Contribution of Agricultural Investments to Stabilizing International Rice Price Volatility under Climate Change

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1. Introduction

International grain prices rose from 2006 to 2008, with possible factors including the increase in global demand for biofuel feedstock, adverse weather conditions in some major grain-producing areas, and speculative funds. Particularly, the rice price increased to 1,015 USD/ton in April 2008, given the export restriction imposed by the governments of Thailand and Vietnam; the rice price has been decreasing since then. However, the international society has increased its interest for price volatility of agricultural commodities. The coefficient of variation (CV) of the international rice price[i] was 0.1786 from 1985 to 1995, 0.2291 from 1996 to 2005, and 0.2782 from 2006 to 2015. Higher CV of price means instability of price, and lower CV indicates stability of price.

The summary for policy makers and the related report of the Working Group's (WGII) contribution to the Fifth Assessment Report of the Intergovernmental Panel Climate Change (IPCC) was approved by the 10th Session of WGII in March 2014. The summary report spanned various sectors in low-lying coastal zones, small developing island states, and other small islands. It pointed out—with high confidence—the key risks, such as the risk of death, injury, ill health, or disrupted livelihoods, in those regions as a result of strong surges, coastal flooding, and sea-level rise (IPCC 2014). In addition, the report pointed out the risk of food insecurity and breakdown of food systems linked to global warming, drought, flooding, and precipitation variability and extremes, particularly for poorer populations in urban and rural settings (IPCC 2014). The present study is the first to evaluate how future climate change will affect world rice price volatility, with a primary aim of conducting policy simulations for alleviating climate risks to rice-production systems and rice markets by utilizing a partial equilibrium model.

2. Structure of the model and data for projections

The Rice Economy Climate Change (RECC) model covers the rice markets in 15 countries and regions (Thailand, Vietnam, Indonesia, Malaysia, the Philippines, Cambodia, Lao PDR, Myanmar, China, Japan, South Korea, India, USA, EU28, and the rest of the world). The base year is 2012/14 (three-year average for the 2012-2014 period). Each country or region's market consists of production, consumption, exports, imports, and ending stock up to the year 2035. The RECC model includes equations for projecting the rice yield and harvested area affected by climate change (Figure 1). The rice yield equation depends on the annual averages of minimum temperature, maximum temperature, precipitation, and lagging investments in land development and agricultural machinery & equipment, among others. The planted and harvested area equation for rice depends on the producer prices of rice and wheat, precipitation, lagging investments in land development, and other factors.

The baseline projection adopts a set of assumptions for the general economy, agricultural policies, and technological changes without any policy shocks during the outlook period. This study hypothesizes that the growth rates of investments in land development range from -0.1% to 1.9% and those of machinery & equipment range from -0.1% to 0.9% in 15 countries and regions. The climate variables (minimum/maximum temperatures, precipitation) in each country and region are exogenous to the model. All climate variables for the baseline outlook and policy scenario are procured from climate change projections by Model for Interdisciplinary Research on Climate (MIROC)[ii], a global climate model under the RCP 4.5 scenario[iii].

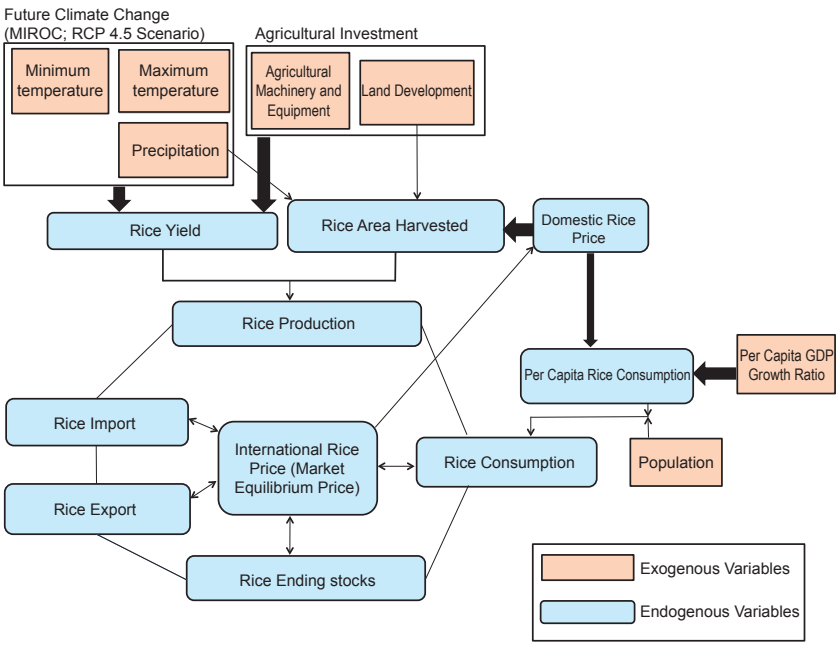

Figure 1. RECC model

3. Projection results and impacts of agricultural investments on the world rice market

Under the baseline assumptions, world rice production and consumption are expected to increase at a rate of 1.3% per annum from 2012/14 to 2035. During the same period, world rice exports are expected to increase at a rate of 3.1% per annum and

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rice imports are expected to increase at a rate of 3.4%. The international rice price (5% broken milled white rice, Thailand's nominal price quota) was 518.9 USD/ton in 2012/14 but is expected to be 1,168.6 USD/ton in 2035. The CV of international rice price from 2012/14 to 2035 is 0.2062.

This study applied alternative scenarios to the baseline projection and produced outlooks under three policy scenarios as listed in Table 1. In scenario 1, we hypothesize that the growth rate of investments in land development and in agricultural machinery & equipment in the eight ASEAN countries will increase by 2.0% and 1.0% per annum, respectively, from 2012/14 to 2035. In scenario 2, we hypothesize that the growth rate of investments in land development and in agricultural machinery & equipment in Thailand will increase by 2.0% and 1.0% per annum, respectively, from 2012/14 to 2035. In scenario 3, we hypothesize that the growth rate of investments in land development and in agricultural machinery & equipment in Vietnam will increase by 2.0% and 1.0% per annum, respectively, from 2012/14 to 2035. In scenario 4, we hypothesize that the growth rate of investments in land development and in agricultural machinery & equipment in the eight ASEAN countries will both be 0 from 2012/14 to 2035.

The projections were made using various agricultural investment scenarios in selected countries for a comparison against the baseline outlook. These agricultural investments can be considered climate change adaptation measures. Projections in all four scenarios are compared against the baseline projection in 2035. Under scenario 1, the international rice price is expected to decrease by 25.9%. Using scenario 2, rice production and export in Thailand are expected to increase and the international rice price is expected to decrease by 13.2%. The results of scenario 3 show that rice production in Vietnam is expected to increase and the international rice price is expected to decrease by 5.1%. Under scenario 4, the rice production and export are expected to decrease and the international rice price is expected to increase by 20.2%. The CV of the international rice price from 2012/14 to 2035 is 0.2062 in the baseline outlook. As a result of policy scenarios, the CV is calculated to be 0.1527 during the simulation period (under scenario 1), 0.1790 (under scenario 2), 0.1955 (under scenario 3), and 0.2519 (under scenario 4), as shown in Table 1.

Table1. Policy scenario and simulation results

	Countries	Growth rate of agricultural investment during the projection period (2010-2030)		CV of International Rice rice (2012/14-2035)
		land development	machinery & equipment	
Baseline	15 Countries and regions	Same as 2000-2007 average rate from -0.1% to 1.9%	Same as 2000-2007 average rate from -0.1% to 0.9%	0.2062
Scenario 1	ASEAN 8 countries	2.0% annum	1.0 % annum	0.1527
Scenario 2	Thailand	2.0% annum	1.0 % annum	0.1790
Scenario 3	Vietnam	2.0% annum	1.0 % annum	0.1955
Scenario 4	ASEAN 8 countries	0.0% annum (no growth)	0.0% annum (no growth)	0.2519

4. Conclusion

This study utilized a partial equilibrium model to conduct policy simulations for alleviating climate risks to rice production systems and rice markets. We examined how future agricultural investments will impact the world rice market, especially the volatility of international rice prices, by factoring in future climate change. The simulation results suggest that a constant increase in agricultural investment in eight ASEAN countries will contribute to the reduction of international rice price volatility, taking into account climate change. The same investment increase in Thailand and Vietnam will also contribute to reducing international rice price volatility. This study concludes that a constant increase of agricultural investments in the eight ASEAN countries, especially Thailand and Vietnam, has a crucial role in stabilizing international rice prices as rice production becomes increasingly affected by climate change.

References

IPCC (2014) *Climate Change 2014 Impacts, Adaptation, and Vulnerability, Summary for Policymakers*, Working Group Ⅱ contribution to the fifth assessment report on the intergovernmental panel on climate change.

[i] CV represents the ratio of the standard deviation to the mean, and the data was derived from 5% broken milled white rice, Thailand's nominal price quota.

[ii] MIROC, a coupled atmosphere-ocean general circulation model, was developed in collaboration with the Center for Climate System Research (CCSR), University of Tokyo; National Institute for Environmental Studies (NIES); and the Frontier Research Center for Global Change (FRCGC).

[iii] Stabilization without overshoot pathway to 6 W/m^2 at stabilization after 2100.

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