The development of agricultural markets in sub-Saharan Africa: the case of rice in Uganda

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Abstract

If agricultural markets do not work well in sub-Saharan Africa, it will be inconceivable to increase crop yields, as this requires the increased application of purchased inputs and the marketing of increased output. This study therefore investigates whether and to what extent rice markets function in Uganda, where rice is a new crop. We found that the number of rice millers has increased in response to the increase in rice production. As the number of rice millers and traders has increased, the price differentials of milled rice across wide areas have come to depend on transportation costs, which indicates the more efficient functioning of local rice markets.

Keywords: agricultural markets; market efficiency; rice; Uganda

1. Introduction

The rural population in sub-Saharan African countries (SSA) is highly dependent on agriculture for their livelihood. Using agriculture as the basis for economic growth and poverty reduction in such agriculture-based countries requires a productivity revolution in smallholder farming (World Bank 2007). Given that rice is a major cereal crop that has great potential for increases in productivity in SSA, strategic efforts to enhance rice production are needed urgently, not only for food security but also for income generation (Diao *et al*. 2008; Kijima *et al*. 2008; Larson *et al*. 2010; Otsuka & Kijima 2010; Otsuka & Larson 2012). It would not be possible to realise a rice green revolution in SSA, however, if agricultural markets do not function well, since inefficient markets discourage producers from intensifying input use and expanding production by increasing input prices, depressing output prices, and heightening price volatilities. How well agricultural markets function therefore is critically important to enhance the income and productivity of the smallholders in SSA.

It is widely believed that the market does not function well in SSA because the poor infrastructure, weak institutions and lack of credit lead to inefficient operation (Fafchamps 2004; Stephens & Barrett 2011). This belief has been reinforced by empirical analyses testing the degree of regional integration of an agricultural market using time-series price data (Fackler & Goodwin 2001). More recently, the recommended test for market efficiency involves not only price information, but also additional information on non-price data, to describe the function of the markets (Moser *et al*. 2009; Rashid & Minot 2010). In this study we look closely at the entry decision of market agents. To our knowledge, few studies have examined such entry decisions in SSA, with the exception of Barrett (1997) and Fafchamps and Hill (2008). As a case of a newly emerging agricultural market, we examine the rice milling industry in Uganda, where the production of rice, though not a traditional crop, has been expanding rapidly, partly because of relatively high rice prices and partly because of the introduction of new upland and lowland rice production technologies (Kijima *et al*. 2006, 2011, 2012).

In Uganda, similar to other countries in SSA (Furuya & Sakurai 2005), rice producers transport their paddy to rice millers by bicycle and motorcycle if the distance between the farm gate and the rice miller is short, or by loading the rice on buses and hiring trucks if the distance is long. Rice millers charge milling fees to the producers depending on the amount processed. Producers then sell the milled rice to traders, who wait for the producers to come to the rice millers. It is rare that traders buy paddy from rice millers, although it is common that traders and middlemen buy paddy from farmers in Asia (Hayami & Kawagoe 1993; Minot & Goletti 2000). In some of the rice-producing areas with high transportation costs to the rice millers, the wholesaler comes to and buys the paddy rice at the farm gate. This practice, however, is not common in Uganda. According to Fujiie (2009), traders prefer milled rice to paddy rice, since the quality of milling machines is not good in Uganda and buying rice in paddy form leaves traders the risk of acquiring low-quality rice. As better quality milling machines become more available, this practice may change in the future.

The currently traded rice price is announced by the rice miller and the transaction between the producers and traders is made based on this price. In other words, rice millers seem to play the role of intermediary between producers and traders. Without the rice millers, the marketing of rice by smallholder farmers would be quite difficult. In fact, in areas where rice production has recently started, farmers have faced problems selling rice after harvest because of the poor access to rice millers (Kijima *et al*. 2008).

To investigate how the rice markets function, we interviewed 374 rice millers in 43 districts in Uganda. We found a surge in the number of rice millers, particularly after 2005, which coincided with the rapid expansion of rice production in this country. This suggests that rice millers enter markets where the demand for rice milling services has increased. Thanks to the entry of rice millers, and probably that of wholesale traders as well, the rice market appears to be functioning more efficiently in recent years. Thus, we postulate the hypothesis that the differences in rice prices across wide areas are explained by the transport cost, particularly in recent years, due to the improved functioning of local rice markets.

The rest of the paper is structured as follows. Section 2 describes the survey data and the characteristics of the rice millers. Section 3 postulates the hypotheses. In Section 4, the empirical model and the estimation results are presented, followed by the conclusion in Section 5.

2. Data and Sample

Since there is no directory of all the rice millers in Uganda, we tried to cover all the rice millers by visiting the major rice production areas in Uganda, instead of drawing a random sample. The sample rice millers were located throughout Uganda, as shown in Figure 1, where each dot on the map indicates the location of a sampled rice miller. In the eastern region, many dots overlap, which indicates the formation of clusters where large wetland areas have been converted to paddy fields.

The data was collected in March 2009. As shown in Table 1, a total of 374 rice millers were interviewed in 43 districts. The locations of the rice millers were categorised into urban towns with populations of more than 60 000, rural clusters in which there were more than four rice millers in the same small locality, and rural non-clusters. Sixty-two percent of the operating millers were located in rural non-clusters.

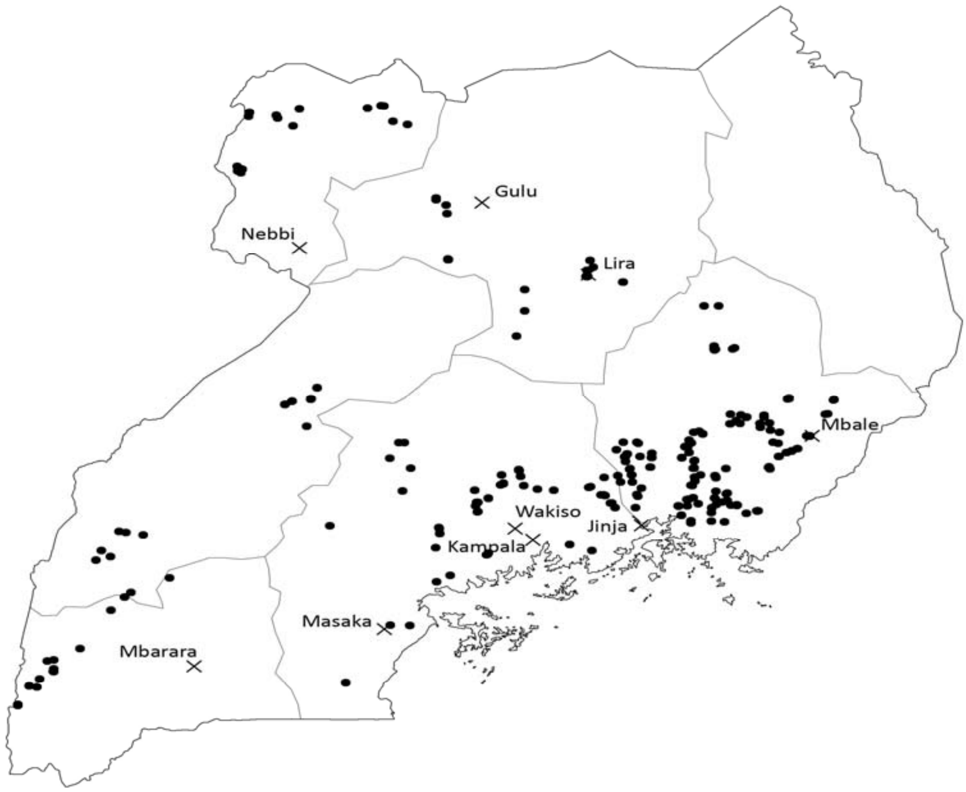

Figure 1: Location of rice millers

Table 1: Number of rice millers by region and year of establishment

Region	Number in sample	%	Percentage of sampled rice millers by year of starting business at given region and location				Percentage of sampled rice millers by region and location at given time			
			before 1990	1990 -1999	2000-2004	2005-2009	1990	2000	2005	2009
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
All	374	100	3.8	17.6	26.5	52.0	100	100	100	100
North	47	12.6	4.4	28.9	26.7	40.0	14.6	20.6	12.7	9.7
East	229	61.2	5.3	19.7	28.1	46.9	85.4	68.5	64.9	55.2
Central	49	13.1	0.0	4.1	30.6	65.3	0.0	3.1	15.1	16.5
West/Southwest	49	13.1	0.0	10.4	14.6	75.0	0.0	7.7	7.2	18.9
Urban	28	7.5	10.7	17.9	39.3	32.1	21.1	7.6	11.1	4.6
Rural cluster	114	30.5	5.3	23.9	38.1	32.7	42.5	41.4	43.8	19.2
Rural non-cluster	232	62.0	2.2	14.4	19.2	64.2	35.9	50.8	44.9	76.6

"Cluster" = area where there were more than four rice millers in the same location.
Urban = towns with population of more than 60 000.

In columns 3 to 6, the distribution of the rice millers is indicated by the years of starting the business and the location. Only 4% of the rice millers entered the rice milling market before 1990, and these early entrants are located in the northern and eastern regions, where lowland rice cultivation was introduced by the Chinese in the 1970s, along with a few irrigation schemes (FAO 2006). The rice millers in urban towns seem to have entered the market earlier than those in rural areas, as shown in column 3. The entry of rice millers accelerated in the 2000s, especially after

2005. More than half of the sampled rice millers started their businesses between 2005 and 2009, as shown in column 6, especially in the western and south-western regions, where new upland rice varieties have been introduced since 2004 through dissemination programmes provided by the government and international donor agencies (Kijima *et al*. 2008, 2011).

The entry pattern of rice millers and the location shifts are clearly seen in columns 7 to 10. Column 7 shows the situation in 1990, when rice millers were only found in the eastern and northern regions. Even in 2000, most of the rice millers were located in the eastern and northern regions (column 8). By 2005, however, rice millers had entered the central and western regions. As shown in column 10, by the time of data collection, the number of rice millers had increased greatly in the western region. Compared with the eastern region, the number of rice millers in the northern region had not increased much, probably because one of the irrigation schemes in the region was abandoned in the 1990s due to the mismanagement of the pumps. Also, since 1996 and until recently, attacks and the abduction of children by rebels caused farm households to escape to refugee camps and thus deterred agricultural production in many of the northern districts (Blattman & Annan 2009). Overall, it seems clear that rice millers are entering the market in areas where the demand for rice milling services has newly emerged.

In the rice miller survey, we asked rice millers the names of the major rice-producing areas from which their customers (i.e. rice producers) come. Subsequently, we visited 107 sub-counties and interviewed key informants by using a simple questionnaire. Table 2 shows the characteristics of the rice-producing sub-counties. The first column shows the earliest year in which the rice production began in the sub-county in each region, while the second column shows the median year. In sub-counties where rice production started early, the rice millers should have been in operation for relatively long periods. In the northern and eastern regions, rice production started around 1960, while it began in the central region in 2000. As can be seen from Table 1 (columns 7 to 10), the proportion of rice millers who were located in urban areas was highest in 1990. One reason may be the availability of electricity, which is often needed to operate milling machines. As shown in column 3 of Table 2, most of the production areas did not have access to electricity. This means that rice millers in rural areas had to use alternative sources of energy to operate rice-milling machines, such as diesel. However, the use of diesel has a negative impact on the quality of the milled rice, since diesel power is weaker than electricity and thus rice millers need to mill rice at least twice to remove husks and bran, which tends to increase the breakage rate of milled rice. Another reason could be that, when rice-producing areas were scattered and only a relatively small amount of rice was produced in each location, it would have been advantageous for rice millers to be located in commercial centres.

Table 2: Year when rice production started, by region

	Year when rice production started		Years since electricity became available	Rice-related programme		Percentage of (district level census data)		
Region	**Earliest**	**Median**		**Years since programme started**	**% of house-holds benefit-ting from programme**	**wetland/ total land area**	**households with cars**	**households with all basic needs***
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
North	1960	1993	0.06	2.55	22.5	3.02	1.49	15.62
East	1960	1986	3.33	3.74	24.7	10.07	1.88	19.12
Central	2000	2004	3.56	2.92	26.9	6.33	4.36	25.02
West/ Southwest	1977	2002	0.36	2.64	38.5	1.76	3.48	22.06

Source: Sub-county-level data (columns 1 to 5), census data (columns 6 to 8).
*soap, sugar, shoes and blankets

In columns 4 and 5, the years and coverage of the rice production programmes available in the sub-counties are shown. Rice programmes that include extension services and training programmes by NAADS, and NERICA seed distribution promoted by the government and donors such as the FAO and JICA, started in the past two to four years, and 20 to 40% of the households have benefited from these programmes. This suggests that the rapid increase in rice production after 2005 took place as a result of these rice programmes, which may explain the massive entry of new rice millers since then.

Data on the district-level proportion of wetland areas, obtained from the national land-cover statistics of 1995, and the proportion of households owning cars and with access to all basic needs (soap, sugar, shoes and blankets), from the census data of 2002 (Uganda Bureau of Statistics 2006, 2009), are also presented. The proportion of wetlands was used to identify whether the rice-producing ecosystem is lowland or upland. The ownership of cars and access to basic needs was used to capture the differences in income and assets across districts.

Table 3 shows the characteristics of the owners of the rice mills, the milling machines, and the business performance by location. The owners' education level was higher than that of farm household heads in Uganda in general (Matsumoto *et al*. 2006) and of rice farmers in particular (Kijima *et al*. 2012). Four percent of the millers used to be rice traders, and therefore who be knowledgeable about whether and where the operation of rice mills would be profitable. Rice millers in urban towns were larger, measured by the number of permanent and temporary employees and milling capacity. The income per kilogram of milled rice was calculated by deducting the labour and operating costs per kilogram (variable costs) from the milling charge per kilogram (revenue per 1 kg of milled rice). The operating costs consist of the cost of electricity and diesel used for generators, as well as the rental costs of milling machines and shop floors. Rice millers in urban towns processed a larger amount of rice than those in rural areas. In rural clusters, millers processed smaller amounts of paddy at cheaper milling fees, resulting in lower incomes than in the urban areas and rural non-clusters. Given that the labour costs and operating costs per kilogram of milled rice in rural clusters were not significantly different from those in the urban clusters and rural non-clusters, the lower income in rural clusters is mainly due to the lower milling charge.

Table 3: Rice millers' average characteristics in 2008, by location

	Urban	Rural cluster	Rural non-cluster
Age of owner	41.8 (11.4)	42.3 (12.8)	40.7 (13.9)
Years of education	9.8 (4.5)	8.9 (3.6)	9.6 (3.8)
Rice trader experience dummy (%)	7.1 (7.9)	4.6 (7.1)	2.4 (4.3)
Capacity of milling machine (kg/h)	1 277 (1 991)	1 114 (1 190)	719 (900)
Number of permanent employees	2.7 (1.9)	1.6 (1.9)	1.8 (1.6)
Number of temporary employees	6.0 (7.3)	2.3 (3.9)	1.4 (2.2)
Number of family workers	0.5 (0.8)	0.5 (1.0)	0.6 (1.3)
Amount of paddy milled (tons/year)	314 (381)	105 (131)	135 (201)
Milling charge (Uganda shilling/kg)	70 (25)	59 (15)	77 (34)
Hired labour cost (Uganda shilling/kg)	11.8 (14.2)	22.8 (26.7)	23.7 (28.8)
Operating cost (fuel and electricity + rental costs) (shilling/kg)	50.3 (57.0)	41.3 (38.9)	39.7 (45.1)
Fuel and electricity costs (shilling/kg)	36.0 (38.2)	38.6 (37.7)	38.1 (43.3)
Rental cost (milling machine, shop floor) (shilling/kg)	14.3 (17.7)	2.7 (6.0)	1.6 (5.8)
Income (Uganda shilling/kg)	9.7 (56.0)	-3.2 (51.3)	14.6 (62.5)
Adoption of milltop milling machine (%)	47.8 (51.1)	50.5 (50.2)	36.1 (48.2)
Diesel use (%)	34.8 (48.7)	37.6 (48.7)	62.4 (48.6)
Percentage of rice sold to local retail, shops, individuals (district average)	19.3 (5.8)	17.2 (11.0)	40.2 (11.0)
Milled rice price (shilling/kg) in 2008			
1st cropping season	1,370 (225)	1,209 (285)	1,264 (317)
2nd cropping season	1,486 (259)	1,272 (271)	1,321 (314)
Off-harvest season	1,650 (255)	1,432 (286)	1,514 (343)

Note: The numbers in parentheses are standard deviations

In the urban areas and rural clusters, Milltop milling machines are used more widely. The other type of milling machine, namely Engleberg, can also be used for other crops such as maize and cassava, although the quality of rice milled by Engleberg machines tends to be lower (Sakurai *et al*. 2006). To the extent that the quality of milled rice affects the price, there should be a large demand for Milltop milling machines. Additional devices that can improve the quality of milled rice, such as moisture meters, dryers, cleaners and de-stoners, are rarely installed in Uganda (not shown in the table). In rural non-clusters, the proportion of rice millers using diesel as the energy source for milling machines is about the same as that in urban areas.

In each season, the milled rice price is higher in urban areas than in rural areas. This is because the price in urban areas includes the transportation costs from the rice production areas. In each location, the price in the off-harvest season is highest because the supply of rice is less than during the harvesting seasons. The proportion of milled rice sold to local retailers and individual consumers is highest in rural non-clusters. This suggests that the amount of rice produced around rural non-clusters is relatively small compared to that in rural clusters.

3. Hypotheses

Based on the descriptive statistics and field observations, we postulate several hypotheses on rice millers' entry and the milled rice price in this section.

3.1 Rice millers' entry and location decisions

The decision of potential rice millers to enter the market or not is affected by the expected profit. The profit is determined by the demand for the service and market-specific costs (Klepper 1996).

Since rice is not a common food crop in the rural areas of Uganda, it is produced primarily for sale to the market (Haggblade & Dewina 2010). Wherever rice is cultivated, there must be a demand for the milling service. One milling business can be started with a small initial investment and, hence, the entry barrier is not high (Barrett 1997). In areas with long rice-growing experience, the demand for the milling service should have been created some time ago, and hence rice millers should have been in operation for many years. In areas where rice has been newly introduced, many rice millers should have entered the market recently. Such information about the increasing demand for rice-milling services in particular areas could have been obtained earliest by rice traders, who travel around the country. Therefore, those with rice-trading experience are likely to be the early, innovative entrants.

To increase profits, rice millers need to maintain a high utilisation rate of the milling machines, given that there is scale economy in the milling business. If rice-producing areas were scattered, the amount of production may be too small to achieve positive profits if a mill is located in a particular rice-producing area. In such cases, rice millers would prefer to be located in big towns to attract many customers from the wider surrounding areas, as explained by the well-known Hotelling's law (Hotelling 1929). This is likely to be the case in many upland rice-producing areas. Once rice production has increased sufficiently for millers to earn profits in a particular rice-producing area, they will come to locate themselves near the production areas. In contrast, lowland rice tends to be produced in concentrated areas, which used to be large, unused wetland areas. Based on these arguments, we would like to postulate the following hypotheses.

Hypothesis 1: In areas where rice production started earlier, rice millers entered the business earlier.
Hypothesis 2: In areas where rice is grown upland, rice millers tend to be located in towns.

3.2 Price of milled rice

Traders buy rice in rice-surplus areas where a large amount of rice is produced, such as in the eastern region, and sell rice in rice-deficit areas, including the capital city, Kampala, where the demand for rice is highest. If the rice market functions well in Uganda, the rice price observed at the rice mills in rice-producing areas is expected to be lower than the price in Kampala due to transportation costs. If the area under study is a rice-deficit area, the local price may be higher than in Kampala due to the transportation cost, to the extent that Kampala is a centre of the rice trade in Uganda. Since the number of rice millers has increased dramatically over the past five years, the functioning of the rice market would have improved, particularly more recently. Thus, it seems reasonable to postulate the following hypothesis.

Hypothesis 3: If markets for milled rice function well, the price at a particular rice miller is explained by the transport cost from Kampala, which may be measured by the travelling time between the two locations. If rice markets do not function well, which is likely to be the case in the earlier years, regional rice price gaps may not be explained by the transport cost.

4. Estimation Model and Results

4.1 Timing of entry and location decisions of rice millers

The determinants of the timing of entry were analysed by the ordinary least squares (OLS) method, in which the dependent variable is the log of the years in the rice-milling business, and the independent variables include the proxies for the demand for rice-milling services and the location and personal characteristics of the rice millers. The demand for rice-milling services is considered to be related to the amount of rice produced in the surrounding areas. Where rice is produced, rice millers can find business opportunities. The factors affecting the timing of a rice miller's entry can be measured by the years of rice production in the surrounding sub-counties. This variable, however, can be endogenous, since rice production may be encouraged in areas with many rice millers, resulting in more years since the establishment of rice millers. Although it is preferable to use a more direct indicator of rice production in Uganda, there are no disaggregated rice production data. Rainfall data are available, but are not a suitable proxy for rice production in a Ugandan setting, since lowland rice production seems to have increased in wetland areas regardless of rainfall. Given that lowland rice production was started in irrigation schemes and then expanded to the surrounding areas with access to wetlands over time, the percentage of wetland area at the district level, which is an exogenous variable, is used as a proxy variable for rice production in an alternative specification.

The timing of entry can be affected by an owner's characteristics, such as age, education and background. Experience as a rice trader in particular is expected to help in starting a rice-milling business because of its advantage regarding gathering relevant information.

As a variable indicating the location of towns, we used a district capital dummy and the travelling time to Kampala. The travelling time is calculated by using GIS position coordinates at the millers. We overlaid their positions on digitised road maps and selected the shortest route from each miller to Kampala using ArcGIS. We classified roads into four groups: trekking paths, dirt roads, loose-surface roads, and tarmac roads. Except for the trekking paths, we applied the average driving speed on each of the three road types and calculated the driving time from each miller to Kampala. On the trekking paths, we calculated the walking time. The region dummies were also included, and average rainfall was included to control for geographical differences.

In the analysis of location choice, we used a dummy variable indicating whether a rice miller was located in town or not as a dependent variable. If there was enough rice to mill in a small area, as in the case of lowland rice, rice millers would prefer to be located in a rice-producing area. The coefficient of the percentage of wetland area at the district level therefore is expected to be negative. Given that milling machines require a reliable energy source for operation, the unavailability of electricity may discourage millers from locating close to rice-production areas. To control for this, we used the years since electricity became available in a major rice production area whose farmers are the main customers of rice millers. If electricity is available in a rice-producing area, rice millers do not need to be located in towns. The other explanatory variables are the same as those for the analysis of the timing of entry.

The results are shown in Table 4. As may be expected, the coefficients of the years since rice production started in the surrounding sub-counties and the district capital dummy are positive and significant (column 1). In an alternative specification (column 2), the coefficient of the percentage of wetland area is significant with the expected sign. This corroborates hypothesis 1, that rice millers enter markets where the demand for rice-milling services has emerged from rice producers. The coefficient of the trader dummy is positive and significant, suggesting that the experience of rice trading is significantly related to early entry into the rice-milling industry.

Table 4: Determinants of rice millers' timing and location of entry

	log of years since establishment		**Rice miller's location is in town+**
	OLS coefficients		**probit marginal effects**
	(1)	**(2)**	**(3)**
Characteristics of major source of rice			
Log of years since rice production started (sub-county level)	0.114*		
	(1.760)		
Percentage of wetland area in total land area (district level)		0.007***	-0.002*
		(2.777)	(-1.713)
Log of years since electricity became available to this sub-county	0.276***	0.196**	-0.140**
	(2.983)	(2.011)	(-2.371)
Location of rice miller			
Log of travelling time to Kampala (hours)	-0.077	-0.132	0.097
	(-0.746)	(-1.275)	(1.563)
District capital = 1	0.221***	0.253***	
	(2.742)	(3.114)	
Characteristics of rice miller			
Log of age of owner	0.217*	0.215*	-0.010
	(1.844)	(1.845)	(-0.135)
Log of years of education of owner	0.056	0.056	0.068
	(0.752)	(0.760)	(1.428)
Rice trader experience dummy	0.034***	0.034***	0.003
	(5.328)	(5.360)	(0.796)
Average rainfall (mm)	-0.000	-0.000	-0.001**
	(-0.865)	(-0.740)	(-2.444)
Number of observations	326	326	326
R-squared (pseudo R-squared)	0.349	0.318	(0.136)

Dependent variable in columns 1 and 2: log of years since establishment, column 3: dummy variable indicating unity if rice miller's location is in town
t-statistics in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Region dummies are included as explanatory variables in all specifications
+ Town = areas with population more than 15 000

The results of the location choice of the rice miller are shown in column 3. The figures are the marginal effects evaluated at the means. As expected, the proportion of wetland area affects the rice miller's location significantly. The negative marginal effect means that rice millers tend to locate in towns where rice is mainly produced upland. This result supports hypothesis 2. The availability of electricity is found to be one of the factors explaining the location of rice millers close to rice-producing areas.

4.2 Price of milled rice

In order to test hypothesis 3, we estimated the milled rice price determination function by OLS for each year from 2004 to 2008 separately. For this analysis, we collected the prices of three kinds of milled rice traded at rice millers: the average prices in the off-harvest season, the major harvesting season and the minor harvesting season. This is because the rice prices in the off-harvest and minor harvesting seasons tend to be higher than in the main harvesting season, since the amount of rice produced and traded is less in the off-harvest and minor harvesting seasons. The number of observations is different in different years because the number of operating rice millers is not the same over time. Although the price of the milled rice should be adjusted by an appropriate spatial price index, such an index is not available in Uganda. In this analysis, the differences in the price level across space are controlled for by the district-level variables related to assets and income levels, such as the percentage of households owning cars and having access to basic needs, as well as the region dummies and the location variable (district capital dummy). The milled rice is traded from surplus to deficit areas, and the milled rice price is lower in surplus areas than in deficit areas. As a variable indicating whether a rice miller is located in a rice-surplus area, we used the proportion of wetland area. This is because rice production is concentrated in wetlands and the amount of marketable rice surplus tends to be higher in areas with a higher proportion of wetland. As an indicator of deficit areas, we used the percentage of rice milled that is sold to local retailers, shops and individuals, because in deficit areas rice tends to be traded within the locality to satisfy the local demand.

The results of the estimation are shown in Table 5. The coefficients of travelling time to Kampala are not significant until 2008, and even positive in 2004 to 2006. These findings indicate that, until recently, the milled rice price was not determined by the transportation costs between rice-producing areas and the major consumption area, Kampala. In 2008, the coefficient of the travelling time to Kampala turned negative and significant. These results suggest that the milled rice market in Uganda is now functioning well.

The coefficients of the other controls take the expected signs. The positive sign of the district capital dummy indicates the higher price level in towns and the price including transportation costs from the production areas, while the negative sign of the percentage of wetland area shows that the price is lower in surplus areas. As would be expected, the coefficients of the off-season dummy are positive and highly significant, whereas those of the first (main) cropping season dummy are negative and significant.

5. Concluding Remarks

In this study we examined the development of rice markets in Uganda, where, except in a few areas, rice is a relatively new crop and its production has been expanding rapidly in recent years. The regression analyses of the timing of rice millers' entry corroborated the hypothesis that rice millers entered in areas where the demand for milling services increased. Since it is not common for paddy rice to be purchased by traders at the farm gate, rice millers play a critical role in assisting farmers to sell rice to traders. In all likelihood, it would not have been possible for rice production in Uganda to expand so rapidly in recent years without the development of the rice-milling industry. The rice price analyses provided consistent results, showing that the rice market has come to function better in recent years. This suggests that the realisation of impressive increases in rice production in Uganda would have been unlikely without the development of an output market.

Table 5: Determinants of log of milled rice price (Uganda shilling/kg), OLS

	2004	2005	2006	2007	2008
Log of travelling time to Kampala (hours)	0.207	0.156	0.072	-0.009	-0.064*
	(1.495)	(1.444)	(1.007)	(-0.151)	(-1.765)
District capital = 1	0.197***	0.135***	0.126***	0.091***	0.039**
	(4.555)	(3.638)	(4.391)	(3.618)	(2.378)
Percentage of rice sold to local retailers, shops and individuals (district average)	0.008***	-0.004	0.001	0.001	0.001
	(3.226)	(-1.027)	(0.297)	(0.936)	(0.797)
Percentage of wetland area in total land area (district level)	-0.020**	-0.021***	-0.029*	-0.013	-0.011**
	(-2.382)	(-2.845)	(-1.941)	(-1.413)	(-2.086)
Percentage of households owning cars	0.157	0.029	-0.043	0.011	-0.039
	(1.013)	(0.791)	(-0.831)	(0.421)	(-1.144)
Percentage of households with access to basic needs (soap, sugar, shoes, blankets)	-0.002	0.016	0.009	-0.017	-0.009
	(-0.246)	(1.127)	(1.578)	(-0.688)	(-0.995)
Electricity-use dummy	-0.030	-0.030	-0.042	-0.016	-0.003
	(-0.843)	(-0.925)	(-1.587)	(-0.711)	(-0.195)
Average rainfall (mm)	-0.000	0.000	-0.001	-0.000	-0.000
	(-0.159)	(0.308)	(-1.224)	(-1.042)	(-0.567)
Off-harvest season	0.107***	0.095***	0.114***	0.094***	0.115***
	(3.740)	(3.536)	(5.097)	(4.649)	(8.364)
First cropping season	-0.064**	-0.068**	-0.073***	-0.067***	-0.059***
	(-2.228)	(-2.506)	(-3.247)	(-3.279)	(-4.171)
Proportion of Supa	0.085	0.090	0.096	0.023	-0.008
	(0.875)	(1.127)	(1.403)	(0.376)	(-0.176)
Proportion of K-series	-0.052	-0.007	-0.040	-0.006	-0.013
	(-0.617)	(-0.095)	(-0.664)	(-0.105)	(-0.353)
Proportion of upland (non-NERICA)	-0.151*	-0.082	-0.042	0.005	-0.019
	(-1.684)	(-1.118)	(-0.806)	(0.096)	(-0.538)
Proportion of NERICA	-0.222**	-0.199**	-0.028	-0.025	0.010
	(-1.969)	(-2.187)	(-0.466)	(-0.445)	(0.245)
Observations	394	498	634	742	937
R-squared	0.525	0.435	0.449	0.347	0.423

t-statistics in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, district and region dummies are included as explanatory variables in all specifications.

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