The Impact of Quality-Based Pricing Scheme on Local Paddy Transactions in the Northern Region of Ghana

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To meet increasing demand of urban consumers for rice, the improvement of local rice quality is urgent in Sub-Saharan Africa. In 2014 a quality-based pricing scheme for purchasing paddy was introduced by a large-scale rice milling plant in the Northern region of Ghana. Does it have any impact on the quality of local rice? Applying 2SLS to 1,054 paddy transactions data collected around the plant, this study reveals that the introduction of this grading system has indirect effects on local paddy transactions: some farmers adopt transactions with quality consideration and get higher prices in selling paddy to local traders.

Key words: quality grading system, rice marketing, Sub-Saharan Africa

1. Introduction

Globalization through trade liberalization has allowed developing countries to be integrated with international markets. Farmers who face this trend should develop competencies to cope with the changing environments since opened international markets give domestic consumers a new opportunity to choose from more variety of goods that could not been produced in their home countries.

The rice market in Sub-Saharan Africa (SSA) is one of the most typical cases of this current trend. In this context, quality improvement of rice products is required to meet rice demand in urban markets since locally produced rice is differentiated from high-quality imported rice and sold at a lower price due to relatively inferior quality (Demont and Ndour, 2015).

However, such an improvement in locally produced rice has not been taking place in SSA. The lack of incentive for farmers to produce better quality products is considered to be one of the reasons for the lack of improvements in quality. For instance, itinerant traders in SSA seldom consider the quality of rice in price determination when they buy paddy from farmers and hence farmers have little incentives to improve their product quality. However, it is still unknown whether rice farmers will respond to incentives and improve the quality of paddy if such incentives are provided. This study attempts to answer this question utilizing the case of the Northern region of Ghana where a quality-based paddy pricing scheme was introduced by a large-scale rice milling plant.

This study assumes that the quality-based pricing scheme is an incentive given to farmers and considers that its emergence is a natural experiment. Thus, applying 2SLS (two stage least squares) estimation method, this study shows that farmers respond to the incentive. That is, farmers who are located near the milling plant are more likely to adopt transactions with quality consideration\textsuperscript{1}) and as a result receive higher prices than others when they sell paddy to local traders.

This study will contribute to the proliferating literature on rice production in SSA. Although it has been argued that SSA can achieve a significant increment of rice production and productivity with the adoption of new technologies and improved management practices through training by experts and diffusion between farmers (deGraft-Johnson et al., 2014; Otsuka and Larson, 2016; Kijima, 2018; Nakano et al., 2018; Takahashi, Mano, and Otsuka, 2019), there have been few empirical studies on rice quality improvement in SSA.

2. Description of Research Site

In 2011 a large-scale, modern rice milling facility was established in Tolon near Tamale, the third largest city in Ghana, located in the Northern region. It was the first modern milling plant in the Tamale area targeting urban market. Moreover, in 2014, the milling company has introduced a

\textsuperscript{1}Quality consideration” is used in this paper. It implies that buyers (rice traders) and sellers (rice producers) do the inspection of paddy quality and take the quality into account when they determine the price.
new pricing scheme for purchasing paddy from farmers, in which the company determines the purchasing price based on 8 quality parameters.\(^2\)\(^3\) This kind of quality-based pricing scheme had never existed in the Tamale area and was new to farmers. Thus, the emergence of this urban market-oriented milling plant with quality-based pricing scheme was an exogenous shock to rice farmers in the Tamale area, and we consider it as a natural experiment.\(^4\)

We expect two kinds of impact from this exogenous shock on rice farmers. One is a direct impact: since the scheme attaches a better price to better quality paddy, it gives rice farmers an incentive to improve their paddy quality and to sell it to the milling plant at a better price. The other is an indirect effect, or externality: the quality-based pricing adopted by the milling plant may create competition in local paddy market and local rice traders have to pay a good price for good quality paddy, otherwise they cannot buy good quality paddy from farmers.\(^5\) From farmers’ point of view, those who produce good quality paddy will seek for traders who will check paddy quality and pay a better price if the quality is good.

It is important to note that “quality” as used in this paper refers to something observable in paddy and potentially influential in sale price after milling. The large-scale milling plant clearly indicates the 8 parameters, but local traders do not necessarily use all the parameters in trading with farmers. The important point about the quality grading system is that most of parameters depend on farmer’s production, harvesting, and post-harvest practices, although some of them are affected by weather conditions during the production. Among the 8 parameters, aroma is mainly determined by rice varieties, and aromatic rice varieties have become popular in the Tamale area as revealed in Ogura and Sakurai (2019) and Xu and Sakurai (2019). But in 2012 when their data were collected, it was still not clear whether local traders paid higher price for the paddy of aromatic rice than non-aromatic rice.

### 3. Data

This study utilizes 1,054 paddy transactions data during 12 month period from August 2017 to July 2018 collected from randomly drawn 1,080 rice producing households in randomly selected 108 villages (called communities in Ghana) around the location of the large-scale rice milling plant. Data collection was implemented by a research team of University for Development Studies, Tamale and the University of Tokyo from August to September 2018.

Procedures of sampling of the households were as follows. First, we drew a 54km by 54km square on 1/50,000 scale topographic sheets, at the center of which the large-scale rice milling plant is located. Then, we identified all villages within the square. Second, we divided the square into 9 blocks of 18km by 18km square, and randomly selected 12 villages from each of 9 blocks. Thus, we obtained 108 villages in total. Third, after conducting rice farmer census in each village, we randomly drew 10 rice producing households per village for interview. As a result, we got 1,080 randomly sampled rice farmers.

In addition to the interview with the uniquely sampled households, we measured GPS data of the location of each of the 108 villages and the rice milling plant. From the geographic location data, we obtained the geographical

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2) According to the official announcement of the large-scale rice milling company, the company purchases paddy from any rice farmers or entities who bring paddy to the company. Therefore, there is no restriction on selling to the company in terms of the size of sales, which means any farmer who satisfies the requirement of the quality parameters will be allowed to sell paddy.

3) The 8 parameters are moisture content, cracked rice, foreign matters, red grain, mixture of varieties, discolored grain, immature grain, and aroma. The company indicates that the paddy price of aromatic rice and non-aromatic rice. For example, in January 2018 they were 1.25 GHS/kg and 1.10 GHS/kg respectively in the case of grade A paddy. The exchange rate was about 1 GHS = 25 JPY in January 2018. Unlike the local market where seasonal price changes are significant, the paddy purchase price of the company is constant throughout a year. Such a pricing scheme attracts more paddy in the harvesting season and allows the rice milling plant to collect better quality paddy.

4) Although the establishment of the large-scale rice milling plant is exogenous to farmers, it is possible that there is a placement bias of the plant. For example, the company may have chosen the plant location in the area where farmers who have good quality rice. To be explained in the following section, we use the distance from the milling plant to each village as an instrumental variable for “the adoption of quality consideration” in the price determining equation. If the location is intentionally chosen, the exclusion restriction condition of instrumental variable will possibly be violated. However, according to managers of the company, the company did not choose the plant location based on the farmers’ potential. In fact, buyers of the company are visiting villages located far from the plant to gather paddy. Therefore, we consider that the placement bias does not exist and that the distance from the milling plant is a valid instrumental variable.

5) In the authors’ casual interviews made in August 2019, some farmers mentioned that after the establishment of the large-scale rice milling plant, there is competition between traders and the rice milling plant. In fact, some traders told us their experience in gathering paddy from farmers and selling it to the rice milling plant. Although it does not happen in a large-scale yet, this is one of the examples of the indirect effect of the rice milling plant on farmers’ paddy transactions.
distance (L² Euclidean distance) between the plant and each village.

4. Estimation Method

In order to investigate the impact of the emergence of the quality-based grading system on farmers’ rice transactions, we postulate the following two equations. In the first equation, assuming that the influence of the grading system is captured by the distance from the large-scale rice milling plant to each village, we estimate its impact on the adoption of paddy quality consideration in transactions with buyers. Then, in the second stage, we examine the impact of quality consideration on paddy price in transactions. They are specified as follows:

\[
\text{Quality}_{vt} = a + \mathbf{x}_v^\prime \mathbf{b} + \mathbf{x}_t^\prime \mathbf{e} + \theta \text{Dist}_{plan,v} + \epsilon_{vt} \quad (1)
\]

\[
\text{Rice Price}_{vt} = a + \mathbf{x}_v^\prime \mathbf{b} + \mathbf{x}_t^\prime \mathbf{y} + \delta \text{Quality}_{vt} + \epsilon_{vt} \quad (2)
\]

where subscript v, i, and t indicate the level of observation as village, household, and transaction respectively.

Equation (1) is the first stage estimation to determine the impact of the proximity to the milling plant on quality consideration in paddy transactions, where \( \text{Quality}_{vt} \) is a binary dummy variable that takes 1 if quality is considered in paddy transaction t between household i in village v and a buyer. \( \text{Dist}_{plan,v} \) is the distance from the milling plant and village v in km, and \( \theta \) is its coefficient. \( \mathbf{x}_1 \) and \( \mathbf{x}_2 \) are the vectors of household level and transaction level control variables respectively, and \( \mathbf{b} \) and \( \mathbf{e} \) are the vectors of the coefficients. a is constant, and \( \epsilon_{vt} \) is error term.

Equation (2) is the second stage estimation to examine the impact of quality consideration on paddy price in transaction t between household i in village v and the buyer. \( \text{Quality}_{vt} \), \( \mathbf{x}_1 \) and \( \mathbf{x}_2 \) are the same in the first stage. \( \delta \), \( \mathbf{b} \) and \( \mathbf{y} \) are their coefficients, a is constant, and \( \epsilon_{vt} \) is error term.

The binary variable of quality consideration in equation (2) can be endogenous because of potential reverse causality from selling price to quality consideration as well as due to omitted variables affecting both. Therefore, using the variable of distance from the milling plant to each village as an instrumental variable, we estimate the two equations simultaneously by 2SLS (two stage least squares). Regarding the validity of this instrument, please refer to the discussion in footnote 4. In this way, we obtain LATE (Local Average Treatment Effect) of the adoption of quality considered transactions on the selling price of paddy.

5. Descriptive Statistics

Table 1 compares the average price of paddy between transactions with quality consideration and those without quality consideration. It indicates statistically significantly higher paddy price for quality considered transactions than otherwise, which suggests that paddy quality matters in the market. This is a new and important finding since it has long been believed that product quality is of little consideration in the local rice markets in SSA. In the next section we will examine if this change was caused by the emergence of the quality-based pricing scheme introduced by the large-scale rice milling plant.

Table 2 shows the location of paddy transactions. According to the table, about 80% transactions were at farm gate and the remaining 20% were in the market place. None of the sampled farmers sold paddy to the large-scale rice milling plant. Therefore, what we observe is indirect effects of the introduction of the quality-based pricing scheme.

Table 1. Paddy price difference

| Quality considered | Quality not considered | Diff. (a)-(b) |
|--------------------|-----------------------|---------------|
| Paddy price (GHS/kg) | 1.34 (0.42) | 1.24 (0.56) | *** |
| Observations | 637 | 417 |

Note: *** indicates 1% statistically significant level. Numbers in parenthesis are standard deviation. Source: Authors’ own survey.

Table 2. Location of paddy transactions

| Selling place          | N   | %  |
|------------------------|-----|----|
| Farm gate              | 825 | 78 |
| Market place           | 214 | 20 |
| The large-scale milling plant | 0   | 0  |
| Others                 | 15  | 1  |
| Total                  | 1,054 | 100 |

Source: Authors’ own survey.
quality-considered paddy transactions. It implies that such transactions are practiced under the influence of the large-scale milling plant. Combined with this relationship and the fact that price is statistically significantly higher for quality-considered paddy transactions, it is hypothesized that farmers near the rice milling plant are more likely to be involved in quality-considered paddy transactions with local traders, and in turn they will get higher paddy price.

5. Results

Table 3 shows the estimation results of 2SLS estimation. The first stage result is given in the second column. It shows that a statistically significantly negative effect of the distance on the adoption of quality-considered transactions. The second stage result shown in the third column confirms that quality consideration in paddy transactions has a statistically significant positive effect on paddy price. Taken together, these results suggest that due to the influence of the grading system of the large-scale rice milling plant, quality is considered in local paddy transactions in the research site, and in turn farmers get a price premium for the quality of paddy.

6. Conclusion

This study examined the impact of the emergence of the quality grading system and the quality-based pricing scheme on local paddy transactions in the Northern region of Ghana. 2SLS estimation result shows that the new scheme really has impacted on local paddy transactions, and then farmers obtain a price premium by the adoption of quality-considered transactions with local traders.

Our finding not only contributes to the literature on rice production in SSA, but also provides a relevant policy implication for the development of domestic rice market in SSA, where rice market has been regarded as inefficient in the sense that there is no stable quality-price relationship.

There remain several unanswered questions in this study to understand the whole mechanism. First, does this quality-price relationship change the actual behavior of the farmers in the production and post-harvest management practices? This is not examined in this study and remains for the future studies.

Second, we could not examine direct effect because no farmer sold paddy to the rice milling plant. Why does this happen? What will make them sell paddy to the rice milling plant is left for future studies.

By unpacking the whole mechanism, we will be able to formulate appropriate policies to incentivize farmers in SSA to upgrade quality.

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Table 3. Impact of quality-considered transactions on paddy price (2SLS estimation results)

| Explanatory variables                              | First stage (1) (Quality consideration) | Second stage (2) (Paddy price) |
|----------------------------------------------------|----------------------------------------|-------------------------------|
| Distance to milling plant                          | -.01***                                | 0.57*                         |
| Quality consideration in paddy transactions        |                                        | 0.29                          |
| Constant                                           | 1.07***                                | 0.71**                        |
| Other control variables                            | Yes                                    | Yes                           |
| Observation                                        | 1054                                   | 1054                          |
| First stage effective F statistics                 | 11.72***                               |
| R squared                                          | 0.22                                   |

Note: ***, **, and * indicate 1%, 5%, and 10% statistically significance level respectively. Standard errors are clustered at the village level.

Source: Authors' own survey.

Appendix: Table A1. Descriptive statistics of control variables

| Household level (x1)                              | Quality considered (a) | Quality not considered (b) | Differences (a)-(b) |
|---------------------------------------------------|------------------------|----------------------------|--------------------|
| Age of the farmer (years)                         | 40.15 (10.69)          | 41.72 (12.47)              | **                 |
| Total number of adult household members (age 15-60)| 8.23 (4.95)            | 8.07 (4.75)                |                   |
| If the farmer is household head (binary dummy)    | 0.66 (0.47)            | 0.66 (0.47)                |                   |
| English literacy: at least speak, read, or write (binary dummy) | 0.14 (0.34)          | 0.14 (0.35)                |                   |
| Off farm activity: at least one member is involved in off-farm activity (binary dummy) | 0.28 (0.45)          | 0.30 (0.46)                |                   |
| Total value of farming/non-farming assets (1,000 GHS) | 33.29 (131.33)        | 7.93 (39.77)               | ***                |
| Rice cultivation experience of the farmer (years) | 13.87 (8.86)           | 11.83 (8.86)               | ***                |
| Degree centrality of the farmer: the ratio of the number of sample farmers known by the farmer in total number of sample farmers | 0.92 (0.15)          | 0.95 (0.13)                | ***                |

| Transaction level (x2)                            |                         |                             |                   |
|---------------------------------------------------|------------------------|-----------------------------|--------------------|
| If price was searched at market before selling (binary dummy) | 0.38 (0.49)          | 0.28 (0.45)                | ***                |
| If paddy was sold at farmgate (binary dummy)      | 0.74 (0.44)            | 0.86 (0.35)                | ***                |
| If the farmer has a long-term relationship or relies on traders (binary dummy) | 0.39 (0.49)          | 0.39 (0.49)                | ***                |
| If paddy is sold in lean season from May to October (binary dummy) | 0.25 (0.43)          | 0.25 (0.44)                |                   |
| Geographical distance between the village and the rice milling plant (km) | 18.18 (6.82)         | 23.39 (8.22)               | ***                |
| Geographical distance between the village and the central market of this region (km) | 18.51 (7.66)         | 23.95 (7.23)               | ***                |

Note: *** and ** indicate 1% and 5% statistically significance level respectively. Source: Authors' own survey.