Rising temperature and farm-gate price of rice

-Direct-to-consumer selling as an adaptation strategy-

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1. Introduction

Many econometric studies have investigated the impacts of changing climate on agricultural crop yield (e.g., Deschênes et al., 2007). In the case of rice, a major crop in Japan, rising temperatures caused by climate change can negatively affect not only yield but also quality. Quality-degraded rice is typically given lower grades, resulting in a decrease in its farm-gate price. Previous studies have evaluated the weather impacts on rice grades and then estimated the weather impacts on farm-gate price or revenue, warning that heat damage will seriously affect rice production without adaptation (e.g., Kawasaki et al., 2016). While many farmers sell their rice only to agricultural cooperatives and are directly affected by the grading of rice, some farmers have alternative selling options, such as direct-to-consumer selling. However, previous studies do not consider these as an adaptation strategy.

In this paper, we aim to evaluate whether, and to what extent, farmers can mitigate the negative effects of rising temperatures through direct-to-consumer selling. To achieve this, we set two research objectives: first, we evaluated the impacts of rising temperatures on the farm-gate price of rice using farm-level data; second, we estimated how direct-to-consumer selling can mitigate these negative effects on farm-gate price using the above estimated model.

2. Methodology and Data

We used farm-level data from the “Statistical Survey on Farm Management” (SSFM), collected by the Ministry of Agriculture, Forestry, and Fisheries from 2008 to 2011 (an 4-year unbalanced panel). We included data from family farmers with full-time farmers younger than 65 years old. We calculated the farm-gate price by dividing the gross revenue of rice for staple food by the amount of rice sold as staple food. Variable related to the direct-to-consumer sales are drawn from “2005 Census of Agriculture and Forestry” and then connected to SSFM using farm-level code.

To add climatic variables to the SSFM, we used rural community-level geographical information. We utilized the Agro-Meteorological Grid Square Data provided by the National Agriculture and Food Research Organization (NARO). After data processing, the total sample size is 9,260, with

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an average panel length of 4.5 years. We used temperature, precipitation, and global solar radiation data, and processed the temperature into growing degree days (GDD) and temperature bins.

We adopted a panel estimation model to evaluate (i) the relationship between the farm-gate price of rice and temperature and (ii) the mitigation effect of temperature by direct-to-consumer selling. The estimation model using GDD is expressed as follows:

$$P_{it} = \beta GDD_{it} + \beta_{direct} GDD_{it} \times Direct_i + \gamma_1 prec_{it} + \gamma_2 prec_{it}^2 + \gamma_3 GSR_{it} + \gamma_4 GSR_{it}^2 + \mu_i + \lambda_t + \epsilon_{it} \quad (1)$$

where P_{it} is the farm-gate price of rice, GDD_{it} is the growing degree days over 25 degrees Celsius after 3 weeks of the heading date, $Direct_t$ is a dummy variable indicating whether or not the farmer conducts direct-to-consumer selling, $prec_{it}$ and GSR_{it} are precipitation and global solar radiation, and μ_i and λ_t are farm and year level fixed-effect, respectively. Additionally, we conducted estimation using temperature bins instead of GDD.

3. Results

The main results of this study are as follows. First, according to the model using GDD, we find that the level of GDD negatively affects the farm-gate price of rice. Additionally, we observe the same trend in the temperature bin model, which shows that the number of days with temperatures above 30 degrees Celsius significantly affects the farm-gate price.

When considering direct-to-consumer selling as an adaptation strategy, we find that direct-to-consumer selling significantly mitigates the effects of climate change in the model using GDD. According to the coefficient of equation (1), β_{direct} is 10.83, whereas the coefficient of β is -10.59, indicating that the mitigation effect could be sufficient to offset the decrease in prices. On the other hand, the model using temperature bins did not show statistically significant mitigation effects by direct-to-consumer sales.

4. Conclusion

We show that rising temperatures significantly influence the farm-gate price of rice. This finding is important as we directly estimate the effects of rising temperatures rather than inferring them through changes in grade. Additionally, our results show the possibility that direct-to-consumer selling can work as an adaptation strategy to climate change. However, this result is not robust across all estimations and requires further investigation.

Reference

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