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Establishing the Link Between Poverty and Changes in Climatic Conditions in the Philippines

by

Agustin L. Arcenas*

*Associate Professor, University of the Philippines School of Economics

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U.P. School of Economics

Abstract

This paper investigates whether changes in climatic conditions significantly contribute to incidence of poverty in the Philippines. Due to the lack of sufficient regional estimates of poverty, this study utilized food cpi data to proxy for poverty level. The relationship between poverty level and food cpi were tested and found to be moving in parallel direction, and hence, could be substituted for each other for this study's purposes. The relationship between poverty and food prices has also been verified in the literature, as higher food prices is the dominant variable that results in higher poverty levels.

The results show that higher agricultural wages as well as extreme climate-influenced shocks such as El Niño and La Niña were significant determinants of poverty. Higher agricultural wage benefits agricultural workers, but the income effect may be small, and that overall, the net effect of is higher food prices that, in turn, exacerbates overall poverty. The negative impact of El Niño and La Niña on food prices (and therefore, poverty level) could be attributed to the consistent and appropriate government response to these weather shocks, which have stabilized supply of food. Government programs to stock up on rice during weather shocks, and the automatic assistance to farmers during calamities, have had the overall effect of neutralizing the potential poverty impacts of climate-related shocks. These are useful insights in carving out a climate-resilient economic development plan, and emphasize the importance of timely and appropriate government action and adaptation programs.

Key Words: Poverty, El Niño, La Niña, climate change, food inflation

JEL Codes: Q11, Q15, Q18, Q20, Q21, Q54

Introduction

There have been many facets to the issue of climate change but it is safe to say that the general concern regarding the issue is how changes in climatic conditions impact (or could potentially impact) human welfare. While there has been a great deal of interest on the specific aspects of human welfare and how these are affected by prolonged changes in temperature and rainfall, for instance, it has been only in the last few years that policy makers and researchers have started to widen their understanding of the connection between changes in climatic conditions, and the attainment of development objectives. Even if the exact impacts of changes in climatic conditions on the different facets of human welfare remain under study and scrutiny, there is a growing consensus that these changes—specifically, extended changes in temperature and precipitation—manifest themselves in over-all indicators of development such as the level of poverty.

The emerging information from the literature points to the impacts of climatic conditions on the agricultural workers' productivity as the link between changes in climatic conditions and income and consumption (Hertel & Roch 2010; Ahmed et al., 2009; Jacoby et al., 2014), non-farm households are likewise negatively by affected by climate-related factors through the impacts on real wages which decline due to supply-induced inflation. This is exacerbated by climate-related shocks such as droughts and floods which have a negative effect on per capita income (Winters et al., 1998).

The emerging link between changes in climatic conditions and the level of poverty, therefore, could be traced to the impact of changes in temperature and rainfall on agricultural performance and on real wages. The pathway by which these variables convert into the impacts that affect the state of poverty of households, is through how prices of goods change that causes real income to change. It is conceivable that the Philippines follows the same gateway of effects, and that inflationary pressures surface when supply-side drivers are affected when changes in climatic conditions cause production and distribution costs to rise. In addition, the country may also “import” inflation when climate change also affects the prices of imported goods and fuel that the Philippines buys in the international market.

But the literature, reporting on the same topic, also reveals that the potential poverty impacts of changes in climatic conditions are blunted by how well the climate-change adaptation programs and projects of a country are designed and implemented. The empirical evidence that shows how the appropriate policy response to the threats of climatic change have been reported and suggested in the literature, with development agencies such as the Asian Development Bank and the World Bank articulating the same. This suggests that development policies and projects, and appropriate adaptation measures have the potential to limit the potential negative impacts of changes in climatic conditions on the level of poverty in the Philippines.

Given all these developments, this paper examines and verifies if there is a link between changes in climatic conditions and the poverty level in the Philippines. In specific terms, this study investigates if temperature, rainfall, and weather shocks that have been reportedly affected by climate-change, have significant effects on the poverty situation in the country. This is done through econometric testing, and uses the available data from the Philippines Statistics Authority and the weather-reporting agency, PAGASA. This inquiry is not extensive and is hampered by the limited data available, and only aims to provide some evidence that shows the connection between environmental factors and developmental goals. While it is expected that the results of this study would be sufficient to guide the general direction of policy crafting for the country, there are areas of inquiry that this study has uncovered that would need further consideration.

On Energy Use and Climate Change

Despite the doubts expressed by some policy makers and members of the private sector, scientists all over the world seem to agree that the "human expansion of greenhouse gases" is one of the major determinants of global warming. A report by the Intergovernmental Panel on Climate Change reveals that the probability that human activities cause a higher than average global temperature is 95 percent.[1] It is not surprising, therefore, to find global efforts on climate change such as the Paris Agreement to be heavily concentrated on anthropogenic factors. Special interest is given to energy use, as combustion of fossil fuels contribute to 78% of total greenhouse gas emission from 1970 to 2010 (IPCC, 2014).[2]

There is a growing number of studies that link operations of the energy and their effect on climate change. Davis et al., (2010) for instance, simulated global temperatures using global CO2 scenarios from the energy and non-energy sector to determine and measure the effects of the release of carbon dioxide into the environment and changes in global temperature. Taking off from the assumption that that there would be no increase

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[1] https://climate.nasa.gov/causes/

in CO_2 emitting devices, these researchers found that it is the energy sector that will most likely contribute the most to CO_2 emissions in the future, due to the long lifetime of power plants and their significant initial share in CO_2 emissions. The large difference between their estimate and that of other studies stems from their forecast that much of the CO_2 emissions contributed by the energy sector would come from power plants that have yet to be built. The authors also concluded that the non-energy sector, which include transport, and industrial, residential, and commercial infrastructure, contributes significantly to CO_2 emissions.

Other studies found that there was a feedback effect between changes in climatic conditions and energy demand—particularly those from industrial, residential, and commercial sectors—which, in turn, magnifies the long-term changes in climatic conditions. Amato et al. (2005), for example, estimated the response of regional energy demand on extreme temperature and found that the demand for winter heating and electricity was lower during winter and higher during the summer season, respectively. This meant that prolonged changes in temperature due to the generation of energy, would further alter the demand for energy, resulting in more greenhouse gases that produce more changes in climatic conditions. Isaac and van Vuueren (2009) and Akhmat et al. (2014) also found similar trends and occurences in their examination of domestic energy use. This positive feedback loop between energy use and climate change, has made the phenomenon of climate change more complicated to deal with.

Another possibility, however, is that climate change induces societies to build infrastructures more consistent with sustainable development. Li, Yang, & Lam (2012) used degree days method and building simulation technique to determine how climate change affected energy use in US, Europe, and Asia. They found that the decrease in heating requirements during winter time would outweigh the increase in the cooling requirements during summer (Li, Yang, & Lam, 2012). Other studies demonstrated the same trend, emphasizing the need and importance of microclimate on forecasting electricity demand (Dirks et al., 2015; Santamouris et al., 2001; Vallati, et al., 2015)

In general, these studies imply that feedback effects have to be taken into account in order to determine the relationship between energy use and climate change. Adaptation, especially for residential, industrial, and commercial infrastructure, provides a potential policy tool that governments can use to fulfill their respective national commitments in the Paris Agreement.

Framework of Analysis

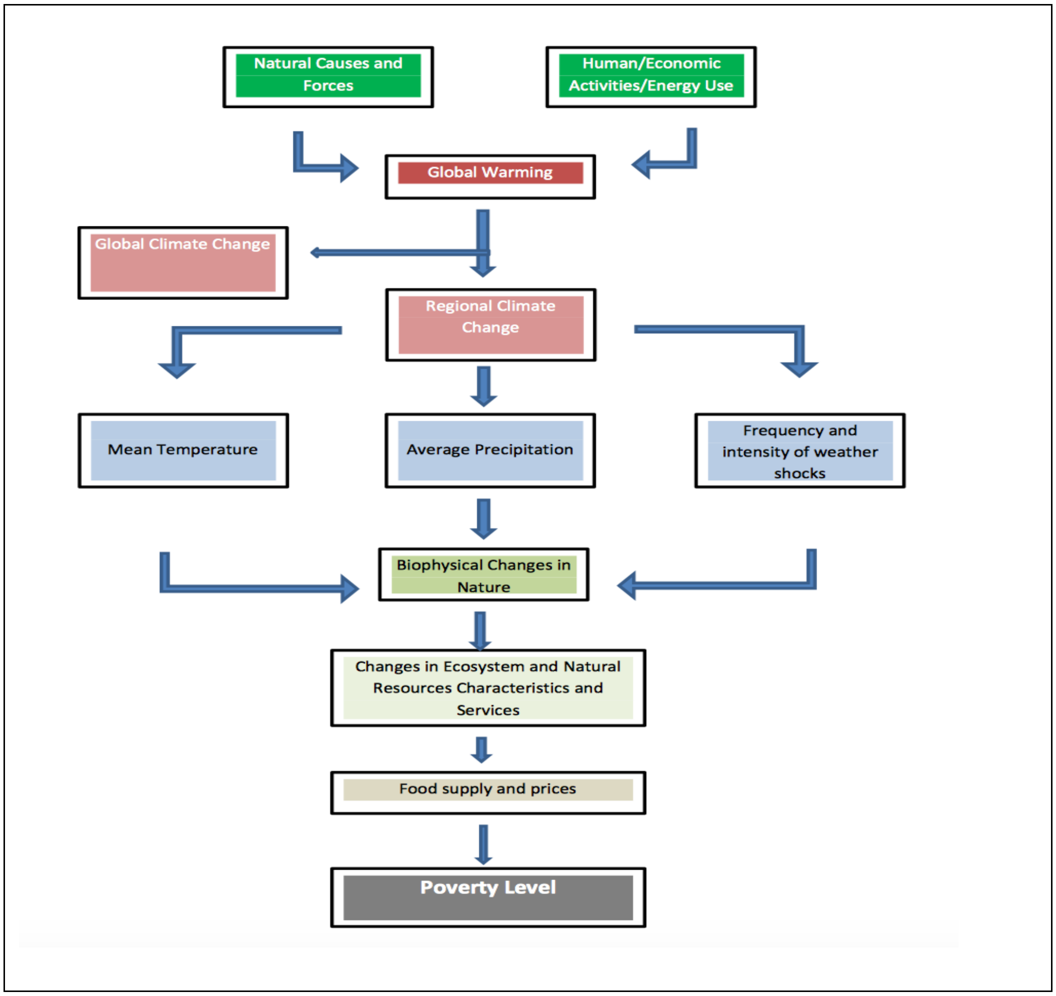
This study examines one facet of the welfare implications of environmental hazards—specifically, the increase in average temperature and precipitation—which is poverty level. The scientific literature indicates that changes in climatic conditions are natural, and that these changes follow a natural trend and cycle. The literature also indicates, however, that three is a growing amount of evidence that these natural cycles—the length and duration of these cycles—have been affected by the human activities, especially those that release and emit greenhouse gases. Given this, the objective of this study is to trace and determine one causal relationship between the creation of greenhouse gases and the attainment of one development objective, which is the elimination of poverty.

The issue of poverty is complex, and admittedly there is still so much to learn in order to combat it, especially on a global scale. Even if there are different perspectives as to what the causes of poverty are, there has been recent consensus that environmental factors and hazards significantly affect the level of poverty by way of their impacts on economic activities, prices, access to food, and livelihood. Extreme weather phenemona—pegged to be affected in terms of strength and frequency—have been linked to the rise in global temperature. With the poor being the most vulnerable to these weather conditions, it becomes apparent that this is another line of causal relationship between changes in climatic conditions and the exacerbation of poverty.

In a nutshell (and to emphasize), this study examines the link between changes in climatic conditions and human welfare, with the take-off point that there are different factors that cause climate change one of which is energy use. While this relationship between energy use and changes in climatic conditions will not be tackled in this paper, this study does acknowledge the findings of other studies that conclude that the use of fossil-based energy sources to fuel modern economic activities have contributed to the stock of greenhouse gases. The rise in the levels of greenhouse gases, in turn, has caused climatic conditions to change, the result of global warming, resulting in additional hazards and risks for man.

Different aspects of human existence are affected by these hazards which threaten society residents' access to food, livelihood, and health, among others. Since poverty is generally defined in terms of these components, we can discern the link between the use of energy sources that are prone to greenhouse gases, and poverty level. The diagram below maps out these relationships, and the link between changes in climatic conditions and the level of poverty.

Diagram – Pathway of Effects: Climatic Conditions and Poverty



A summary of the potential effects of changes in climatic conditions on food availability and poverty is shown below:

Pathways of Effects Between Changes in Climatic Conditions and Poverty Level

Climatic Condition	Impact on Natural Environment	Impact on Agricultural Activities	Impact on Food Availability	Impact on Poverty Level
Increase in average temperature	Alter soil qualities and the bio-dynamics of growth of plants. Population of pests and other animals that interact with plants would be impacted as well.	Production costs would change, specifically irrigation and inputs costs. Crops and livestock inventory could change because of the heat. Potential losses in crop and livestock inventory from heat	Local food supply would be affected, possibly decline, leading to changes in food prices. Increase dependence on importation to augment local production	Increase poverty level
Changes in precipitation	Moderate change in precipitation would have minimal effect Prolonged reduction precipitation will lead to loss of vegetative cover, water supply for irrigation, and loss is suitability of soil for planting Prolonged rise in precipitation could be beneficial for some crops that need more water, but would reduce growth/production for those crops that do not need much moisture.	Increase in irrigation costs for prolonged reduction in water. Increase drainage costs for prolonged precipitation Increase in feeding costs for livestock	Sharp reduction or increase in precipitation could lead to reduction in food availability because of increase in cost of agricultural production	Depending on the magnitude of impact, increase poverty levels.

Changes in location and timing of precipitation	Changes in soil and land characteristics, particularly moisture retention Potential change in aquifer recharge Potential changes in population and development of pests and plant/animal diseases	Increase insurance costs due to the higher uncertainty on yields Possible increase in production costs to take into account adjustments in agricultural practices in order to accommodate the uncertainty of precipitation	Likely local impact would be increase in price of food (decline in food availability) as agricultural production costs increase	Increase in poverty levels.
Increase in the frequency and intensity of monsoon storms/typhoons	Increase wind intensity Increase the water level in rivers and other bodies of water Create natural physical barriers across locations Potential changes in population and development of pests and plant/animal diseases	Physical damage to crops Loss of livestock due to illnesses and drowning Increase soil erosion causing removal of topsoil Increased transportation costs	Likely local impact would be increase in price of food (decline in food availability) as agricultural production costs increase	

The climatic factors included in this study—temperature, precipitation, and extreme weather events, El Niño and La Niña—were evaluated based on the pathways of effects listed above. Only El Niño and La Niña, representing extreme weather shocks, were included in the study. Storms, typhoons, and other wind-based weather anomalies were excluded because of the very limited data.

Empirical Framework

This paper aims to test if there is a significant causal relationship between poverty level in a region in the Philippines and changes in climatic conditions, based on the analytical framework discussed earlier. Poverty is defined in this study as simply the state of having insufficient income to allow for basic necessities to be purchased. In the Philippines, poverty is defined in terms of having sufficient income (poverty threshold) to be able to purchase basic food and non-food needs such as housing, health, and education, transportation and clothing. The PSA estimated the poverty line (or threshold) in 2015 to be on average Php 9,140 montly income for a family of five, with the poverty threshold calculated as:

Poverty Threshold (PT) = FT / (FE/TBE),

where FE = actual food expenditure within the +/- ten percentile of the food thresholds[3] , and TBE = total basic food expenditures families within the +/- ten percentile of the food threshold. Note that based on this formula, the PSA estimates that as of 2015, 21.6% of the country's population falls below the poverty threshold, or are considered poor.

Variables Tested and the Availability of Data

For quite some time, the factors that contribute to regional poverty level have been categorized into two: the physical and political characteristics of the region, as well

[3] The PSA defines the food threshold as "…the minimum income required to meet the basic food needs and satisfy the nutritional requirements of the Food and Nutrition Research Institute (FNRI) to ensure that one remains economically and socially productive." The food threshold is normally utilized to estimate subsistence poverty, or the state of extreme poverty wherein the household's income is not enough to meet the minimum caloric requirement of the members of the household.

macroeconomic policy regimes. Recently, however, with more studies and data, there is now a general consensus between the scientific community and civil society (and even among social scientists) that environmental factors and risks such as prolonged changes in climatic conditions, have direct and indirect impacts on the magnitude of poverty incidence.

To ascertain if this link between environmental factors and poverty also happens in the Philippines, this study utilizes econometric testing to determine if the changes in climatic conditions have a statistically significant impact on a region's poverty level in the country. An inventory of the poverty data in the country, however, revealed that regional estimates of poverty are only available for years 2006, 2009, 2012, and 2015. This meant that it would have been feasible to test whether climate-change variables affect poverty estimates due to insufficient data points. As such, it had become necessary to use a proxy variable for the poverty estimates in order to accomplish the econometric testing.

Based on the literature, a variable that follows the same movement as poverty trends is food prices (Hertel, Burke, and Lobell, 2010; Hertel and Rosh, 2010; Jacoby, Rabassa, and Skoufias, 2014). Most empirical studies do indicate that food inflation has a direct correlation with poverty levels across various definitions of poverty. The findings of Shrestha and Chaudhary (2012), for instance, show that a 10 % rise in food inflation results in a 4% increase in overall poverty in Nepal. Similarly, Ivanic and Martin (2008) found that a 10% increase in 7 key food items resulted in a 0.4% rise in poverty headcount in seven countries. Wodon and Zaman (2008) had similar conclusions when they found that a 50% increase in the price of cereals in West and Central Africa could increase the poverty share in total population by 4.4%. The Asian Development Bank, in a 2012 study, also concluded similarly when it found that there would have been 112 million less poor people had food prices not escalated.

The reason for the positive relationship between food inflaction and poverty level is due to the fact that majority of poor households spend a significant majority of their income on food (de Hoyas and Medvedev, 2009). This was the consistent with the findings of Shrestha and Chaudhary (2012) who found that 72% of the Nepalese's household consumption was for food. Since food is non-substitutable within the poor household's expenditures—unlike other items in the household budget—an increase in food prices effectively reduces that household's disposable income and welfare. The effect of food inflation on poverty level is said to be only tempered by the gains of those who produce food, who benefit from higher food prices (consumption effect vs. income effect of higher food prices). An overall gain from higher food prices, however, is only possible, if poor households are not net consumers of food.

It must be noted, however, that the literature regarding the direction of causality between agricultural wage and food inflation is mixed, with some findings indicating it is the higher agricultural wages that cause higher food prices and not the other way around. For instance, Sonna et al. (2014) found that the increase in agricultural wage was the most significant determinant of food inflation in India during the period of study, while Gulati, Jain and Satija (2014) concluded that it was the growth in the construction industry that explained the growth in agricultural wages. The Gulati et al. study, along with the study done by Goyal and Baikar (2014), suggest that it is the forces in the agricultural labor market—specifically, the supply function—that significantly cause agricultural wages to change, and not the income effect from the changes in food prices. While this area of inquiry is quite fascinating and no doubt important, it is not within the scope of this study, and will be left as a future area for research. The important point to consider is that there is a positive relationship between agricultural wage and food prices, even if the direction of the effect may vary from country to country. In the Philippines, however, there are indications that agricultural wage is mainly determined by the rising demand for labor from other (non-agricultural) sectors and changes in labor productivitly (Briones 2017), and migration. This study has not found any empirical evidence of an income effect from changing food prices. As such, this paper assumes that it is agricultural wages that could affect food prices and not the other way around. This, of course, may be verified separately in another future study, in which case, the model in this paper would naturally have to be adjusted to accommodate any change in assumptions.

In the case of the Philippines, close to 60% of total consumption of the bottom 30% of the population (in terms of income) is on food[4] in 2015, according to the Philippine Statistics Authority. Since most of the Filipino households are food consumers and not food producers, food inflation significantly and positively affects poverty, especially for the urban poor (Fujii 2011). As such, the use food prices as the proxy for poverty levels in order to have more data points for this study's analysis is reasonable and consistent with other studies that show these two variables move in the same direction.

To further emphasize the relationship between food inflation and poverty level, it must be noted that empirical studies have found that changes in climatic conditions have

[4] In contrast, the data show that the upper 70% of the population spend 39% of their income on food. For the entire country, 42% of the Filipino household's budget is for food expenditures.

resulted in lower agricultural productivity and consequently, higher food prices. Because the burden of higher food prices falls more on poor households whose food expenditure comprises a significant portion of their total expenditure, these changes in climate (and weather) conditions have contributed significantly to poverty incidence. Taking this lead, this study tested if there were food prices and poverty estimates in the country moved in the same direction and found that they did. Using poverty estimates and food CPI for 2009 and 2012 respectively, this study concluded that there is evidence of a positive correlation between the two.[5] With this result and based on the existing empirical literature, this study uses food inflation as the proxy for poverty levels in the econometric testing.

Econometric Model

Utilizing panel data for years 2009 to 2012 from several sources (see Appendix 1) this study used the following a fixed-effects model to test the relationship between food prices and climate change variables, as described in the model below:

$$fCPI_{it} = a_i + \beta_1 l.totrainfall_{it} + \beta_2 l.meantemp_{it} + \beta_3\ l.El\ Nino_{it}$$
$$+\beta_4 l.La\ Nina_{it} + \boldsymbol{X_{it}\theta} + u_{it}$$

where *totrainfall* refers to annual rainfall, *meantemp* refers to mean temperature, and *El Nino* and *La Nina* are dummy variables for such weather occurrences.

[5] Rudimentary statistical testing and computation showed that the correlation between food CPI and poverty incidence was statistically significant for both years. In the year 2009, it was at 68% (p = 0.003), while in 2012 it was at 76% (p= 0.0004).

In order to account for the delayed impact of a change in climatic variables on food production, the climatic condition variables were lagged. The other variables that were contained in the vector $\boldsymbol{X_{it}}$ include the following controls: population, agricultural wage, volume of irrigated palay produced, volume of rainfed palay produced, volume of corn produced, and the total area irrigated. The index *i* refers to region, while *t* is the year index. [6]

To account for the possible endogeneity of agricultural wage, this study employed a fixed effects instrumental variable model, which in this case were regional labor productivity and proportion of laborers employed in agriculture as instruments. This is consistent with the literature on agricultural productivity as discussed and by Imai, Gaiha, and Nucci (2014). A summary of the variables (and their description) and data used in the econometric tests is shown in the table below:

Variable definitions and data sources

Variable	Definition
Food CPI	The food consumer price index (CPI) describes the market value of a basket of food commodities which include bread and cereals; rice; corn; meat; fish; milk, cheese and eggs; oil and fats; fruits; vegetables; sugar, jam, honey, chocolate and confectionery; and other food products. The study makes use of 2006 as the base year.
Population	Data for population come from the 2010 Census of Population and Housing by the Philippine Statistical Authority (PSA). Using the projected growth rate and the 2010 population as base, we computed for the population per region from 2009, 2011 to 2015.

[6] The Hausman test revealed that there was significant evidence to reject the null that a random effects model was appropriate. A similar test was also conducted to test whether pooled OLS was a better estimation methodology. The statistical test revealed that the fixed effects model was the appropriate one to use.

Agricultural wage (real)	PSA defines this as the daily nominal wage rate, deflated by the consumer price index (CPI) for that year. Data comes from PSA's Agricultural Indicators System (AIS).
Labor productivity in agriculture	This refers to the amount of agricultural output produced by each employed person in agriculture, measured in constant 2000 prices.
Proportion of employed persons in agriculture	This is the total number of employed persons in agriculture divided by the total number of employed persons per region.
Volume of irrigated *palay* produced	Regional production of irrigated *palay* (paddy) in metric tons. Data comes from PSA's Major Crop Statistics of the Philippines.
Volume of rainfed *palay* produced	Regional production of rainfed *palay* (paddy) in metric tons. Data comes from PSA's Major Crop Statistics of the Philippines.
Volume of corn produced	Regional production of corn in metric tons. Data comes from PSA's Major Crop Statistics of the Philippines.
Area irrigated	This refers to the total area irrigated per region, measured in hectares. Data comes from PSA's Agricultural Indicators System (AIS).
Total rainfall[7]	This is defined as the total precipitation or condensation from the atmosphere, "as received and measured in a rain gauge". This study makes use of rainfall data from the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA).
Mean temperature	This represents the average temperature in a region in Celsius. In cases where multiple stations exist within a region, the average temperature from all stations within that region is computed.
El Niño	This is a dummy variable taking a value of 1 if a region experienced El Niño in that year, 0 otherwise.
La Niña	This is a dummy variable taking a value of 1 if a region experienced La Niña in that year, 0 otherwise.

[7] Weather stations exist in some, but not all regions. This implies that not all regions have climate-related variables, and were thus, dropped.

Results and Analysis

The preliminary test—specifically, the Hausman test—indicated that the fixed effect model was more appropriate than the random effect model (see Annex for details). Based on this, econometric testing was done with the following results:

Results Matrix with Regional Food CPI representing Regional Poverty Level.

Independent Variable	*Fixed Effect Coefficients*	*Standard Error*
Agricultural wage (real)	***0.146	(0.0372)
Population	0.000	0.0000
Volume of Irrigated Palay	***(0.000)	0.0000
Volume of Rainfed Palay	0.000	0.0000
Volume of corn production	*(0.000)	0.0000
Area irrigated	**0.000	0.0001
Total rainfall (previous year)	0.001	0.0012
Mean temperature (previous year)	(1.125)	1.4426
El Nino	***(13.49)	1.9778
La Nina	**(4.434)	(1.807)
Constant	109.173	(67.1436)

*** = Significant at the 1% Confidence Interval (See Annex)

** = Significant at the 5% Confidence Interval (See Annex)

* = Significant at the 10% Confidence Interval (See Annex)

The results indicate that poverty level (as captured by the food cpi) is significantly affected by the agricultural wage rate, the production of irrigated palay, total irrigated area in the agricultural sector, and the occurrence of the extreme weather phemenona, El

Niño and La Niña. The first three variables point to a rise in food production, and the last two to the occurrence of climate-related shocks that.

The results indicate that agricultural wage and food prices are positively related which is consistent with the literature (no matter which direction of effect one would assume). Further, the supply variables area of irrigated palay and area of corn production also negatively affect the price of food, which is consistent with the literature.

As far as climatic factors are concerned, the results indicate that the changes in average temperature and precipitation do not significantly affect food prices, and hence are not significant contributors to poverty levels. This is consistent with the findings of Arcenas (2017) that found the same results when testing for the impacts of these same variables on the production of palay and corn in the Philippines. This statistical insignificance of average temperature and precipitation can be attributed to the successful adaptation of farmers to the changes in these variables.

The surprising result is the significant but negative relationship between El Nińo and La Niña, and food prices, which indicates that the occurrence of either of these weather shocks could lessen poverty in the Philippines. The scientific literature and empirical studies which both point to a negative relationship between these weather shocks and food production in countries close to the equator[8], which means that their presence could result in higher food prices and ultimately higher poverty level. As discussed in the literature, El Nińo causes extended dryness in these countries and

[8] In cold to temperate countries, El Niño generally softens the harsh cold weather and extends the favorable weather for agriculture (growth (http://time.com/3916200/climate-change-plant-growth), but causes the heat and relative dryness in tropical countries to become extreme which, in turn, threatens agricultural production. The effect of La Niña on agricultural production is parallel to El Nińo in areas that are generally very dry.

increases irrigation costs, and ultimately food prices. La Nińa, on the other hand, pours unusual amount of water which could soak and drown crops if not addressed. In most cases, adaptation to La Niña involves additional drainage structures and investment in new varieties of seeds that could survive too much water, both of which would increase production costs and, ultimately, food prices.

The results would indicate that the occurrence of El Niño or La Niña could actually lead to higher food supply and, in turn, lower food prices. This is counterintuitive at first glance, until one probes deeper and examine what occurs during times of weather shocks in the country. The Philippine government, through its rice and corn programs, and financial assistance to farmers during times of natural calamities, have had the overall effect of reversing a food price increase. It is not so much that these weather shocks cause the decline in food prices, but rather the government's response to counter the negative impacts of the shocks on agiculture and food supply that ultimately does.

While this hypothesis regarding the efficacy of government programs in controllling food inflation must tested with research rigour, there are indications that these programs might be working properly. A check with the Department of Agriculture's Systems Wide Climate Change Office indicates that the government has developed and set in place an adaptation and mitigation plan to aimed at climate-change-proofing the country's agricultural sector. Included in the plan are programs and assistance to farmers during El Niño and La Niña years in the form of cash and credit assistance, non-farm jobs generation, productivity-enhancing training, and irrigation subsidy. These programs could very well have reversed the physical and food-inflation effects of these two weather shocks, and may indicate that the government's adaptation measures could be working. Further investigation, however, needs to be done to ascertain if this is indeed the case.

Conclusion and Way Forward

This study had set out to determine if changes in climatic conditions significantly impact the level of poverty in the Philippines by way of their impact on food inflation. The hypothesis was that, based on the literature, changes in climatic conditions would alter the physical characteristics of a country's natural assets and the corresponding ecological services they provide. This in turn would have affected the supply of food in the country, causing a change in prices and, ultimately, household income and regional poverty level.

There were three categories of climatic conditions investigated in this paper, namely: long-term change in mean temperature, long-term change in average precipitation, and the occurrence of weather shocks, El Niño and La Niña. The scientific literature tells us that these variables should have a negative impact on agriculture unless communities (or government) install programs and initiatives to blunt the impacts of these climatic changes. The empirical literature attests that appropriate and correct adaptation measures and programs have neutralized these negative effects.

This paper verified that changes in long-term mean temperature and precipitation are not significant factors in food inflation, and hence, of poverty. Consistent with the conclusions in other empirical studies, the gradual (albeit long-term) change in temperature and precipitation has given farmers and public at large to adapt to the change. This would have entailed building irrigation infrastructure, altering planting seasons, and utilizing technology to develop varieties of crops that would be more resilient to heat and too much water.

As reported in the literature, the experience of other countries indicates that the agricultural sector is bound to be more vulnerable to the weather shocks El Niño and La Niña, especially with those countries that are close to the equator. The presence of either to these two climate anomalies is expected to negatively affect food supply, and thus, increase prices and push poverty level up.

Surprisingly, however, the results of the econometric testing done for this paper showed the reverse, and that the presence of El Niño and La Niña, in fact depressed food prices up and ultimately the poverty level down. Closer examination, however, indicates that the expected results would have happened if not for the implementation of the disaster and climate-change adaptation program of the country. It now appears that the government's initiatives to make the agricultural sector disaster and climate-chage resilient may be functioning. Further verification and investigation, however needs to be done to ascertain this possibility.

It now appears that government initiatives designed make the country's agricultural sector develop resiliency against weather shocks would make for a sound anti-poverty program based on the results of this study. This is true to the extent that these programs reduce food inflation, and thus would reduce food poverty. These government programs could partially account for the decline in the overall poverty level in the country until 2015.

But poverty has many dimensions, and the results of this study may create the impression that the poverty level could be fully addressed with climate-change resiliency programs aimed at agriculture alone. The author contends that while the creation of a plan towards climate-proofing agriculture is step toward stabilizing the economy, there are other aspects of the poverty discussion that need to be addressed. For instance, the government program on the resiliency of the agricultural sector mainly addresses the plight of the poor in the agricultural sector, and does not seem to have its counterpart to assist the non-agriculture poor. In fact, there seems to be very little information gathered regarding the welfare of the urban or non-agriculture poor across the regions during times of climate-change-related shocks in the country. This is an area that needs to be investigated by researchers and policy-makers in the future.

Even among the agricultural poor, there need to be better directed and focused programs that must target the different types of poor in the agricultural sector, such as the non-terrestrial agricultural poor, the indigenous people, and other non-farm workers living in the rural sector. One may argue that with the limited government resources, the course of action should be to secure the food supply first. There is no argument that food security is indeed important especially during these times where climate-change hazards are imminent, but it would be worthwhile to keep in mind that total resilience to disasters and climate-change hazards must eventually involve the long-term protection of all sectors.

Finally, the data constraints this study encountered, highlights the urgent need for the data problem in this country to be addressed. For instance, one would think that since the country has been dealing with the poverty issue, there would be a solid system that gathers information on various aspects of the poverty issue on a disaggregated level – but there does not seem to be one. As a result, this study had to use proxies and had to reduce the number of observations in the analysis. While the paper stands by the trend in the relationships among the variables despite the data limitations, the magnitude of effects could be better estimated with more data points. It is imaginable that other research initiatives face similar data issues.

It must be pointed out that no sound monitoring of government projects and programs could be feasibly and reasonably done without accurate and sufficient data. Hence, in order to determine if use of government funds in addressing poverty (or any other development objective) has been effective in attaining its desired outputs and outcome, there has to be better supply of data that can be used in government project evaluation. Without this information, assessment would be reduced to primarily soft evaluation with quantitative evidence, which is a second-best case.

Despite the obvious limitations, this study has provided evidence-based insights regarding the potential development impacts of hazards, and has shown proof that appropriate and targeted programs do work in minimizing the effects of climate-change-related risks. This should serve as guidance for government in crafting policies and programs related to adaptation initiatives. The results that indicate that the change in climatic conditions have minimal effect on the food welfare of the poor, demonstrates the efficacy of adaptation even on a household level. It is important for policy-makers in government to take heed of this insight.

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Annex

Stata Output

```
Fixed-effects (within) IV regression        Number of obs      =        50
Group variable: region                      Number of groups   =        11

R-sq:  within  = 0.9337                     Obs per group: min =         1
       between = 0.0389                                    avg =       4.5
       overall = 0.0099                                    max =         5

                                            Wald chi2(10)      =  88793.27
corr(u_i, Xb)  = -0.9085                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------------
           food_cpi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------------+---------------------------------------------------------------
          real_wage |   .1462198   .0372188     3.93   0.000     .0732722    .2191673
                pop |   8.78e-06   8.79e-06     1.00   0.318    -8.45e-06     .000026
palay_irrigated_vol |  -.0000191   6.56e-06    -2.92   0.003     -.000032   -6.30e-06
  palay_rainfed_vol |   .0000152   .0000339     0.45   0.655    -.0000513    .0000817
           corn_vol |  -8.22e-06   4.86e-06    -1.69   0.090    -.0000177    1.29e-06
     area_irrigated |    .000183   .0000812     2.25   0.024     .0000239    .0003421
                    |
        ttlrainfall |
                L1. |   .0008926   .0012072     0.74   0.460    -.0014735    .0032586
                    |
           meantemp |
                L1. |   -1.12544   1.442631    -0.78   0.435    -3.952944    1.702064
                    |
            el_nino |  -13.49008   1.977776    -6.82   0.000    -17.36645    -9.61371
            la_nina |  -4.433517   1.806987    -2.45   0.014    -7.975147   -.8918881
              _cons |   109.1735   67.14364     1.63   0.104    -22.42565    240.7726
--------------------+---------------------------------------------------------------
            sigma_u |   27.14333
            sigma_e |   3.367691
                rho |  .98483984   (fraction of variance due to u_i)
------------------------------------------------------------------------------------
F  test that all u_i=0:     F(10,29) =     3.59           Prob > F    = 0.0034
------------------------------------------------------------------------------------
Instrumented:   real_wage
Instruments:    pop palay_irrigated_vol palay_rainfed_vol corn_vol area_irrigated
                L.ttlrainfall L.meantemp el_nino la_nina labor_prod_real
                prop_agri_employed
------------------------------------------------------------------------------------
```

```
TEST FOR APPROPRIATENESS OF FIXED EFFECTS vs RANDOM EFFECTS
. hausman fixe rand

Note: the rank of the differenced variance matrix (4) does not equal the number of
coefficients being tested (10); be sure this is what you expect, or
        there may be problems computing the test.  Examine the output of your
estimators for anything unexpected and possibly consider scaling your
        variables so that the coefficients are on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |      fixe         rand        Difference          S.E.
-------------+----------------------------------------------------------------
   real_wage |    .1462198     .0290103        .1172095               .
         pop |    8.78e-06    -1.12e-06        9.90e-06        8.78e-06
palay_irri~l |   -.0000191     3.27e-06       -.0000224        5.38e-06
palay_rain~l |    .0000152     -.000024        .0000392        .0000332
    corn_vol |   -8.22e-06    -4.58e-06       -3.65e-06        3.99e-06
area_irrig~d |     .000183    -.0000217        .0002047        .0000723
L.ttlrainf~l |    .0008926     .0002296         .000663         .000595
  L.meantemp |    -1.12544    -2.216799        1.091359               .
     el_nino |   -13.49008    -14.50825         1.01817        .8619439
     la_nina |   -4.433517    -10.66849        6.234968               .
------------------------------------------------------------------------------
                         b = consistent under Ho and Ha; obtained from xtivreg
          B = inconsistent under Ha, efficient under Ho; obtained from xtivreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       12.96
                Prob>chi2 =      0.0115
                (V_b-V_B is not positive definite)


. *FE appropriate under 0.05 significance
```