WELFARE VALUATIONOF THE IMPACT OF CLIMATE CHANGE TO RICE FOOD SECURITY: A THEORETICAL IMPLICATIONS**

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Abstract

Philippines' vulnerability to adverse effect of climate change greatly affects the country's rice food security. The study proposed tools to evaluate impact of climate change to rice security by using welfare measures like compensating and equivalent valuation. These tools are used to measure the welfare of households as a result of price change. This study attempts to discuss limitations of compensating and equivalent variation as assessment tools for welfare change or the impact of climate change on rice food security.

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Introduction

The geographical feature and low economic capacity of the Philippines aggravated by environmental challenges make it vulnerable to the impacts of climate change. The Philippines is located in a region of ascending air and widespread equatorial cloudiness resulting in 20 tropical cyclones annually, aside from other rainfall-causing weather patterns like monsoon, fronts, easterly waves to name a few. In the last quarter of 2011, GDP grew by 3.7% compared to 6.1% on the same quarter of 2010. The Philippines is lagging behind its neighboring Asian countries like Malaysia, Korea, and Japan. Alongside with the low economic performance, the Philippines is toppled with several environmental challenges- raging environmental issues like deforestation, small scale mining, overfishing, and agricultural land conversion. These circumstances make climate change an even bigger threat.

In agriculture, new evidence showsdeclining crop yield due to rising temperature, extreme weather events, and changing weather conditions. The falling crop harvest, rising farming price inputs, declining arable land due to land conversion, and aggravationfrom farmers switching from producing food crops to producing bio fuel crops – all thesesupply side factors pressures, on one hand, and the constantly rising demand, on the other hand - induce price increases for food crops.

Amongst the cereal crops, rice is part of the food basket of the Filipinos.Aside from the fact that it is part of the culture, itis the only major crop that is consumed immediately after harvest. Rice is a staple food for many households. In 2006 study of PIDS, 11 percent of the household's income is spent for rice. No wonder, Philippines imports tons of rice from Vietnam and Thailand. The price inelastic demand for rice makes Filipinos vulnerable to the effect of climate change to rice food security.

Recent studiesevaluate the impact of climate change to rice security by using welfare measures like compensating and equivalent valuation. These tools are used to measure the welfare of households as a result of price change.This studyattempts to discuss limitations of compensating and equivalent variation as assessmenttools for welfare change or the impact of climate change on rice food security. The paper is divided into three parts. Part I discusses rice food security and climate change. Part II presents the framework of compensating and equivalent valuation as a welfare change measurement tool and some of its shortcomings. Part IIIwould include the summary and recommendations for future related studies.

Impact of climate on rice security

Climate change is a global "buzz" lately. It is not because it is a current issue but because its impact is evident and massive. United Nations Framework Convention on Climate Change, defined climate change as:

> *A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable periods of time.*

Considerable amount of data has it that for the last 50 years, the change in the climate is attributable to human activities. Human presence competes with the quality of the environment. As population increases, human activities become complex causing tremendous and sometimes irrevocable effects to the environment. It changes the course of nature; same is true with the current content of gases which form our atmosphere. Earth's natural greenhouse effect makes life possible. Notwithstanding,theenormous amount of green house gases (GHG) in the atmosphere makes it an alarming issue.

On a global scope, Philippines contributes less than one percent of world's total carbon dioxide emissions for all sectors while Organization for Economic Co-operation and Development (OECD) countries are the major culprits for global warming. On a local scope, electricity and heat production is the top contributory sector due to its nature. Transportation sector followed by manufacturing industries and construction contribute 22.6 and 13 percent respectively. Not surprisingly, the major source of emission from the transportation sector came from road related activity. Other sectors and energy industries are liable for comparably small amount of carbon dioxide emission.

Table 1: CO_2 emissions by sector in 2008 *

Areas	Total CO_2 emissions from fuel combustion	Electricity and heat production	Other energy industries *	Manufacturing industries and construction	Transport	*of which: road*	Other sectors	*of which: Residential*
Phils.	72.3	29.6	2.2	13.0	22.6	20.4	4.9	2.5
Asia	3 022.8	1 384.5	161.4	737.8	447.7	418.5	291.5	140.2
OECD Total	12 629.6	4 992.0	672.3	1 819.1	3 386.5	2 999.4	1 759.8	984.4
World***	29 381.4	11 987.9	1 491.9	5 943.6	6 604.7	4 848.4	3 353.4	1 905.1

milliontonnes of CO_2

Source: International Energy Agency, 2010.

* This table shows CO2 emissions for the same sectors which are present throughout this publication of EIA.

** Includes emissions from own use in petroleum refining, the manufacture of solid fuels, coal mining, oil and gas extraction and other energy- producing industries.

*** World includes international bunkers in the transport sector.

This only attest to most findings that countries which contribute least to the global green house gases (GHG) and have less access to resources are countries most vulnerable to the impact of climate change. In the case of agriculture, Bureau of Agricultural Statistics shows that in year 2000, the share of agriculture to Gross Domestic Product (GDP) is 12 percent.

Table 2: Agricultural Sub Sector Contribution

Sub Sector	Distribution
Crops	48
Palay	19
Corn	5
Coconut	5
Banana	5
Sugarcane	2
Mango	2
Pineapple	2
Others	8
Fisheries	21
Livestock	14
Poultry	10
Agricultural activities and services	7

Source: BAS, 2010

Composition of agricultural harvest is enumerated in Table 2. Crops account for 48 percent of the basket of agricultural yield, followed by fisheries, then livestock which constitute 21 percent and 14 percent respectively. Poultry and agricultural activities and services have the least sub sector contribution. As observed, palay constitutes the biggest volume of harvest for crop cereals, which is the staple food of the Filipinos. In the 2002 study of Nguyen, it was shown that Filipinosobtainmore than 800 kcal/person/day from rice.

In the study of Amadoreet al. (2005), they observed that the most affected aspects of economic life by climate change, so far, is agriculture and food security. The sharpest fall in agricultural productions are experienced during strong El Niño events and after the occurrence of severe tropical cyclones. The highest typhoon damage was 1.17% of GDP and 4.21% of agriculture. In a separate study of Cruz et al (2007), they cited that on an average, 20 cyclones with eight to nine landfalls each year will cross the Philippines Area of Responsibility (PAR). They also observed during period 1990 to 2003, an increase of 4.2 in the frequency of cyclones entering PAR.

People relying on rain fed agriculture are conventionally thought to be the ones to feel the brunt of the impact of climate change on rice security and food security in general. In the Philippines, the population of small farmers is estimated to be 6.23 million. Other sectors vulnerable to changes in prices of rice are the indigenous people who directly depend on the environment for their food consumption. Climate change will definitely increase their food insecurity due to expected lower yields and crop failure. Simply focusing on these sectors, however, will understate the consequences of climate change in relation to food security. Climate change will be more broadly felt through escalating food prices.

Rice food security exists when all people have economic access to rice to meet their dietary needs for an active and healthy life. It is measured through availability and accessibility of rice as staple food for the Filipinos. Availability of rice is a function of rice price, input price, irrigation investment, water input, technological change and climate change. On the other hand, accessibility is a function of rice prices, income and population.

The United Nation's Food and Agriculture Organization (2009) describes the mechanism of how climate change will cause changes in the global food system and thus conceivably, food prices. Climate change would impact water and energy used in food processing, cold storage, transport and intensive production, and food itself which will reflect the higher market values for land and water, and payments to farmers. Research on climate change shows that increase in temperature can open up more land for rice cultivation such as in areas in China. However, for tropical regions, the likely net effects are negative.

The near term effects of climate change to the process of rice production and security would be increase in the incidence of extreme weather events, such as droughts and typhoons, which will destroy crops and reduce yields. Indirect impacts on rice production would be through floods that will damage production equipment of farmers and infrastructure supporting production such as dikes, roads, and dams. For the long term, increase in global mean temperatures, rise in sea level, and increase in weather variability are expected to negatively impact rice production. Flooding and typhoons are threats to rice productions because rice cannot survive if submerged in water for extended periods. Elevated temperatures make rice flowers sterile so that they don't produce grains. Droughts would cut water source for rice production. Also associated with changes in weather variability and water shortages are increase in pests, diseases, and weeds growth. (IRRI, 2012)

Most studies suggest that it is not only the production of rice that will be affected but also the quality of rice. Most farmers are practicing rain fed agriculture, and during extreme weather conditions like droughts, harvest would be dramatically affected. On the other extreme, rice is not resilient toexcessive water. Thus, most farmers see to it to plant during rice's particular crop months. With climate change, one cannot exactly forecast the correct time to plant and harvest rice. In the study made by Philippine Rice Research Institute (2011), they enumerated high risk areas due to the impact of climate change. The areas most at risk to climate and weather-related risks in general are Southeastern Luzon and Western Visayas. Areas in Central Luzon and Eastern Mindanao that rank very high on the combined risk to climate disasters are primarily rice areas.

During the 2008 rice price inflation caused by export tightening (ADB, 2011), increases in the price of rice in the Philippines were estimated to have a negative impact on 85.5% of households because they are net consumers of rice and benefit only 12.5% of households who are net producers and derive income from palay production (Reyes, Sobrevinas, Bancolita, & de Jesus, 2009). Obviously an increase in rice prices has a clear negative impact for the majority of the population. Needless to say, the poor would suffer most from rice inflation as they spend 17.5% of their income on rice alone.

For the general population, the average spending on rice based on the Family Income and Expenditure Survey for 2006 is P 11,461 annually, which is 11.9% of the average total expenditure. The wealthiest part of the population spends much less of their budget on rice with only 3.5% of total expenses on rice. Poorer households tend to spend more on rice as their income rises up to a certain point, which is opposite to the spending behaviour of wealthier households, who appear to have inelastic expenditure on rice with respect to changes in income (Reyes et al, 2009).

In 2009, the International Food Policy Research Institute (IFPRI) published projections for food prices, including for rice, for 2050 using climate projection models by the National Center for Atmospheric Research, US (NCAR) and that of the Commonwealth Scientific and Industrial

Organization, Australia (CSIRO). For the estimates of agricultural production, consumption, prices, and trade, IFPRI used the global agricultural supply and demand projection model (IMPACT 2009) linked to a biophysical crop model (DSSAT). These models were used to give projections for both scenarios of no climate change and with climate change. In the absence of climate change, price of rice was forecasted to increase 61.6% from 190 US$ per metric ton to 307 US$ per metric ton. With climate change, the rate of increase climbs up to 113.4% using the NCAR model and 121.2% using CSIRO model. Both rates are computed barring the positive CO_2 fertilization effect to crop growth brought about by increasing concentration of greenhouse gases on the atmosphere.

Traditional Measures of Welfare Change, CV, and EV

The consequence of changing rice prices on Filipinos is a topic much discussed in the literature. The treatment for measuring "welfare", however, seems to be limited to how rise in the price of rice will affect income distribution and how it will change the poverty headcount of the country (Cororaton, 2004; Reyes et al, 2009). There are no studies employing the analytical tools compensating variation (CV) and equivalent variation (EV) in order to give a measure of welfare change defined as the change in the well-being of an individual.

In the study of Reyes et al (2009), the authors concluded that increasing costs of rice will have an adverse impact on the urban population more than on the rural population. IN addition, even if majority of rice farmers (73.7%) could possibly benefit from increasing prices, 26.3% are still expected to lose from inflation. These farmers grow rice on a smaller scale and earn P 10,701 a year on average on rice production, and in fact spend more, P 16,179 a year, for their consumption of the crop. This study shows that rice price inflation is expected to have a net negative effect on human welfare. Another local study which tackled the welfare repercussions of price change is one by Cororaton (2004) which sought to predict how the quantitative restrictions and tariff reductions on rice imports could affect poverty and income distribution. The results show that this policy reform would adversely impact farmers through reduced demand for factor inputs and decrease in factor prices so that factor income for those in the agricultural sector will similarly drop. The decrease in consumer prices will not be adequate to mitigate the drop in income for farm workers. From these studies, one can conclude the consequences of price changes in rice are not the same across the population. Majority of rice producers, for instance could gain, but consumers will be unambiguously worse off. Welfare in these studies, it could be said, is measured in terms the increasing expenditures for rice and examining whether this would push a person into poverty.

In the valuation of a change in welfare in response to changes in price or quantity purchased, analysts look at the household's behaviour and use this information to work out money measures of the consumer's welfare changes. Compensating variation for the price increase is the amount of money has to be given to bring his budget line back up to the old indifference curve. On the other hand, equivalent variation is the amount of money that social planner would take away from the household before the price change to leave him just as well off as he would be after the price change.

To calculate CV and EV, the following formulas are used:

$$EV(p^0, p^1, w) = e(p^0, u^1) - e(p^1, u^1) = e(p^0, u^1) - w$$

$$CV(p^0, p^1, w) = e(p^0, u^0) - e(p^1, u^0) = w - e(p^1, u^0)$$

Where p are prices, w stands for wealth, u for utility, the superscripts 0 denote the baseline values and superscripts 1 denote the new values.

The appeal of CV and EV is that these tools quantify improvements or declines in the well being of people due to changes in costs of food and also changes in wealth. They will enable us to describe in monetary terms how much worse-off or better-off an individual is as a result of these changes. In the context of climate change and rice security, CV and EV can be used as tools to measure how the anticipated inflation in prices of rice will change individuals' hinder access to the staple, and as consequence, the anticipated decline of an individual's welfare or well-being.

In the literature, it is usual to see CV and EV used to compute for changes in welfare in response to food inflation. For example, Wood, Nelson and Nogueria (2009) used CV and EV to measure welfare losses due to the increase in prices of major food commodities for Mexican households, during the to the food price inflation from 2006 to 2009. They observed large differences in the welfare losses for poor and non-poor households, with the former losing 10.48 pesos per week against 6.45 pesos per week in utility. In a 2010 study by Cranston and Haq, they have found out that the total global compensating variation associated with the food price inflation between

2005 and 2008 is estimated at US$515 billion. Their study also shows trend that per capita compensated variation as a percent of per capita expenditure for developing countries are higher than those for developed countries. This means that the welfare impact of rice price inflation is relatively bigger for people in developing countries. Findings in a Brazil study show that most of the population showed a decline in welfare, even if the country is one of the largest food exporters in the world. The average compensating variation is 7% of average expenditure, with a range from 11% for the lowest income group to under 2% for the top percentiles groups. (Ferreira, Frutterro, Leite&Lucchetti, 2011)

Limitations of CV and EV as Measures of Welfare Change

CV and EV analysis is done in such a way that we calculate the change in a consumer's welfare when a price of particular good is changed, holding other prices of goods constant. However, in reality, increases in the rice prices have spill over effects because it would also cause inflation in the prices of other products and services.In the study of Reyes et al (2009) using Input-Output analysis, they have determined that 39.6 percent increase in the retail prices of rice and 34.9 percent increase in farmgate prices of rice would lead to a 2.14 percent increase in the prices of goods and services, in general. Though the ceteris paribus assumption is employed to isolate the first order effects of rice price increases, it would be more realistic if the cost of other goods would be allowed to react to the change in rice prices. If so, CV and EV can fully capture the total changes in an individual's utility as a result of the increases not only in the price of rice but also of related goods and services

In the case of rise in food costs, a two-good CV and EV analysis will produce a measure of income change that will describe how much more wealth is necessary to restore a person to his old utility level when the prices were lower (CV) or how much wealth needs to be taken away from his original income level to make him as worse off as when the prices had risen (EV). CV and EV however, will be not helpful in terms of suggesting what exactly will substitute for the staple food in the event of price increases particularly if the second good in the analysis is a composite good. This piece of information is important for policy because aside from buffering the effects of climate change on rice production and access, policy makers should also look into how it can secure the supply and access to this substitute good, when consumption is diverted to this substitute.

Though CV and EV are helpful measures of welfare changes, it cannot substitute for other means of examining the welfare implications of changes in the price of food costs. One important dimension of food security is food utilization, which refers to the nutritional content in a person's food intake. For policymakers, more concrete and specific measures of welfare such as change in caloric intake would be preferable to CV and EV.

Conclusion and Recommendations

The Philippines is vulnerable to the consequences of climate change. Particularly for an agricultural country like the Philippines where 11 million people find their living from the agricultural sector and rice is a staple food, climate change will have a huge impact on production processes, crop yields, real incomes and standard of living. Welfare analysis using CV and EV would contribute to the discussion for policy making with the end of mitigating climate change impacts. Local literature shows that it is an underutilized tool and replication of existing empirical studies would enrich our current knowledge base and help us prepare for the consequences of climate change.

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