avoid

a loss in its workers' productivity (and remain competitive), would be to adjust the operations and production process, necessitating an investment in adaptation.

Based on the experience and insights from the other studies reviewed, the main hypotheses that this study has formed are as follow: 1) weather anomalies such as El Niño and La Niña would generally result in shifts in the price level in the Philippines (a tropical country) because they are short-term and global in nature—basically, they are shocks and responses to shocks do not have immediate impacts, and that their impact would be in the food production and enery generation sectors; and, 2) long-term changes in temperature and rainfall—normally defined as characteristics of climate change—might not have significant effects on prices as firms would naturally adapt to the change, thus neutralizing most (if not all) impacts. These hypotheses will be verified by way of econometric tests, the results of which will be discussed later in this paper.

Empirical Model

This paper utilized econometric tests to determine causal relationships between the dependent variable (food production) and a list of independent factors that could impact food production in the Philippines (including weather-related variables such as El Niño and La Niña), using published and unpublished data from the Philippine Statistics Authority (PSA) and information from Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA). Other the occurrence of El Niño and La Niña, the independent variables included in the econometric model were three macroeconomic variables, and other indicators of climatic conditions in the regional areas in the Philippines specifically temperature and rainfall. As a mathematical representation of the empirical relationship between price increases (the dependent variable) and the different independent variables identified earlier, the general functional form of the relationship is shown below:

$$Rate\ of\ Inflation = f(Unemp, Forex, Int, Pop, Climate, Env)$$

where Unemp = unemployment rate;

Forex = Peso to USD exchange rate;

Int = interest rate;

Pop = population;

climate = a vector of climate/weather related variables, total rainfall, average temperature; and,

Env = occurrence of El Niño or La Niña (dummy variables)

This regression primarly aimed to find out if the weather anomalies El Nino and La Niña have (statistically) significant effect on inflation, and whether climate-related variables could significantly affect the general price level in the Philippines. Other macroeconomic factors were included to complete the model—the choice of these variables was based on the literature which indicate that supply (cost of production, interest rate, foreign exchange) and demand (population, income) have significant impacts on inflation.

The original intent of this study was to perform two levels of econometric tests, one to ascertain the general relationships between general price and the variables listed, and the other to test the relationships between sectoral price level and the same variables. The first econometric test was to determine if there was a statistically-significant link between the rate of inflation (general price changes) and the weather and climate-related variables. The result of this test would be used as the basis for the second test, which was to determine if the hypothesis that it is the agricultural sector—which is the country's main food supplier—that is one of the main links between the El Niño and La Niña phenomenon and inflation. Unfortunately, the available data were only sufficient for the first econometric test, and not the second test. The main data problem was the absence of regional-level price data for each

of the different sectors that comprise the general consumer price index. This hurdle was too much to overcome, and the second econometric test had to be abandoned.

Results

Regional and quarterly (for twenty years) panel data were utilized for this study. Following the framework laid out in the previous section, the following variables were tested with the corresponding data counterpart.

Table 1 – List of Variables

Variable	Data (Quarterly)	Description
Inflation	Consumer Price Index	Regional inflation rate with 2006 as the base year.
Macro Variables	Unemployment rate Interest Rate Foreign Exchange Rate	Unemprate is the average unemployment rate of the region for the year philrealintrate is the average Philippine interest rate for the year. phpusdave is the average peso dollar exchange rate for the year, acquired by averaging the average peso dollar exchange rate of each month. *(*Note: Interest and Foreign Exchange Rate are yearly averages)*
Population	Total population	Pop is the population of each region each year.
Climatic Condition	Average Temperature Total Rainfall	The variable meantemp is the average temperature in each region for the year. This was acquired by averaging the average temperature of each region per year. Rainfall is the recorded rainfall per region for each year.

Weather Anomaly/Climate Shock	El Niño La Niña	elnino and lanina are both dummy variables that indicate whether the country experienced either El Nino or La Nina during the year.

The variables listed in the table above were used in the econometric tests, with the macro variables, population, climatic conditions and the presence of the weather anomaly as the independent variables; while the inflation rate (represented by the consumer price index or CPI for each region) is the dependent variable. The regional CPI was acquired by using the formula for inflation on the CPI values per region per year, with the prices of the year 2006 as the base (meaning national CPI for the year 2006 is equal to 100). The data consists of entries for each variable for the years 1996 to 2014 (19 years).

Econometric Results

Regional panel data (regional information and time series data) from 1996 to 2014 were collected and sourced mostly from government sources. With this type of data, two techniques were possible to run the econometric tests, namely fixed effects (FE) and random effects (RE). A Hausman test was performed to determine which of the two would be the more appropriate technique, and result indicated that the random effect (RE) regression was the appropriate method, and should be utilized.

The econometeric results show that the specified model has a modest fit with an R^2 of 0.44. Out of the eight variables included in the econometric test, five registered statistical significance in explaining the changes in inflation rates (See Table 1 below). Consistent with the literature on macroeconomics, three variables—interest rate, foreign exchange rate, and unemployment rate—significantly influence the movement in the general price level. Interest rate and the foreign exchange both have the expected effect of increasing prices, due to their

positive impact on the cost of production. Higher interest rate and the depreciation of the peso would cause the prices of inputs—especially the cost of imported inputs—to rise, thus increasing the general price level. Unemployment rate, on the other hand, is correlated with a decline in productivity, which would in turn, push the cost of production up.

The climate variables, total rainfall and average temperature, registered insignificant impacts on price levels, as hypothesized. The discussion earlier already pointed out that long terms changes in climatic conditions would spur adaptation responses from the different sectors in the Philippine economy. It is reasonable to expect that producers—farmers, manufacturers, and even services suppliers—would adjust their production and operations with their knowledge of the changes in climate change.

Further, the econometric tests also proved that the hypothesis that the two weather anomalies, El Niño and La Niña, significantly impact general price levels was correct. The findings indicated that during the years that there were either La Niña or El Niño, the general price level in the different regions rose with the rise significantly determined by the presence of either of these two phenomena. This was again consistent with other studies and supports this study's hypothesis that it was mainly a weather shock in the form of a one-period (but temporary) rise in temperature and level of precipitation that would affect the general price level—an upward push in the price level—and not permanent changes in climatic conditions, such as a rise in average temperature or rise in total rainfall per year.

Table 2 - Summary of Econometric Results (Indicating Significance of Variables)

Inflation Rate = Dependent Variable	**Coefficient**	**Standard Error**	**Z**	**P > |z|**
Significant				
Interest Rate	0.1181143	0.04727	2.50	0.012

Foreign Exchange Rate (Php = USD)	(0.001553)	0.00017	(8.89)	0.000
El Niño Presence (Dummy)	0.0261456	0.0027	9.38	0.000
La Niña Presence (Dummy)	0.0146414	0.0027	5.38	0.000
Unemployment Rate	0.2511658	0.0703	3.57	0.000
Insignificant				
Population	(2.05e-12)	4.30e-10	(0.00)	0.996
Total Rainfall (TotRain)	(1.28e-06)	1.62e-06	(0.79)	0.432
Mean Temperature (MTemp)	(0.003214)	0.0022	(1.43)	0.154
Constant	0.1618106	0.0641	2.53	0.012

The question that needed to be answered next is why do these two weather anomalies reflect significantly on price levels. The literature and the composition of the consumer price index—wherein, the food and beverage sector comprises 39 percent of the of the CPI—could explain the results. Examining the sectoral impacts of El Niño and La Niña, it was reasonable to suspect that it would be the changes in food prices that mainly caused the changes in the general price level in response to the occurrence of these two weather phenomena. This change in food prices, one may surmise, could mainly be caused by a rise in irrigation costs in response to the extreme dryness brought about by El Niño, and the destruction of crops due to La Niña-induced excessive rain.

From the results as well, the statistical significance of the impact of La Niña on food prices could be traced to the impact of unexpected and extreme swing in precipitation would have an impact on growth of crops, especially rice and corn, which could affect production level. This needs to be verified, however, and would entail additional information to run econometric tests.

With data from PSA, this study initiated initial regression runs on a per sector level[11] to determine if there were any indication of significant association between the individual sectors and the weather and climatic conditions. The preliminary results indicated that there was a significant statistical connection between the food and beverage sector and the presence of the weather anomalies El Niño and La Niña. The curious thing, however, was that all of the signs of the variables significantyly influencing the price of food and beverages, registered counterintuitive direction—including that of El Niño and La Niña—which none of the literature reviewed for this study could support. A study done by Arcenas in 2016, wherein the impact of El Niño on rice and corn supply was tested, possible offers a plausible explanation: that the onset of El Niño triggered massive government support—particularly, the Department of Agriculture— for rice farmers and importation that caused a short-term increase in supply. The results of that study, however, did not make an assessment if the increase in supply caused a downward pull for food prices, or if the effect was only to stabilize domestic prices of rice and corn during the El Niño period.

This paper attempted to investigate further as to what the probable cause of the counterintuitive results could be, but no clear answer as of yet has emerged. The data used for both the general and sectoral models were generated from the same source, the PSA, which actually deepened the "mystery" surrounding the results. Testing the othere sectoral influences also yielded counterintuitive results, specially in the power sector where it was expected that the price of power would have a positive relationship with El Niño and a negative relationship with La Niña. The literature, as well as a logical reasoning, point to El

[11] The results of these regressions are similar to the initial results, with the same controlled variables and independent variables, however this time they were regressed on the different breakdowns of the national CPI. A random-effects regression was used each for the different product types (sectors) included in the CPI, specifically: 1) food and beverages; 2) clothing; housing and repair; 3) fuel, light, and water; services; and 4) miscellaneous. The variable names that correspond to these products are inflfoodbev, inflclothing, inflhousrep, inflfuellightwater, inflservices, and inflmisc respectively. (see Annex)

Niño's negative influence on the supply of hydropower—with La Niña, having the opposite effect—thus, it should have been that the occurrence of El Niño would push prices of hydropower up on the supply side; while the extreme dryness that El Niño brings in, should increase the demand for electricity, further pushing the price of electricity up. The econometric results, however, were not consistent with what the logical interpretation of the econometric results point to.

The sectoral effects, therefore, need to be evaluated separately—as another research initiative with sectoral data for each region—in order to ascertain what the sectoral dynamics are, and how the El Niño and La Niña affect the different sectors. This paper attempted to include a sectoral analysis, but unfortunately, there was no available data that could be used. As such, this study could not ascertain conclusively and econometrically determine which sector or sectors are significanly affected by these two climate shocks to the extent that the general price level would be affected. This study, thus, relied on the empirical literature that defined the framework of analysis, to explain the results of the econometric tests which, admittedly, is only a scratching of the surface when it comes to fully understanding the relationship between the two climate shocks and human welfare.

Summary, Conclusion and Policy Recommendation

The fundamental question that this paper has addressed is whether a climate-related weather shocks such as El Niño and La Niña could significantly affect general welfare by way of a general change in price. In this study, it is not long-term change in climatic conditions such as rise in average temperature or increase in annual precipitation level that is the concern, but a steep short-term change in these two climatic conditions as brought about by these two weather phenomena.

The literature offers different perspectives regarding the potential impacts of long-term climatic conditions on different aspects of human welfare, from health to economic impacts. But the literature does acknowledge that human society does have the ability to adapt, and given the correct information, society—through techology innovations, behavioral adjustments, and policy reforms—has the potential to neutralize some of the potential harmful effects of environmental changes such as climate change. There is evidence, for instance, that the labor productivity might dip if there were a sharp and short-term change in temperature, but that this decline in productivity disappears once adaptation takes place—which would entail investment and concerted effort by stakeholders to address. Once adaptation is complete, it can be expected that the effects of long-term changes in climatic conditions (such as temperature and precipitation) would be blunted. It must be emphasized, however, that there is a cost to adaptation and that adaptation takes time before it is completely in place—not to mention that it is likely that adaptation has limits on what it can achieve.

With this in mind, this paper hypothesized that short-term extreme changes in weather conditions such as those that characterize El Niño and La Niña would have an effect on the supply and demand for food and power—the main determinants of the general price level in the Philippines—which would significantly affect prices. Based on the literature, it was not expected that long-term changes in average temperature and annual precipitation would have a significant impact on prices, because firms and consumers would engage in adaptation that would allow them to soften (if not totally eliminate) the impacts of changes in climatic conditions.

The results of the econometric tests were consistent with the hypothesis, with the dummy variables for El Niño and La Niña registering significant statistical impacts on the general price levels. Further, the usual determinants of prices, specifically, foreign exchange,

interest rate, and unemployment rate also registered significant statistical impacts, consistent with both the theoretical and empirical literature. The directions of impacts were also consistent with the literature, with El Niño and La Niña positively affecting prices, or that the presence of either of these two weather phenomena causes prices to rise.

The literature provides the explanation for the econometric results, and that is weather and climate shocks affect food supply and the cost of production. These explanations are particularly true for the Philippines where the compostion of the general price index is mainly occupied by food and power prices.

One major limitation of this study is its inability to trace the effects of El Niño and La Niña on sectoral prices that comprise the consumper price index. Unfortunately, the unavailability of regional data for each of the sector prevented econometric testing on the sectoral level. Meaningful results that would have shown and given evidence to what the literature asserts would have been possible if the data could be disaggregated and separate tests be done for the agricultural crops, processed food, and other food types. Further, the power sector data should likewise be disaggregated and analyzed per type of power supply, to complete the discussion.

In summary, the findings of this study indicate that while long-term changes in climatic conditions are important to consider in planning, short-term but sharp changes in temperature and rainfall—weather shocks—such as those characterized by El Niño and La Niña do have significant impacts in the economy and human welfare and must, therefore, be addressed. One of the main objectives of macroeconomic managers is to make sure that price levels are stable in order to preserve economic order; and this study has shown that a stable price may in fact be jeopardy due to these two weather phenomena. It is worthwhile,

therefore, for policy managers and government in general, to take this information to heart—to use as an input in assuring macroeconomic stability.

Despite its limitiations, this study has provided additional evidence that the changes in climatic conditions do affect welfare of the general public; and that this paper, through its contribution toward fully understanding the welfare implications of changes in the environment and climatic conditions, adds an additional argument for more initiatives toward reducing the risks posed by these changes. In these times and in the current state of the environment, a nation like the Philippines needs to be more "flexible", knowledgeable and more adaptive in order to preserve the gains it has gained through the years. In most cases, adaptation is characterized by retrofitting of infrastructure and additional investment in physical projects and programs that induce a change in behavior or the way that things are done, that would likely avoid the negative impacts of climatic conditions. It must be pointed out, however, that successful adaptation means that the probability of a decline in welfare that climate change could cause has been eliminated.

Let it be pointed out that adaptation is the end product of initiatives that begins with an assessment of the new and long-term (if not permanent) conditions. The results of this study, for instance, suggest that the negative effects of the long-term change in temperature and precipitation in the Philippines could be blunted by a successful adaptation. The importance of timely and appropriate adaptation, therefore, has been called out, and it is now up to policy-makers to respond by way of programmatic strategies.

This paper contends that the answer the Philippines need not be helpless in neutralizing the negative impacts of El Niño and La Niña on welfare, as partly measured by the change on the general price level. Through the findings of this study and those of other studies of similar nature, policy-makers do possess useful information that can be used to

protect the welfare of citizens. The extreme heat and dryness that El Niño brings, and the unusual level of precipitation brought about by La Niña, are known, along with when they would occur. This gives the government time to prepare for the expected increase in heat and dryness by putting in place policy and programs that are targetted at specific impacts across the different sectors and situations. In the case of price impacts, the government could begin by creating public investments and encouraging private initiatives, that would soften the impacts of climate and weather hazards in the agriculture and power sectors. But there is a need for more creative and new initiatives in order to expand the range of choices of alternatives to address climate and weather issues. In the case of dryness from El Niño, for instance, it has been suggested that there should be greater efforts to store rainwater during typhoons and periods of La Niña, which would be released for irrigation and consumption during drought. There are other potential initiatives, of course, all of which should be examined and tested for feasibility and effectiveness. Given these, this paper's parting point, therefore, is that the current policy reality must now examine development objectives using climate-lens in order not to jeopardize growth and development objectives.

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