Discussion Papers In Economics And Business

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Abstract

Monopsony is often observed in local agricultural markets in developing countries because of the high entry cost to buyers; farmers in such markets therefore sell their agricultural products at a lower price. However, this situation seems to be changing with the diffusion of mobile phones. This paper investigates how access to market information through mobile phone usage impacts the selling price of rice in rural areas in Cambodia. We conducted a survey of farmers' households concerning agricultural production processes and rice sales in 20 villages in four provinces (Battambang, Prey Veng, Pursat, and Takeo). We find that farmers who have access to market information through the use of mobile phones are more likely to sell their rice at a higher price. In addition, we observe that the offers received by farmers with better access to market information through mobile phone usage tend to affect selling prices. The results imply that improved access to market information through the use of mobile phones improves farmers' bargaining power against traders, enabling them to sell their rice at a higher price.

JEL Classification Codes: O12, D82, D83

Key word: Agricultural Prices, Mobile phone, Cambodia

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* We are deeply grateful to Tsunehiro Otsuki and Masaru Sasaki, Hiromasa Matsuura, and the participants at the seminars at Osaka University for their helpful comments and discussions. We would also like to thank Dr, Meas Pyseth and Vichet Sorn for providing us with useful information on rice farming in Cambodia. All remaining errors are our own.

1. Introduction

Monopsony is widely observed in local agricultural markets in developing countries because of the high entry cost of buyers such as traders. As a result, farmers tend to sell their agricultural products at less than the wholesale price in the local agricultural market.

This situation has changed with the diffusion of information communication technologies (ICTs). These technologies allow farmers to acquire information on market outcomes such as selling prices in other markets, enabling them to sell their agricultural products in other markets at higher prices. Since one of the widely used ICTs, the mobile phone, is relatively inexpensive and does not require an urban environment, it is used by many people in rural areas. In fact, 50–60% of households in rural areas in countries such as the Dominican Republic, Guyana, and Swaziland own mobile phones (Jensen, 2010). If the mobile phone contributes to the effective functioning of markets by improving access to market information, the selling prices of agricultural products should increase.

Previous studies have also examined the impact of ICTs on the selling price of agricultural products. Svensson and Yanagizawa (2009) investigated the impact of market information transmitted via FM radio on the farm-gate price of maize in Uganda and found that informed farmers sell at higher prices. Ochiai and Yamasaki (2013) found that the diffusion of mobile phones in rural areas in India increased the selling price of wheat for small-scale farmers. However, SMS-based commercial services that deliver market and weather information had no impact on selling prices in India (Marcel and Minten, 2012). Lee and Bellemare (2013) showed that farmers in the Philippines sell agricultural crops at higher prices in cases where either a household's father or his spouse owns a mobile phone. However, household ownership of a mobile phone is not correlated with selling prices. As described, the impact of the ownership of a mobile phone or improved access to market information on selling prices is not necessarily positive. Our contribution in this literature is that we estimate the impact of improved access to market information through mobile phone usage on the selling price of rice in rural areas in Cambodia. To examine the reasons for its effect, we first analyze how improved access to market information affects farmers' bargaining power against buyers.

We carried out a survey of rice farmers in 20 villages in four provinces (Battambang, Prey Veng, Pursat, and Takeo) in Cambodia from December 2012 to January 2013 as a part of an

assessment of the post-harvest technology intervention of the International Rice Research Institution (IRRI). The IRRI has implemented such interventions to improve living standards in rural areas in Cambodia since 2005. In this survey, we collected extensive information on the status of mobile phone ownership, usage of mobile phones to access market information, agricultural activities during the past year, marketing activities, usage conditions of post-harvest technologies, social and demographic characteristics, and non-agricultural income sources. The survey allows us to analyze the impact of improved access to market information through the use of mobile phones on the selling price of rice while controlling for the effects of other determinants on selling prices such as the quality of sold rice and household characteristics.

Farmers who access market information using mobile phones are likely to sell their rice at a higher price. However, ownership of mobile phones does not affect the selling price. This implies that it is not the ownership of mobile phones but rather access to market information via mobile phones that determines the increase of the selling price of rice. In addition, offers of farmers with access to market information through the use of mobile phones tend to affect selling prices. Improved access to market information through mobile phone usage increases the farmers' bargaining power against buyers, and thus, farmers can sell rice at a higher price.

The rest of the paper is organized as follows. In the next section, we review previous studies regarding the impact of market information on agricultural markets and on the selling prices of agricultural products in developing countries. Section 3 explains the agricultural situations in Cambodia and our study's survey design. Section 4 explains the estimation methods that we apply and examines the effect of improved access to market information through mobile phone usage on the selling price of rice and on farmers' bargaining power against buyers. The last section concludes.

2. Literature review

Previous studies have primarily focused on the two channels through which market information affects selling prices.[1] We explain the impact of market information on arbitrage. Suppose there are two markets with one agricultural product. For simplicity, price information does

[1] Other papers also examine the impact of mobile phones on farmers' behavior in developing countries (e.g., Muto and Yamano, 2010).

not diffuse over the two markets and transportation between these markets is costly. We consider a situation in which the price of the product differs between the two markets because of the difference in the quantity of supply of the product in the markets. If farmers can obtain the selling price in the other market and if the transportation cost is not higher than the price difference between these markets, farmers in the market where the product's selling price is lower will go to the other market to sell the product. As a result, arbitrage occurs between the markets, the difference in the prices between the markets will decrease, and Pareto efficiency will be achieved.

Several empirical studies examine the important role of mobile phones in market arbitrage in local agricultural markets in developing countries. Jensen's (2007) study provided an excellent example for this mechanism in the market for sardines in Kerala, a southern Indian state. Before the introduction of mobile phones, arbitrage across markets did not occur because access to price information for sardines was limited. The introduction of mobile phones stimulated arbitrage across markets, price dispersion across markets diminished, and the excess supply of sardines was eliminated. As a result, the profits of fishermen increased by 8% and consumer surplus increased by 6%. Aker (2010) investigated the impact of mobile phones in millet markets in Niger. Since mobile phones facilitate traders' search activity in markets, the expected impact of mobile phones is almost the same as in the case of Jensen (2007). Aker found that price dispersion declined by 10–30% and traders' profits increased by 29%, leading to an increase in consumer welfare. Goyal (2010) analyzed the impact of an internet kiosk that provided information on the wholesale price of market performance in the central Indian state of Madhya Pradesh. Her result supports the proposition that market information improves efficiency in market performance. However, findings by Marcel and Minten (2012) for Maharashtra, a state in western India, contradicted this proposition. They conducted a randomized controlled experiment to deliver market information—including price and weather information—to farmers. Their intervention had no impact on the price variation of agricultural products.

Next, we explain the impact of mobile phone usage on the market power of buyers under monopsony in the local agricultural market. Because of the high entry cost for buyers (e.g., traders must bear fixed costs such as for storage facilities and vehicles for transportation as well as running transportation costs such as gas or access to credit for the purchase of agricultural products), the entry of buyers is limited in the local agricultural market. Monopsony occurs in local agricultural product markets, where farmers sell their agricultural products at a lower price (Jensen, 2010).

Market information may lower the degree of monopsony in local agricultural markets. Farmers who are informed of the selling prices in other agricultural markets sell their product in these other markets[2] if the transportation is not more costly than the difference in the selling prices between the markets. Thus, buyers in the local agricultural market must set a higher price than what they offered previously, and therefore, buyers' monopsony power in the local agricultural market declines (Goyal, 2010). In addition, mobile phones allow farmers to communicate with traders. Since this communication lowers the search cost of traders, the number of traders who enter the local agricultural market increases. As a result, the traders' monopsony power declines in the local agricultural markets (Jensen, 2010). Hence, mobile phones allow farmers to receive a higher price for their output.

A number of empirical papers have investigated the impact of better access to market information on the selling price. Svensson and Yanagizawa (2009) analyzed the impact of market information transmitted via local FM radio stations on the farm-gate prices of maize in Uganda. They found that informed farmers sell at a higher farm-gate price. Ochiai and Yamasaki (2013) estimated the impact of the diffusion of mobile phones on the selling price of wheat in rural areas in India and found a positive impact on the selling price for small-scale farmers. Their interpretations of these results are that the information gained through FM radio or mobile phone usage improves farmers' bargaining power against buyers. Marcel and Minten (2012) investigated the impact of market information through the SMS messaging service of mobile phones on the selling prices of agricultural products. However, they found SMS messaging to have no impact on the selling prices. Lee and Bellemare (2013) analyzed how mobile phone ownership affects the prices that farmers receive for their cash crops in the Philippines. They found that the selling price increases in cases where a household's father or his spouse has a mobile phone, while farmer ownership of a mobile phone did not affect the selling price. Their results imply that the purpose of mobile phone usage is related to whether farmers sell their products at a higher price or not.

Our approach differs from the previous studies in two respects. First, in the survey, we asked not only about farmers' ownership of mobile phones, but also whether they access market

[2] Farmers usually sell their products to traders at the local monopsony market, whereas the traders sell their purchases to wholesalers in a competitive market. If farmers can sell their agricultural products directly at the wholesale market, they can sell their goods at a competitive price.

information at the time they sell their rice. Thus, we can directly analyze the impact of improved access to market information through mobile phone usage on the selling price of agricultural products. Second, we investigate how improved access to market information through mobile phone usage improves farmers' bargaining power against buyers. Previous studies examined the relationship between access to market information and the selling prices of agricultural products. However, they did not specify in detail the reasons why improved access to market information increases the selling price of agricultural products.[3]

3. Data

Rice farming is an important income source in Cambodia. Rice is a main cereal crop, and 80% of farmers in Cambodia are engaged in rice farming, which covers approximately 80% of Cambodia's total cultivated land. According to the World Development Indicators of the World Bank,[4] the percentage of value added by the agriculture sector to GDP was 37% in 2008. Small-scale farmers' production systems and the lack of organized rice farmers associations lower farmers' bargaining power against buyers. Therefore, the selling prices of rice in rural areas tend to be lower than those in urban areas; this creates a profit margin from arbitrage (El-Noush, 2010). In Cambodia, buyers earn 10–15% of the market price as margin (UNDP, 2004).

Many farmers sell their rice immediately after harvest, while others sell their rice after drying. This might be related to limited storage facilities (El-Noush, 2010). In addition, they are under pressure to sell their rice as soon as their crop is harvested because farmers are usually contracted to pay back their debt immediately following the harvesting season. In fact, 25.9 % of farmers borrowed money for farming in wet season in our sample. Therefore, they tend to sell their crop at a price offered by local buyers such as grain traders instead of searching for buyers who could offer a higher price.

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[3] Although previous studies have attempted to identify the causal effect of access to market information on selling prices by using natural experiments (e.g., Svensson and Yanagizawa (2009) applied the difference-in-difference method) or field experiments (e.g., Marcel and Minten (2012) applied the randomized control trial method), these studies could not identify why access to market information raises selling prices. It is necessary to collect not only farmer information but also buyer information to identify the mechanism.

[4] Accessed on December 28, 2013. http://data.worldbank.org/data-catalog/world-development-indicators

We conducted a survey of farmers in 20 villages in four provinces (Battambang, Prey Veng, Pursat, and Takeo) from December 2012 to January 2013 to assess the post-harvest technology interventions that the IRRI implemented to improve living standards in rural areas in Cambodia. The survey period corresponds to the one-month period following the wet season because almost all of the rice farmers in Cambodia are engaged in rice farming during this period. We collected information on farmers' ownership of mobile phones, usage of mobile phones to access market information, agricultural activities during the past year, marketing activities, usage of post-harvest technologies, social and demographic characteristics, and non-agricultural income sources. In the survey, we selected farmers randomly in each village and invited them to a public place in the village. Enumerators were assigned to each farmer. Each enumerator started the interview at a distance from the other enumerators to avoid the influence of other farmers' responses. We requested that the selected farmer be the household head or his wife. The enumerators asked the farmers each question orally to avoid any misunderstanding. Each respondent received a gift at the end of the interview.

Since the primary purpose of the survey is to assess the mid-term impact of these post-harvest interventions, the surveyed villages were divided into treatment villages and control villages. Treatment villages received post-harvest technological equipment[5] from the IRRI while control villages did not. We collected the same information from both groups for our analysis.

Two types of rice seed are predominantly used in Cambodia: traditional variety seed and modern variety seed. The former is an indigenous variety that farmers have used for a long time; the latter is a hybrid introduced to Cambodia in the 1990s (FAO, 2002). The selling prices of traditional variety rice are usually higher than those of modern variety rice—this may reflect Cambodian people's taste. Cambodia has three agricultural seasons: dry, early wet, and wet. The seed types have different tolerance levels: farmers can sow the traditional variety only during the wet season, while the modern variety can be sown in all seasons.

[5] The provided post-harvest technologies in the project include combined harvesting services, mechanical dryers, hermetic storage systems (including 50 kg Super Bags (SB)), granary improvements, rice milling improvements, moisture meters, scales, cleaners, and thermometers.

Our survey asked specifically when farmers sold their rice. According to our data, most farmers sold their rice immediately after the harvest rather than after drying the rice (285 cases of sales were immediately after harvest, while 68 cases were after drying). This is consistent with the anecdotal evidence we mentioned in section 3 (El-Noush, 2010). In our main analysis, we use the sample of farmers who sold their rice immediately after harvest.[6]

Although we surveyed 349 households, not all farmers sold rice in the past year (some farmers produce rice for self-consumption). In our sample, 162 farmers sold rice after harvest at least once in the past year.[7] Table 1 shows the descriptive statistics of the farmers. The average age of a household head is 49 years old. Household heads have completed an average of 4.9 years of education. The share of male heads in our sample is 82.1%. The average number of years of rice farming is 28.1 years. The average total non-agricultural income is 3.2 million riel.

Table 2 displays the descriptive statistics of the variables related to rice sales (including the characteristics of rice and rice plots). The average selling price of rice is 958.0 riel/kg, and 21.3% of farmers' offers affect the selling price. Regarding the usage of mobile phones to access market information, 80.5% of farmers use mobile phones to acquire market information before selling their rice. Regarding the types of rice over seasons in our sample, 44.9% of rice was the traditional variety planted in the wet season, 5.5% was the modern variety planted in the wet season, 21.0% was the modern variety planted in the early wet season, and 28.7% the was modern variety planted in the dry season. Farmers sold an average of 2,744 kg of rice. Average rice plot size was 1.2 ha. Regarding the soil type of the plots, the shares of loam, clay, and sand are 86.0%, 14.0% and 0.4%, respectively.

4. Estimation method and results

4.1 Impact on the selling price of rice

First, we investigate the effect of improved access to market information through the use of mobile phones. We estimate the following model using ordinary least squares,

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[6] If we include both types of farmers in the sample—those who sell immediately after harvest and those who sell after drying—we cannot control for the quality of the rice produced according to the soil quality of plots because farmers aggregate rice after drying.

[7] 230 farmers sold their surplus rice at least once during the past year.

$$p_{ijt} = \beta_0 + \beta_1 mobile_{ijt} + z_v + u_{ijzt}, \qquad (1)$$

where p_{ijvt} is the log of selling price of rice that farmer *i* grows in plot *j* at period *t*; $mobile_{ijt}$ indicates whether farmer *i* used a mobile phone to acquire market information before selling rice grown in plot *j* at period *t*; z_v is the village fixed effects; u_{ijzt} is the error term. Since common idiosyncratic shocks such as weather in a village may occur, we estimate the heteroscedasticity-consistent standard error, accounting for clustering within villages. Equation (1) allows us to control for the (time-invariant) characteristics of each village (e.g., accessibility to markets in urban areas) and to estimate the impact of the degree of access to market information on the selling price.

The estimated result of Equation (1) is shown in column 1 of Table 3. The coefficients for village fixed effects are not shown in Table 3 to save space. The estimated coefficient for $mobile_{ijt}$ is positive and significant. This implies that farmers who use mobile phones to acquire market information tend to increase the selling price by 4.4 %. However, other factors are omitted in Equation (1), resulting in omitted variable bias in the estimated coefficient of $mobile_{ijt}$. For example, the educational level of farmers is omitted in Equation (1). Educated farmers tend to use mobile phones to acquire market information and sell their rice at a higher price. In this case, the estimated coefficient for $mobile_{ijt}$ in Equation (1) is biased upward because of the effect of educational level. Another factor may induce bias in the estimated coefficient for $mobile_{ijt}$ in Equation (1). Farmers who acquire market information using mobile phones choose a better quality of rice to sell and thus sell it at a higher price. As a result, the estimated coefficient for $mobile_{ijt}$ is biased upward because of the effect from the better quality of rice.

To remove these biases, we add explanatory variables such as farmers' characteristics and rice quality to Equation (1). Equation (1) then becomes

$$p_{ijvt} = \gamma_0 + \gamma_1 mobile_{ijt} + \gamma_2\, selling_{ijt} + \gamma_3\, X_i + z_v + e_{ijzt}, \qquad (2)$$

where $selling_{ijt}$ is a vector of variables directly affecting the selling price, such as the variety of rice, quantity of rice, size of the plot in which the rice was grown, and the soil quality of the plot; X_i is a vector of farmers' characteristics (age of household head, education of head, years of rice farming, sex of head, non-agricultural income in the past year); e_{ijzt} is the error term. We also

estimate the heteroscedasticity-consistent standard error, accounting for clustering within villages. Equation (2) allows us to control for the characteristics of the quality of rice, farmer characteristics, and village characteristics.

The estimation results for Equation (2) are shown in column 2 of Table 3. We do not report the coefficients for the village fixed effects in Table 3 to save space. Along with the estimated results of Equation (1), the estimated coefficient for $mobile_{ijt}$ is positive and significant, but the magnitude of the estimated coefficient for $mobile_{ijt}$ is greater than that for Equation (1). This implies that other uncontrolled determinants of the selling price of rice in Equation (1) are correlated with both the usage of mobile phones and the selling price of rice.

The selling prices of traditional variety rice are higher than those of modern variety rice. The selling prices of rice grown in plots with sandy soil are significantly lower. The quantity of rice significantly increases the selling price. This result is consistent with the anecdotal explanation in El-Noush (2010) that small-scale farmers tend to sell their rice at lower prices. However, it is difficult to explain why small-scale farmers sell at lower prices. Household characteristics are also found to affect the selling price: the coefficients for the age of the household head and total non-agricultural income are positive and significant.

Robustness Check

While most farmers sell their rice to grain traders, some sell to millers or others. Thus far, we have not distinguished to whom the farmers sold rice[8]. Here, we limit the sample to farmers who sold rice to grain traders to estimate Equation (2). Grain traders usually buy rice in villages. The following estimation corresponds to how improved access to market information through mobile phone usage affects the selling price in the local agricultural market. The result is shown in column 3 of Table 3. The estimated coefficient for $mobile_{ijt}$ is positive, while its significance level is lower than that in column 2 of Table 3.

Thus far, we have focused on the sale of rice immediately after harvesting, although some farmers in our sample sold rice after drying. We now check whether our result is robust with the addition of farmers who sold rice after drying to the sample used in column 2 of Table 3. However,

[8] In our sample, 237 buyers are grain traders, 6 buyers are miller and 29 buyers are others.

we cannot control for the conditions of the plots in which rice grows because farmers aggregate rice after drying. Thus, we replace plot characteristics such as plot size and soil quality with a dummy variable indicating whether or not farmers sell rice after drying in Equation (2) and estimate a modified version of Equation (2). The result of this estimation is shown in column 1 of Table 4. The estimated coefficient for mobile phone usage is positive and significant. In addition, we limit the sample used for column 2 in Table 4 to farmers who sold rice to grain traders and estimate the modified version of Equation (2) again. The result of the estimation is presented in column 2 of Table 4. The estimated coefficient for $mobile_{ijt}$ on the selling price is also positive and significant.

Falsification test

As indicated above, improved access to market information through mobile phone usage is positively correlated with the selling price while controlling for rice quality and farmers' characteristics. However, an unobservable heterogeneity of farmers may affect both the usage of mobile phones to access market information and the selling price because whether or not farmers use mobile phones to acquire market information is the farmers' choice. Thus, the conditional independent assumption (CIA) as the necessary condition to identify the hypothesized causality may not be satisfied (Angrist and Pischke, 2008). If the CIA is violated, the unobservable heterogeneity of farmers results in a bias in the estimated coefficient for $mobile_{ijt}$ in our estimation results.

For example, an unobservable difference between mobile phone owners and non-owners may appear in the estimated coefficient for $mobile_{ijt}$ in Equation (2). If the unobservable difference is correlated with the selling price of rice, we are unable to isolate the effects of improved access to market information through mobile phone usage from the unobservable differences among the statuses of mobile phone owners. To test this possibility directly, we replace the variable of $mobile_{ijt}$ with a dummy variable indicating whether the farmer owns a mobile phone or not in Equation (2) and estimate this modified version of Equation (2). The estimated result is indicated in column 1 of Table 5. The estimated coefficient for ownership of a mobile phone is positive but non-significant. This implies that the unobservable heterogeneity in the differences among the statuses of mobile phone owners does not cause a bias in the estimated coefficient for $mobile_{ijt}$ in our estimation results. This is consistent with the result of Lee and Bellemare (2013), who found that the status of farmers' ownership of mobile phones is not correlated with the selling price in the Philippines.

The effects of other unobservable factors may cause a bias in the estimated coefficient for $mobile_{ijt}$ in our estimation results. Farmers who usually take market information into account may sell their rice at a high price regardless of their usage of mobile phones to acquire market information. In this case, the effects of the unobservable characteristics of these farmers cause a selection bias in the estimated coefficient for $mobile_{ijt}$ because of a violation of the CIA. Here, we investigate whether or not the effects of these farmers affect the selling price of rice irrespective of the usage of mobile phones to acquire market information. These farmers are expected to ask their relatives or other farmers about market information and to sell their rice at a higher price. In this case, farmers' source of market information should be positively correlated with the selling price regardless of mobile phone usage for access to market information. To test this possibility, we replace the variables for $mobile_{ijt}$ in Equation (2) with a dummy variable indicating the answer to the question, "What is your source(s) of information on output price?" In particular, we focus on two sources: relatives and other farmers. The results are shown in columns 2 and 3 of Table 5. The estimated coefficients of information sources are not significant. These results imply that these farmers' behavior does not cause a bias in the estimated coefficient for $mobile_{ijt}$.

4.2 Impact on farmers' bargaining power against buyers

We now proceed to the second empirical analysis. As we have shown, improved access to market information through mobile phone usage increases the price of rice; however, at this point, we still cannot specify why this is. In this subsection, we analyze whether or not access to market information through the use of mobile phones improves farmers' bargaining power against buyers. Previous studies have explained the positive effect of market information on selling price as being caused by an improvement of farmers' bargaining power against buyers (Ochiai and Yamasaki, 2013; Svensson and Yanagizawa, 2009). However, they did not directly analyze the effect of market information on bargaining power against buyers.

In our survey, we asked whether farmers' offers affected the selling price of rice at the time of sale. If farmers' bargaining power against buyers is high at the time of sale, farmers' offer should affect the selling price. We use a dummy variable for whether farmers' offers affect the

selling price as an indicator of farmers' bargaining power against buyers.[9] We replace the selling price, the dependent variable in Equation (2), with the dummy variable for the indicator of farmers' bargaining power against buyers. We estimate the modified version of Equation (2) using the probit model. The average marginal effect of the coefficient for $mobile_{ijt}$ is shown in column 1 of Table 6. It is positive and significant.[10] This implies that offers of farmers with access to market information through mobile phone usage affect the selling price. The result is robust even when we limit the sample to farmers who sold their rice to grain traders (see column 2 in Table 6). Thus, improved access to market information through mobile phone usage improves farmers' bargaining power against grain traders, and consequently, farmers are able to sell their rice at a higher price.

5. Concluding remarks

In developing countries, monopsony is widely observed in local agricultural markets because of high entry costs, and thus, farmers sell their agricultural products at lower prices. However, this trend has changed recently with the diffusion of mobile phones. Mobile phone usage contributes to the effective functioning of markets by dispersing market information such as the selling prices of agricultural products. As a result, the selling prices of agricultural products increase. In this paper, we have investigated the impact of improved access to market information through mobile phone usage on the selling price of rice in rural areas in Cambodia, controlling for determinants of selling price such as the quality of rice and the characteristics of farmers. Moreover, in order to examine why improved access to market information through the use of mobile phones increases the selling price of rice, we have analyzed how it affects farmers' bargaining power against buyers regarding the selling price of rice. Our analysis is based on data collected by the authors in 20 villages in four provinces (Battambang, Prey Veng, Pursat, and Takeo) from December 2012 to January 2013.

We found that improved access to market information through mobile phone usage increases the selling price of rice. However, because of the limitations of our research design, we

[9] It is difficult to measure bargaining power between farmers and buyers exactly. We follow an indicator of bargaining power within households in the context of family economics (e.g., Li and Wu, 2011; Reggio, 2010).

[10] The main result does not change even if we use a linear probability model. The results are available from the authors upon request.

were not able to statistically examine the causal relationship between improved access to market information through mobile phone usage and the selling price of rice. However, our results are robust even when we limited the sample to farmers who sell rice to grain traders. The falsification tests show that neither the effect of the unobservable heterogeneity of the ownership of mobile phones nor the effect of farmers who seek market information affects our results. Thus, our results are likely to provide the causal effect of the degree of access to market information on the selling price. In addition, improved access to market information through the use of mobile phones improves farmers' bargaining power against grain traders. Therefore, access to market information through mobile phone usage allows farmers to sell their rice at higher prices.

Table 1. Descriptive statistics of households

Variable	Sample	Mean	Std.Dev
Age of head	162	48.963	11.886
Education of head (year)	162	4.889	3.044
Sex of head (1 = male, 0 = female)	162	0.821	0.385
Years of rice farming	162	28.117	12.662
Total nonagricutural income (riel)	162	3192324	3479706

Notes
1. As of 31 December 2012, US$1 was equivalent to 3,909.4 Cambodian Riel.

Table 2. Descriptive statistics of plot level

Variable	Sample	Mean	Std.Dev
Dependent variable			
Selling price (riel/kg)	272	957.960	194.476
Did farmer offer affect selling price? (0 = yes, 1 = no)	268	0.213	0.410
Independent variables			
Whether farmers use mobile phone for gain market information (1 = yes, 0 = no)	272	0.805	0.397
Quality			
Modern Variety in dry season	272	0.287	0.453
Modern Variety in early wet season	272	0.210	0.408
Modern Variety in wet season	272	0.055	0.229
Traditional Variety in wet season	272	0.449	0.498
Quantity (kg)	272	2744.36	2840.157
Plot size (ha)	272	1.267	1.086
Type of soil			
Clay	272	0.140	0.347
Sandy	272	0.004	0.061
Loam	272	0.860	0.347
Other	279	0.070	0.255

Table 3. Regression result for the impact of mobile phone usage on selling price

Dependent variable : selling price (log)						
Independent variables	Column(1)		Column(2)		Column(3)	
	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err
Whether farmers use mobile phone to obtain market information (1 = yes, 0 = no)	0.044 **	0.016	0.049 *	0.025	0.045 +	0.027
Quality						
Modern Variety in early wet season			0.059	0.041	0.053	0.042
Modern Variety in wet season			0.068	0.044	0.069	0.064
Traditional Variety in wet season			0.269 ***	0.056	0.267 ***	0.055
Quantity (log)			0.030 **	0.013	0.034 **	0.013
Plot size (ha)			-0.010	0.018	-0.012	0.017
Type of soil (reference group = loam)						
Clay			-0.013	0.020	-0.027	0.027
Sand			-0.092 ***	0.025	-0.089 **	0.038
Other			0.025	0.025	0.030	0.028
Characteristics of farmers						
Age of head			0.002 *	0.001	0.002	0.002
Education of head (year)			-0.002	0.003	-0.005	0.004
Sex of head (1 = male, 0 = female)			-0.025	0.036	-0.031	0.041
Years of rice farming			0.000	0.001	-0.001	0.001
Total nonagricutural income (log)			0.032 **	0.015	0.022	0.018
Village fixed effect	YES		YES		YES	
Sample	272		267		235	
Adjusted R squared	0.124		0.420		0.443	

Notes

1. Standard error in parenthesis is clustered at village level.
2. Sample is limited to selling against grain traders in Column (3) of Table 3.

+ significant at the 15% level; * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 4. Robustness check

Dependent variable : selling price (log)	Dependent variable: selling price (log)			
Independent variables	Column(1)		Column(2)	
	Coef.	Std. Err	Coef.	Std. Err
Whether farmers use mobile phone to obtain market information (1 = yes, 0 = no)	0.047 *	0.026	0.059 **	0.025
Quality				
Modern Variety in early wet season	0.071 **	0.034	0.073 *	0.038
Modern Variety in wet season	0.085 **	0.039	0.084	0.052
Traditional Variety in wet season	0.262 ***	0.047	0.268 ***	0.049
Whether selling follows drying or not (1 = yes,no = 0)	0.079 ***	0.023	0.075 **	0.027
Quantity (log)	0.014 +	0.008	0.019 *	0.011
Characteristics of farmers				
Age of head	0.002 +	0.001	0.002 +	0.001
Education of head (year)	-0.003	0.003	-0.005 +	0.003
Sex of head (1 = male, 0 = female)	-0.004	0.027	-0.016	0.031
Years of rice farming	-0.001 +	0.001	-0.001	0.001
Total nonagricutural income (log)	0.036 ***	0.008	0.018	0.015
Village fixed effect	YES		YES	
Sample	332		292	
Adjusted R squared	0.383		0.400	

Notes

1. Standard error in parenthesis is clustered at village level.
2. The sample includes selling of both post-harvesting and post-drying.
3. The sample is limited to selling against grain traders in Column (2) of Table 4.

+ significant at the 15% level; * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 5 . Falsification test

Dependent variable: selling price (log)						
Independent variables	Column (1)		Column (2)		Column (3)	
	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err
Whether farmers own mobile phone or not (1 = yes, 0 = no)	0.015	0.032				
Whats is your source(s) of infromation on output price?						
relative (1 = yes, 0 = no)			-0.006	0.018		
other farmers (1 = yes,0 = no)					0.009	0.021
Descriptive statistics of independent variable	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
	0.961	0.195	0.542	0.4991	0.683	0.466
Sample	269		273		273	

Notes

1. Standard error in parenthesis is clustered at village level.
2. control variable is same as Column(2) in Table 3.

+ significant at the 15% level; * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 6. Regression results for the impact of mobile phone usage on bargaining

Dependent variable: Did your offer affect selling price? (yes = 1,no = 0)				
Independent variables	Column (1)		Column (2)	
	Average marginal effect	Delta-Method Std. Err.	Average marginal effect	Delta-Method Std. Err.
Whether farmers use mobile phone to obtain market information (1 = yes, 0 = no)	0.363 ***	0.051	0.442 ***	0.094
Sample	252		212	

Notes

1. Standard error in parenthesis are clustered at village level.
2. control variables are same as those in Column(2) in Table 3.
3. Sample is limited to selling against grain traders in Column (2).

+ significant at the 15% level; * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.