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Exploring Transformational Adaptation Strategy through Rice Policy Reform in the Philippines

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Notices

ABSTRACT

The Philippines is much more prone to climate change effects than are many other countries. The potential impact on the agriculture sector is of particular concern, given its vital role in the economy and for vulnerable households. Most research warns of the negative impact of climate change on yields for major cereal crops, which could threaten food security and hinder the long-run development process. Incremental adaptation through the introduction of new crop varieties, improved agricultural management practices, and more efficient irrigation are expected to reduce yield losses. However, efforts to promote systemwide adjustment would have broader effects, especially as the risk of climate change increases. This study proposes a new approach for adaptation strategies by exploring policy reform in agriculture as a transformative way to help economic agents adapt to climate change. We specifically explore the rice policy reform currently being pursued by the government through the abolishment of the rice quota program. We find this reform could help transform the agricultural and economic system by allowing scarce resources move from low- to high-productivity sectors, thus increasing the country's adaptive capacity. However, the rice farmer and vulnerable groups that are prone to climate shocks are adversely affected by the policy. Thus, we introduce alternative intervention policies to complement the reform agenda by providing a cash transfers program to vulnerable groups or a subsidy to support rice farmers. Both offer less impact in economic efficiency gains, but the cash transfer program is superior in terms of supporting the vulnerable group in coping with climate change under the rice reform policy. This shows that the transformational adaptation strategy may create a welfare loss to certain agents but that adding government intervention could act as the second-best policy and become a transition pathway before the whole system transforms to reach the optimal efficiency point when the intervention program is eventually phased out.

Keywords: climate change, transformational adaptation, rice policy, computable general equilibrium

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1. INTRODUCTION

The Philippines is among the countries most vulnerable to climate change impacts. Already prone to weather-related disasters, the Philippines will potentially be exposed to increased risk as a result of climate change (UNISDR and CRED 2015; Kreft et al. 2014). Impacts on the agriculture sector are of particular concern, given the sector's vital role in the economy. Agriculture contributes around 10 percent to the country's total gross domestic product (GDP) and employs about 30 percent of the members of the labor force, almost half of whom are identified as poor farmers (Philippine Statistics Authority [PSA] 2016). Most research warns of the negative impact of climate change on yields for major cereal crops (Schlenker and Lobell 2010; Welch et al. 2010; Lobell, Schelenker, and Costa-Roberts 2011; Intergovernmental Panel on Climate Change [IPCC] 2014), which could threaten food security (Schmidhuber and Tubiello 2007; Godfray et al. 2010; Wheeler and Braun 2013) and hinder the long-run development process (Dell, Jones, and Olken 2012).

For the Philippines, with a small open economy accountable for less than 0.5 percent of global greenhouse gas emissions, exploring adaptation strategies is imperative. Incremental adaptation through the introduction of new crop varieties, improved agricultural management practices, and more efficient irrigation is expected to reduce yield losses (Mueller et al. 2012; Rosegrant et al. 2014; Challinor et al. 2014). However, efforts to promote systemwide adjustment would have broader effects, especially as the risk of climate change increases (Lonsdale, Pringler, and Turner 2015; Kates, Travis, and Wilbanks 2012; Rickards and Howden 2012). The importance of systemwide adaptation is emphasized in the Fifth IPCC report, where societywide transformational change is highlighted as a key component for building resilience and adjusting to climate change impacts (IPCC 2014).

This study proposes a new approach for adaptation strategies by exploring policy choices under the rice market reform. We consider the reform as a transformative adaptation strategy because it meets the characteristics that are usually perceived as radical and against the status quo and entails fundamental change in a system (Lonsdale, Pringle, and Turner 2015). It is also dramatic and difficult to get full agreement from all participating agents, especially the rice farmers and other economic actors across the value chain who will potentially incur loss in the competition as rice imports flood into the country. On the other hand, the potential benefit from eliminating the cost and inefficiency of the status quo policy is quite significant.

It is widely known that the rice policy has depended on major market interventions, namely import quota restrictions and price subsidies for rice, and despite its noble goal of protecting the poor and aiming for food security, the program has been ineffective due to significant leakage of the subsidy, its high operating costs, and its welfare-reducing impact (Fernandez and Velarde 2012; Jha and Mehta 2008; Roumasset 2000). The policy not only has led to huge budget losses for the government but also creates problematic incentives that hinder agricultural diversification and the structural transformation process (Timmer 2015).

The Philippine government recently took a bold step to open up the rice market by replacing the rice import quota with tariffs (De Vera 2019). We analyze this policy reform in tandem with the climate change analysis through transformational adaptation strategy lenses. We perceive market adjustment from the reform as a fundamental market system change that would help the economy to transform by achieving higher efficiency in reallocating the limited resources that eventually increase the country's adaptive capacity to climate threat. This study shows that eliminating the rice self-sufficiency policy by abolishing the rice quota helps the economy benefit from more efficient market signals in responding to climate change. However, the rice farmers and vulnerable groups[1] who are mainly engaged in the agriculture sector and more prone to climate shocks are adversely affected from this reform. We then further introduce additional policy interventions on top of the rice reform, by introducing cash transfer and the rice subsidy to provide cushion to the potentially affected agents. This alternative policy is meant to reduce the drastic change and significant losses faced by economic agents due to rice market reform as is usually observed in the transformational adaptation process.

Our study contributes to the growing literature on transformational adaptation, broadly understood as proactive changes that aim to improve system structures so as to increase the adaptation capacity of actors through fundamental system change (Lonsdale, Pringle, and Turner 2015; Rickards and Howden 2012; Park et al. 2012; Gillard et al. 2016; IPCC 2014). The concept is rooted in resilience theory originated by Holling (1973), who emphasized the important role of improving system capacity as a way to absorb and accommodate unpredictable future events. Promoting flexibility rather than maintaining stability is the key concept in this adaptation approach. Introducing policy reform in agriculture to allow agents to optimally adapt to climate change under more efficient market structures conforms with this approach. Given that there will be winners and losers coming out of the process, we also explore alternative strategies to compensate the loser as the system goes through fundamental and drastic change.

We believe this study advances the literature by presenting the first country-level analysis demonstrating how transformational adaptation can be achieved through the interplay of policy and market functions as policy reforms create an enabling environment that improves actors' capacity to adapt to

1 *Vulnerable groups* in this study refers to the poorest 40 percent of households.

climate change.[2] We also introduce the alternative policy options on top of policy reform to lay out potential policy choices to help the adversely affected agents cope with the reform. We believe the alternative policy choices could act as transitional stages in the transformational adaptation process and also reduce resistance from the affected agents considering their potential welfare loss under the reform.

To demonstrate this idea, we employ a country-level economywide model to explore options for policy reforms in the rice sector that could increase actors' capacity to adapt to climate change. We evaluate the policy reform by eliminating the rice quota restriction that has created a price gap between domestic and imported rice for decades. We refer to the implicit import tariff based on past years' data to measure the price gap between the import and domestic rice price that has been artificially created by imposing quota restrictions. We measure the implicit import tariff by comparing the domestic wholesale price with the comparable landed price of imported rice at the domestic port. Table 1.1 shows that implicit tariffs were as high as 120 percent in recent years. However, for this study we refer to the average value in the past several years, which is about 90 percent. We also impose a 35 percent import tariff on rice following the new rice tariffication law introduced by the government (de Vera 2019). Even though it still creates protection for the domestic rice market, the level is significantly lower compared to the rice quota system as shown by the implicit import tariff rate.

Given that some actors are adversely affected by the reform, as commonly found in the transformational adaptation process, we explore two alternative policy scenarios that are designed to explore ways to reduce potential losses by some economic agents who mainly engage in the rice sector. We also look at the impact of the reform on vulnerable groups that are prone to climate shocks and introduce policy intervention to help them cope under the new system. We specifically introduce cash transfer to the vulnerable groups and provide a price subsidy to rice farmers. The cash transfer is expected to preclude any significant welfare shock under the policy reform faced by low-income groups that are mainly engaged in the agriculture sector. On the other hand, the subsidy support to rice farmers is meant to help cushion the rice sector when imported rice floods into the country, forcing domestic rice production to go down.

All policy scenarios above are measured against the reference scenario (see Method), which is designed to capture the total climate change effects. This comparison approach captures the net policy impact in order to understand how each policy choice helps improve the economic system in mitigating the climate change effects.

2 We found a similar study conducted by Baldos and Hertel (2015), cited in Campbell et al. (2016), but their analyses mainly focused on the global economy and did not address potential adaptation impacts on vulnerable households that are prone to climate shocks.

2. METHOD

2.1. The Experimental Scenarios

Before we examine the rice policy reform scenario, we need to look at the impact of climate change on the agricultural production system and its spillover effects to the economy. In this study, we capture climate change impacts through changes in both crop yields and world prices. As stated earlier, the yield change across crops is estimated in the Decision Support System for Agrotechnology Transfer (DSSAT) model, while change in world prices is derived from International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) simulation results. This climate change scenario will be our baseline to examine how different approaches to implementing rice reform could act as policy choices in achieving a transformational adaptation strategy.

In the computable general equilibrium (CGE) model, the productivity (efficiency) parameter in the production function that determines output is set to be exogenous. This is the parameter we change following the yield result from DSSAT in order to estimate climate damage to total production across crops. The second parameter that we change in the CGE model is world prices. This parameter is also exogenous in the model. We then use IMPACT results to gauge the changes in global agricultural prices, resulting from climate-related changes in global trade and production, and use this parameter to change the world price parameter on agricultural commodities in the CGE model. Both shocks can be seen as the total shocks of climate change on the Philippine agriculture sector that would hit the economy in 2025.[3] Finally, we did sensitivity analysis around the trade and production elasticities to show the robustness of our results (Appendix A).

To design the rice policy reform scenario, we follow the new rice tariffication law that was recently adopted by the government of the Philippines by replacing the import rice quota with the import tariff rate (de Vera 2019). In order to capture the new policy setting, we first set lower the world imported rice quota to eliminate the implicit tariff rate, which is around 90 percent, and then introduce the import tariff rate by 35 percent following the special tariff rate for Association of Southeast Asian Nations countries, where most imported rice in the country originated. This scenario design is assessed against the climate scenario discussed earlier, and it becomes our first policy scenario (policy 1).

Under the rice reform scenario, the country is expected to increase the amount of imported rice that will replace some domestic rice supply. As a result, domestic rice production has to go down, and it will force some farmers and millers out of business. Some workers in the agriculture and rice sectors will also lose their jobs. Consequently, their incomes will go down, and this will lower their consumption levels,

[3] More information about the modeling framework is provided in the next section.

worsening their total welfare. At the same time, the government will collect some tariff revenue as more imported rice floods into the country. We look at this revenue as a potential resource to compensate the adversely affected agents to better transition into the new system.

We design two additional policies to explore how the government can help the adversely affected agents to cope with the new system under rice reform. This policy can be seen as a second-best solution to help the affected agents transitioning to the new system even with the cost of efficiency gain. The second policy simulation (policy 2) introduces cash transfers to improve the income of the poorest 40 percent of households. Under this scenario, the government still imposes the rice reform scenario as described under policy 1, but it reallocates the revenue from import tariffs to finance the cash transfer program instead of keeping it as government savings (Table 2.1). The motivation of this policy choice is to help the low-income group maintain its welfare in case the reform negatively affects their income source. The third policy simulation (policy 3) focuses mainly on the rice farmers who are directly affected by the reform. We introduce subsidy support to rice producers by also reallocating the revenue from rice import tariffs to increase the farmgate price of rice. Again, this intervention is introduced by keeping the rice reform scenario under policy 1 intact. It is also expected that by providing subsidy support to farmers, they will be more willing to fully embrace the reform and help the transition process into the new market system.

2.2. Model Linkages

We employ a CGE model to help us assess the interaction between policy choices and economywide market systems. The model developed for this study follows the standard International Food Policy Research Institute (IFPRI) CGE model (Lofgren, Harris, and Robinson 2002). The model comprehensively covers product and factor market specifications based on microeconomic theory and provides information about sectoral interlinkages as well as income transfers across economic agents. The CGE model is widely used to examine the effects of economic shocks or policy responses by considering their direct and indirect effects on the economy.

Given that the focus of our study is to assess impact of climate change on the agriculture sector, we developed the model by disaggregating the agriculture sector into more detailed sectors in order to capture impact variation of climate change across crops. We also disaggregate the food industry to capture the spillover effect across value chains and to understand how both exported and imported commodities are affected by climate change. In total, the model includes 14 agricultural subsectors, 2 mining subsectors, 14 food-industry subsectors, 7 other manufacturing subsectors, and 3 service subsectors (Table 2.2). Overall, the Philippine economy is portrayed in the model using the 2015 Social Accounting Matrix (SAM) dataset that was built based on the most recent Input-Output table (PSA 2014). We used the entropy method in constructing the SAM database following Robinson, Cattaneo, and El Said (2001).

In order to capture potential variation of climate change across regions, all production activities in the agriculture sector, with the exception of forestry and fisheries, are disaggregated by the three major regions of the country (Luzon, Visayas, and Mindanao). We also set input factors to be mobile across sectors to properly capture the long-run effect of climate change on the economy. To help us trace down the income distribution effect, we disaggregate labor into four categories based on levels of education to represent unskilled labor at one extreme and highly skilled labor at the other. Then, the model also disaggregated households based on income levels and location. In total, 30 specific household types are included in the model to help us better understand how climate change and policy choices would affect income distribution at both national and subnational levels.

The CGE model is a market economy model that has no information at all about climate effects. It needs other models to estimate the potential impact of climate shocks on the Philippine agriculture sector. To do this, we linked the CGE model with a biophysical crop model to capture the productivity effect of climate change on agricultural crops at a micro level (Figure 2.1). We use two biophysical crop models of the DSSAT model and Water, Nutrient and Light Capture in Agroforestry Systems (WaNuLCAS) model to estimate changes in crop productivity due to climate change effects.

These two biophysical models receive climate information from the results of selected General Circulation Models (GCMs) developed for the Fifth Assessment Report published by IPCC to determine the climate shocks that affect crop productivity (Figure 2.1). The climate parameters that drive the climate change effect used in DSSAT are provided in Table 2.3. The DSSAT model (Jones et al. 2003) is solved at the pixel level based on parameters derived from each GCM. Similarly, for perennial crops, we employ the WaNuLCAS model (Van Noordwijk, Lusiana, and Khasanah 2004) to simulate the impact of climate change on certain crop productivity that is missing in the DSSAT model. In total, we have four yield data shocks for each crop, and we took the median value to generate a single yield shock for the CGE model. We then linearized this number to get the average annual change value before we calculated the total yield shock for the 10-year period from 2015 to 2025, as we introduced in the model. The yield shock value on each crop is shown in Table 2.4.

Given that climate change is a global phenomenon, we also link the CGE model with an international agricultural trade model in order to capture the effects of climate change on the global agricultural and food prices that will then dictate the amount of export and import by the Philippines. To do this, we link the CGE model with the IMPACT model, which is a global partial equilibrium model of the agriculture sector developed and maintained by IFPRI (Figure 2.2). The core IMPACT model is actually linked with several modules of climate, hydrology, and crop models with macroeconomic inputs, water demand trends, and agricultural productivity growths. IMPACT integrates information flows among these component modules in a consistent equilibrium and market-clearing framework that supports longer-term scenario analysis (Robinson et al. 2015). In this study, the global IMPACT model also generates estimates of world prices under four different climate models (GFDL-ESM2M, HadGEM2-ES, IPSL-CM5A-LR, MIROC-ESM-CHEM) based on the RCP 8.5 assumption[4]. The median value on global price changes from the four simulation results in the IMPACT model is fed into the CGE model as an exogenous world price (Table 2.5).

Based on these two parameters (Table 2.4 and Table 2.5), we impose the two shocks together in a single scenario to demonstrate the total effect of climate change. Yield and world price parameters from the crop models and IMPACT, respectively, are transmitted to the CGE model through simulation processes as local productivity and global agricultural price shocks (Figure 2.1). Given that we employ a static CGE model in this analysis, we translated the annual average change for these two parameters into a 10-year accumulated shock period ending in 2025 as explained above. Therefore, what we report in the model result is the economic changes at end year period (2025). Even though we neglect the dynamic process to reach the equilibrium in 2025, the qualitative results will still hold. Furthermore, the focus of the study is on the policy choices, while the climate change scenario is used only as the baseline scenario, as elaborated in the previous section.

The model adopts a small open economy assumption, where import and export prices are assumed to be exogenous, meaning that global price changes can be directly transmitted to the Philippines by altering these two parameters. Changes in world market prices affect both the domestic market and the country's total trade balance. The model does, however, allow for imperfect price transmission between world and domestic prices, which provides flexibility for the domestic market to adjust. Eventually, the spillover effects are captured in the market as all economic agents adapt to the changes by making new decisions according to their best interests.

All the scenarios specified in this study are applied using the same macro closures, whereby the wage rate is allowed to adjust to meet the full employment assumption for all input factors. Factors are also assumed to be mobile across sectors, given the long-term focus of the analysis. A "balanced" macro closure is specified, which assumes that the macro demand aggregates (consumption, investment, and government) are fixed shares of total absorption. Savings rates (including government savings rates) are assumed to

[4] GFDL-ESM2M. Produced by the National Oceanographic and Atmosphere Administration General Fluid Dynamics Laboratory (Dunne et al., 2012; Dunne et al., 2013). HadGEM2-ES. Data from the Met Office Hadley Centre (Collins et al., 2011; Martin et al., 2011). IPSL-CM5A-LR. Generated by the Institut Pierre-Simon Laplace (Dufresne et al. 2013). MIROC-ESM-CHEM. From the Japan Agency for Marine-Earth Science and Technology, Atmosphere and Ocean Research Institute (The University of Tokyo), and National Institute for Environmental Studies (Sakamoto et al., 2012)

adjust to achieve a macro balance. Foreign savings are fixed, and the real exchange rate adjusts to maintain the fixed trade balance.[5] Table 2.6 provides the summary of reference and policy scenarios under the same macro closure.

3. IMPACT OF POLICY REFORM ON IMPROVING ADAPTATION CAPACITY

The main objective of this study is to show, through economic modeling exercises, how agricultural policy reform in the rice sector can be perceived as a transformational adaptation strategy that could dampen the impact of climate change on the economy. In contrast to incremental adaptation that focuses only on certain crop, sector, or specific technology to improve the production system, we show that a transformational adaptation strategy through rice policy reforms is achieved by promoting system updates, jointly across sectors and markets, that create fundamental change in the economic system to attain more efficient (adaptive) production and market structure against climate threat. We do this by examining how the new system promotes crops diversification and economic efficiency at the macro level as well as welfare distribution across households to reflect improvement in resiliency to climate shocks.

To do this, we first set the climate change scenario as our reference (baseline) scenario. In this scenario, the simulation results show the negative impact of climate change on the economy, indicated by reduction in GDP (Figure 3.1). In a general equilibrium framework, we know that all sectors are connected through both factors and commodity markets. Even though we introduce the shocks only on the agriculture sector, the spillover effect is observed through a reduction in labor demand in industry and the service sectors by 0.9 and 0.7 percent, respectively. Consequently, the value added in these sectors has to go down, driving reduction in total GDP by 0.16 percent (Figure 3.1).

Within the agriculture sector, production of export crops is contracted, while the palay (husked rice) sector expanded under climate change due to a combination of higher world prices and lower yield effects from climate change. This production trend diminishes the diversification level, which tends to reduce the adaptive capacity of farmers (Huang et al. 2014; Food and Agriculture Organization of the United Nations 2017). Demand for labor in agriculture also increases with more labor demanded by the palay sector than by exported crops. In total, labor demand in the agriculture sector increased by 1.5 percent. This indicates that climate change could slightly slow down the industrialization process in the country and reduce the opportunity for labor to move out of the agriculture sector to earn better income.

[5] Robinson (1991) and Robinson (2006) provide a rich discussion of macro closures in CGE models.

To demonstrate how the rice policy reform can be perceived as a transformational adaptation strategy to reduce the climate change impact, we emphasize the analyses on how the reform in the rice sector creates market adjustments and spillover effect across sectors that results in economic gains to the whole economy such as improvement in production diversification as well as increase in GDP. Figure 2.2 shows the impact of all three policy choices under rice reform on agriculture production and sectoral value-added against climate change effects. First, we can see that palay production is expected to go down under all three policy options, represented by the full line at the bottom of the figure. The contraction happens because the domestic rice market is now more open to international market allowing for cheaper imported rice coming into the country. In total, imported rice is expected to increase by around 50 to 60 billion pesos under all policy choices (top dotted line). Second, as the rice production decreases, some resources (input factors) move into higher value crops such as exported crops. This resource movement is indicated by the middle line in the figure, where production of exported crops increase by around 15 billion pesos. This production shift shows that the diversification process is being promoted under policy reform, which helps improve the adaptation capacity of farmers and the agriculture sector as a whole.

When we compare the results among the three policy choices, the diversification level that is represented by an increase in exported crops and a reduction in palay production diminishes significantly under policy 3, which is mainly due to the additional intervention included by providing subsidies to rice farmers under the policy reform. Table 2.1 shows that the government allocates PHP 21 billion (Philippine pesos) to finance the rice price subsidy from import tariff revenue. This price distortion has caused some input factors like labor and capital to keep being used in producing palay, which is a low-productivity crop. As a result, a gain in GDP, represented by the dotted line, increases by only PHP 13 billion under policy 3, while the other two policies give higher values.

The bar diagram, on the other hand, shows changes in sectoral GDP. The simulation results show that reduction in agriculture and industry value-added are driven mainly by lower production of palay and milled rice directly caused by the reform. At the same time, we observe increase in services value-added across policy scenarios, which is mainly due to the inflow of input factors that are released from the agriculture sector. However, when we compare all three policy scenarios, the value-added gain in services under policy 3 is much less than the other policy scenarios because, as explained earlier, mainly some input factors, especially labor, are being held up in the agriculture sector to produce more rice incentivized by the price subsidy. This policy choice might fit into the condition when the government decides to pursue rice policy reform but still wants to give a little bit more protection to the rice farmer from abrupt change in rice production from import competition.

Another important characteristic of transformational adaptation is that it entails fundamental change in the system structure, which in this case is the improved adaptive capacity of agents to cope with climate change. We demonstrate this characteristic by looking at the movement of labor across sectors under policy reform (Figure 3.2). The three policy choices show that the demand for low-skilled laborers, who are mainly employed in the agriculture sector, goes down due to a reduction in rice production. In the long run, these laborers will adapt and end up working in industry and services that offer better wages and higher productivity, shown by the positive change in industry and service sectors. This is the reason we observed a positive impact on GDP earlier, given that some laborers earn higher income by moving from a low to a higher productivity sector.

However, when we looked at the distribution impact across households, reflected by real consumption change, we found negative impacts on low-income groups (Figure 3.3). The main reason is because this household group earns a significant amount of its labor earnings from agricultural production that experiences negative shocks under the policy reform. Even though the domestic price of rice goes down thanks to imports, their income from agricultural wages decreases. This is also a common consequence observed in the transformational adaptation process, where drastic change in the system is likely to be painful and has a negative impact on certain sectors or agents (Lonsdale, Pringler, and Turner 2015). Policy 2 shows how the government could help this vulnerable group by extending cash transfer, which is financed from the revenue the government collected from the rice import tariff. Table 2.1 shows the budget reallocation, where an increase in household transfer is equal to the amount collected from the import tariff, which is about PHP 23 billion. As a result, real consumption of the low-income group increases by 0.8 percent under policy 2 (Figure 3.3).

Policy 1 includes only the rice policy reform scenario, without any additional policy intervention by the government, in contrast to policies 2 and 3. This scenario can be seen as the optimal condition, reflected by the highest economywide GDP gain. The main reason is because the economy can optimally allocate resources across sectors without any intervention, such as pulling out government budget to support a cash transfer program or offering a price subsidy as adopted in policies 2 and 3. However, this approach is less likely to work in the real world given the affected agents (that is, low-income groups and rice farmers) who suffer from the reform are being ignored and left behind. In the transformational adaptation lenses, the system should respond to the changes, and there is a strong need to consider the causes of vulnerability within society that have been part of the fundamental aspects of the system (Pelling 2011; Rickards and Howden 2012).

In the case of policy reform, there is high resistance from rice farmers to adopting the policy given that they know they cannot compete with cheap import rice. Similarly, milling companies will have to deal with the issue of getting less palay (husked rice) than before. Ignoring this fact will eventually lead to the failure of the whole system. However, we can perceive the policy 1 scenario as the end point of what policies 2 and 3 represented as transitional stages in the transformational adaptation process. It is the stage when the additional interventions provided by the government (that is, cash transfer and rice subsidies) have been slowly phased out, especially when the affected agents have coped with the new system. As Olsson et al. (2006) pointed out, there is a need for a more adaptive governance strategy to deal with uncertainty and vulnerability during the period of abrupt change or turbulence. We believe the transitional policy option under policies 2 and 3 could move the socioeconomic system to the desirable trajectory that eventually will reach the optimal point as described in policy 1 after the government interventions are slowly phased out.

4. CONCLUSION

Climate change is expected to reduce crop yield and increase global commodity prices. These combined effects push down agricultural production and negatively affect the rest of the Philippine economy through commodity and factor market linkages. The direct impact of climate change on the agriculture sector brings inefficiency to the production system that requires more input factors than before to produce the same amount of output. Consequently, more input resources like labor are being held back in the agriculture sector, which reduces the opportunity for workers to move out of agriculture into industry or services that offer better wages. As a result, we observed negative changes in value-added across sectors that lead to reduction in total GDP.

This study offers a new perspective in exploring how agricultural policy reform in the rice sector through the abolishment of the rice import quota that was recently adopted by the Philippine government can be perceived as a transformational adaptation strategy to reduce the climate change effect. We specifically examine how the reform affects production and market system structures to adjust by pushing resources to move from low- to high-productivity sectors under climate change. This drastic and massive economic adjustment takes place at the national level and involves all economic agents to respond and adapt. First, we have shown that the increase of adaptive capacity to climate change in the agriculture sector is reflected by improvement in the diversification process as some agricultural production shifts from palay to exported crops. Second, improvement in the economywide system structure is shown by the movement of labor across sectors, where more labor is now able to move out from agriculture to industry and services that offers higher productivity. As a result, we observe that a lower domestic price of rice coupled with higher income earnings leads to real consumption increases, which proves that the policy enhances welfare and reduces the climate change effect to the economy.

The transformational adaptation process also results in drastic changes in the system that are likely to be painful and sometimes negatively affect certain sectors or agents. In the policy reform scenario, the flood of imported rice replaces some domestic production that pushes down farmers' earnings. The low-income group, whose members earn a significant amount of their labor income from agricultural production, is adversely affected. We explore two other policy options under the rice reform by extending cash transfers and price subsidies to rice farmers. Even though both offer lower efficiency gains compared to the policy 1 scenario, when the government is passive and ignores the affected agents, we look at the two alternative policies as transitional stages in the transformational adaptation process. This alternative approach can be seen as part of an adaptive governance strategy to deal with uncertainty and vulnerability under rice reform. Eventually, the transition process is expected to move the socioeconomic system to the desirable trajectory that brings the society to reach a higher efficiency point, as offered in policy 1 after the government interventions are slowly phased out.

TABLES AND FIGURES

Table 1.1 Implicit tariff on rice, Philippines, 2001–2017

Year	Import volume (000 Metric Tons)	Import price (CIF)	Domestic price (wholesale) in PHP/kg	Implicit tariff (%)
2001	811	9.6	18.5	92.2
2002	1,200	10.2	19.4	90.3
2003	837	10.7	19.5	81.3
2004	1,002	14.7	19.6	33.9
2005	1,820	16.6	20.5	23.8
2006	1,707	15.3	21.3	39.0
2007	1,798	16.7	22.4	34.3
2008	2,433	35.7	30.4	–14.7
2009	1,760	28.0	30.3	8.2
2010	2,372	31.2	30.8	–1.3
2011	694	22.9	30.3	32.4
2012	1,003	17.1	30.6	79.3
2013	402	17.3	32.8	89.7
2014	1,070	17.7	39.1	121.1
2015	1,077	17.4	38.4	120.7
2016	438	18.6	35.9	93.3
2017	863	18.8	37.6	99.6

Source: Basic data: Philippine Statistics Authority OpenStat (2019) for farmgate, wholesale, retail prices. Trade Map online (2019) for CIF prices of Philippine rice imports.
Note: Prices are in current Philippine pesos per kilogram (PHP/kg). Implicit tariffs are percentages of wholesale prices to CIF import prices. CIF = comparable landed.

Table 2.2 Commodities included in the model

Number	Commodity
1	Palay
2	Corn
3	Coconuts, including copra
4	Sugarcane
5	Bananas
6	Fruit
7	Coffee
8	Cassava
9	Other crops
10	Livestock
11	Poultry
12	Agricultural activities and services
13	Forestry
14	Fishing
15	Mining
16	Crude oil, natural gas, and condensate
17	Slaughtering, meat processing, and dairy products
18	Dairy products
19	Fruit and vegetable canning
20	Fish canning and processing
21	Coconut/vegetable oil
22	Rice and corn milling
23	Flour, grain milling, and starch products
24	Bakery and noodle manufacturing
25	Sugar milling and refining
26	Manufacturing of cocoa and coffee processing
27	Manufacturing of animal feed
28	Other food products
29	Beverage industries
30	Tobacco manufacturing
31	Final goods manufacturing
32	Intermediate goods manufacturing
33	Petroleum and other fuel products
34	Chemicals and chemical products
35	Heavy industrial manufacturing
36	Construction
37	Utilities
38	Trade and transportation services
39	Private services
40	Government services

Source: Constructed by the authors

Table 2.3 Change in annual rainfall and temperature from four General Circulation Models, 2000–2050

Region	Projected change in rainfall (millimeter)				Temperature (ºC)			
	GFDL	HadGEM	IPSL	MIROC	GFDL	HadGEM	IPSL	MIROC
Luzon	167	252	235	250	1.96	2.58	1.86	1.43
Visayas	309	531	297	261	1.77	2.31	1.95	2.16
Mindanao	329	240	200	290	1.46	2.30	2.10	1.75

Source: Calculated by the authors from WorldClim version 1.4 (Hijmans et al. 2005).

Note:

GFDL = Geophysical Fluid Dynamics Laboratory
HadGEM = Hadly Centre Global Environmental Model
IPSL = Institut Pierre Simon Laplace
MIROC = Model for Interdisciplinary Research on Climate

Table 2.4 Productivity shock introduced in the model, 2015–2025

Commodity	Region	Crop yield shock Yearly change from baseline levels (%)
Palay (irrigated)	Luzon	–0.03
	Visayas	–0.17
	Mindanao	–0.01
Palay (rainfed)	Luzon	–1.50
	Visayas	–0.41
	Mindanao	0.44
Corn	Luzon	–4.91
	Visayas	–5.83
	Mindanao	–4.53
Coconuts	Luzon	0.31
	Visayas	0.13
	Mindanao	0.49
Sugar	Luzon	–1.26
	Visayas	–1.17
	Mindanao	–0.17
Bananas	Luzon	–1.99
	Visayas	–0.99
	Mindanao	–0.99
Fruit	Luzon	–1.99
	Visayas	–0.99
	Mindanao	–0.99
Coffee	Luzon	–1.99
	Visayas	–0.99
	Mindanao	–0.99
Cassava	Luzon	–11.25
	Visayas	–10.90
	Mindanao	–5.91
Other crops	Luzon	–1.98
	Visayas	–1.31
	Mindanao	–0.87

Source: Constructed by the authors from Decision Support System for Agrotechnology Transfer (DSSAT) and Water, Nutrient and Light Capture in Agroforestry Systems (WaNuLCAS) simulation results.

Note: The parameters from DSSAT are derived from the median value of four General Circulation Model scenarios' results (GFDL-ESM2M, HadGEM2-ES, IPSL-CM5A-LR, MIROC-ESM-CHEM), based on the Fifth Assessment Report following the RCP 8.5 assumption. Exceptions are bananas and coconuts, which are derived from the WaNuLCAS model.

Table 2.5 World price shock introduced in the model, 2015–2025

Commodity	World price shock: Yearly change from baseline levels (%)
Palay	6.64
Corn	10.73
Coconuts	1.17
Sugar	1.82
Bananas	4.71
Fruit	4.35
Coffee	4.14
Cassava	1.84
Other crops	2.39
Livestock	1.41
Poultry	2.04
Meat, processed	1.41
Dairy	1.41
Fruit, canned	4.35
Coconut oil	0.00
Rice, milled	1.17
Sugar, processed	1.82
Coffee, processed	4.14

Source: Constructed by the authors from International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) model simulation results.

Note: The world price parameters from IMPACT are derived from the median value of four General Circulation Model scenarios' results (GFDL-ESM2M, HadGEM2-ES, IPSL-CM5A-LR, MIROC-ESM-CHEM) following the RCP 8.5 assumption.

Table 2.1 Government accounts under policy reforms, 2025

Government accounts	In billions of Philippine pesos			
	Reference scenario	Policy 1	Policy 2	Policy 3
Government revenue	1,219	1,250	1,250	1,228
Import tariff	0	23	23	21
Government expenditure	1,467	1,473	1,496	1,472
Rice farmer subsidy	0	0	0	21
Transfer to households	0	0	23	0
Government savings	–248	–223	–246	–244

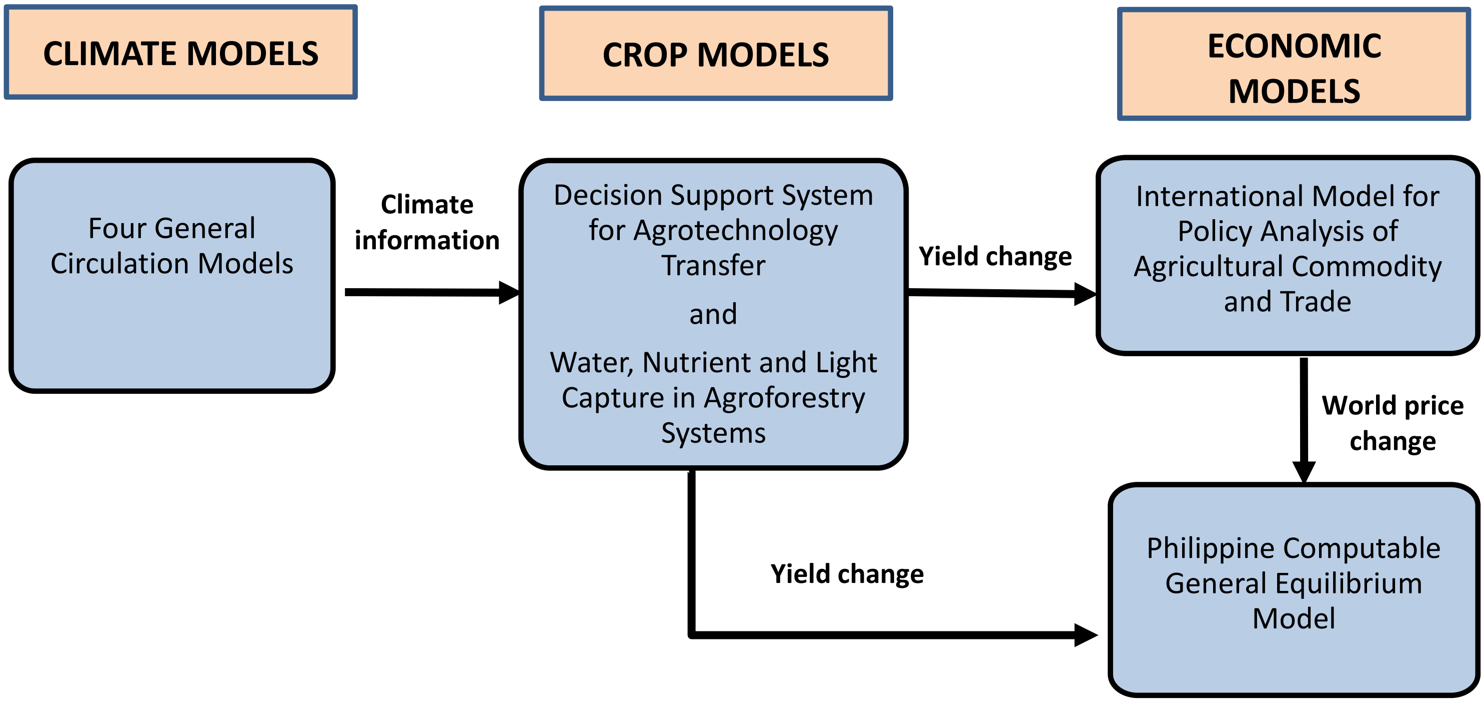
Source: Constructed by the authors from computable general equilibrium model simulation results.

Table 2.6 List of simulation scenarios

Number	Scenario	Description
Reference scenario		
	Combined climate effect and rice import quota	Rice import quota policy and climate shocks are imposed as combination of the crop yield and world price changes from climate change
Policy option/reform		All policy simulations include the total climate effect without rice import quota policy and impose 35 percent tariff on all imported rice (rice reform policy)
1.	No policy intervention	Government keeps the rice import tariff revenue, and government savings increase
2.	Income transfers	All rice import tariff revenue is allocated to finance income transfer to the bottom 40 percent (that is, the lowest two quintiles) of the household groups
3.	Farmer price support	All rice import tariff revenue is allocated to finance rice subsidy at the farmgate price

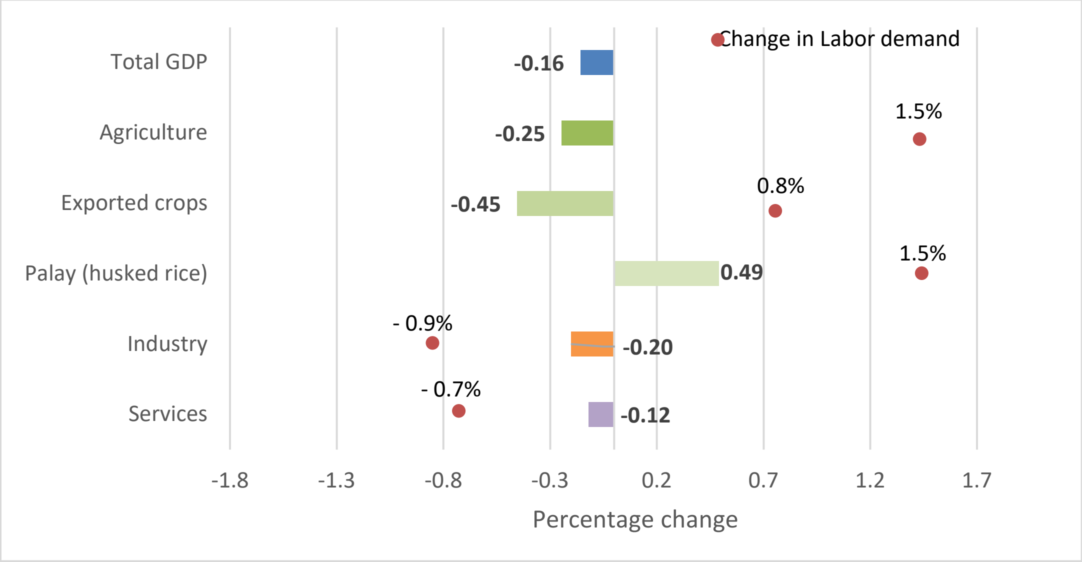
Source: Constructed by authors

Figure 2.1 Model linking for the assessment of agricultural climate change impacts on the Philippine economy



Source: Adopted from Rosegrant et al. (2016).

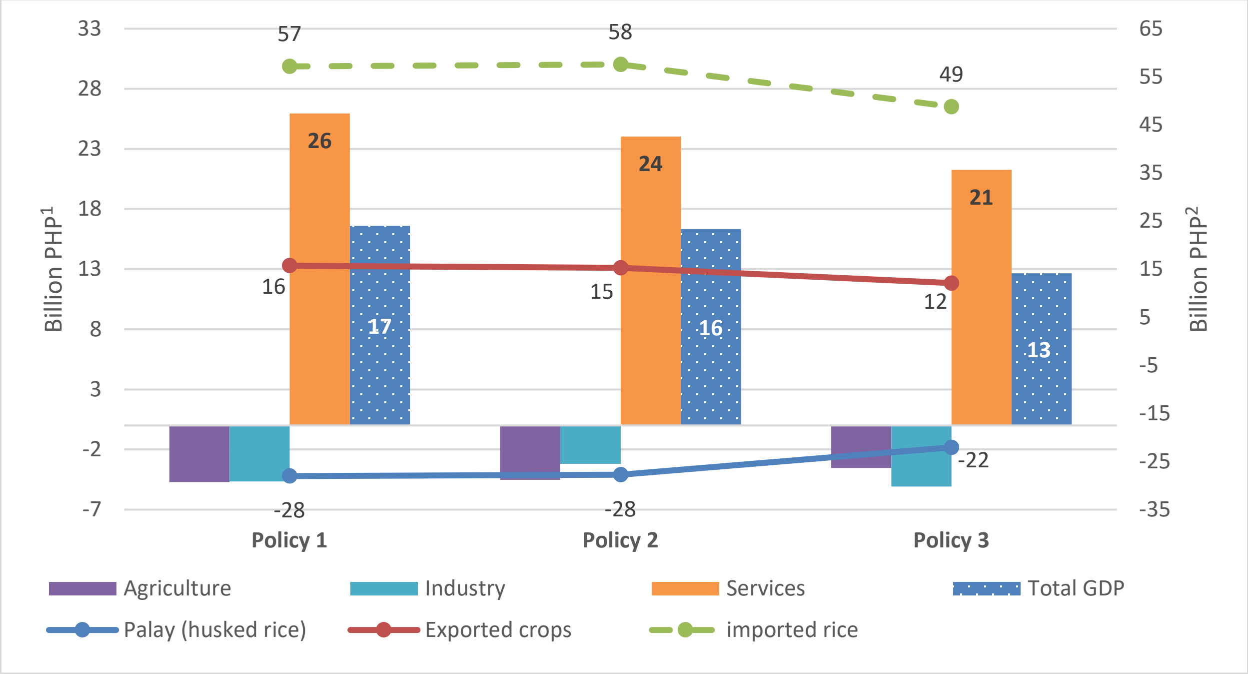
Figure 3.1 Impact of climate change on sectoral GDP and labor demand, 2025



Source: Constructed by the authors from computable general equilibrium model simulation results.

Note: GDP = gross domestic product.

Figure 2.2 Impact of policy response on imported rice, agricultural production, and sectoral GDP, 2025

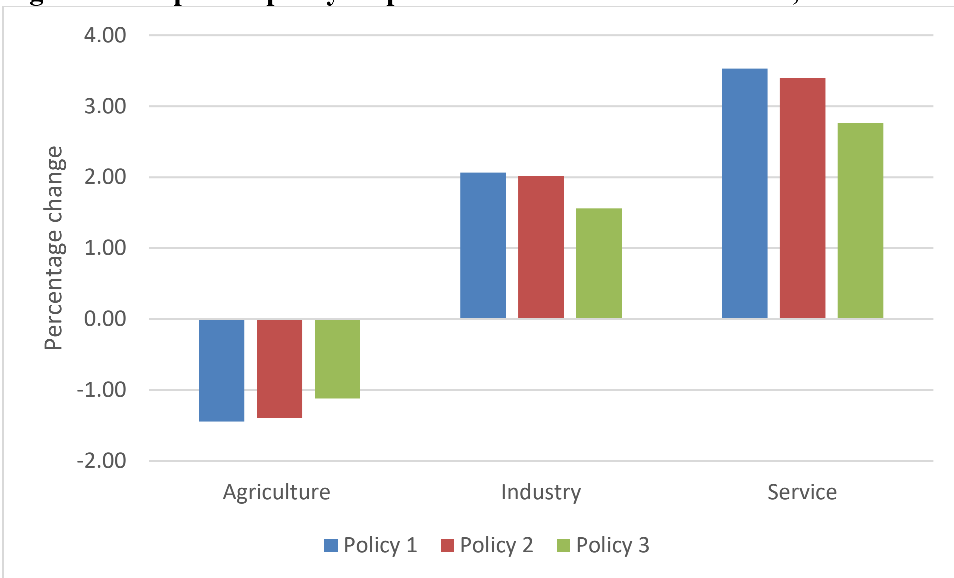


Source: Constructed by the authors from computable general equilibrium model simulation results.
Note: GDP = gross domestic product; PHP = Philippine pesos.

[1]Axis for histogram.

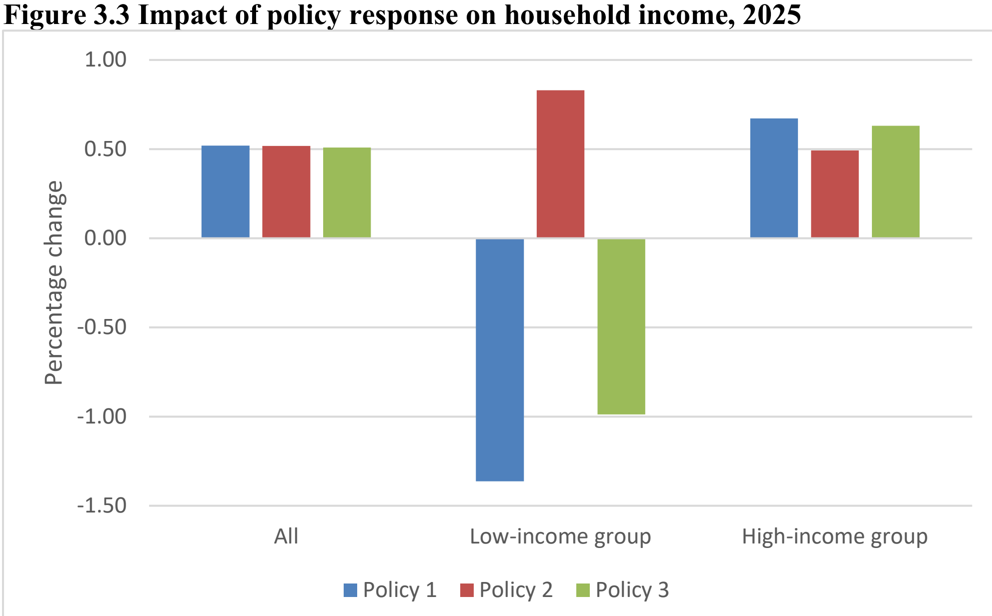
[2]Axis for lines.

Figure 3.2 Impact of policy response on low-skill labor demand, 2025



Source: Constructed by the authors from computable general equilibrium model simulation results.

Figure 3.3 Impact of policy response on household income, 2025



Source: Constructed by the authors from computable general equilibrium model simulation results.

Appendix A

Sensitivity results on trade (σ) and production (α) elasticity parameters

	Change in trade elasticity parameters			Change in production substitution elasticity parameters		
Variable	**1.2*σ**	**σ**	**0.8*σ**	**1.2*α**	**α**	**0.8*α**
Gross domestic product	–.16	–.16	–.16	–.17	–.16	–.15
Agriculture	–.24	–.25	–.26	–.18	–.25	–.32
Industry	–.21	–.20	–.19	–.22	–.20	–.18
Services	–.12	–.12	–.12	–.14	–.12	–.10

Source: Constructed by the authors from computable general equilibrium model simulation results.

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