Information Access and Smallholder Farmers' Selling Decisions in Peru

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ABSTRACT

Previous studies have examined the effects of information access on rural price dispersion and local economy in developing countries, but few studies investigate information access on farmers' selling decisions that directly relate to individual farmer's utility and welfare. No study, to our knowledge, has particularly examined the effects of information access on smallholder farmers in Peru who generally occupy plots of less than five hectares and face enormous disadvantages. To bridge the gap in the literature, we employ an instrumental variable (IV) approach and seemingly unrelated regression (SUR) to examine the effects of internet and cell phones on Peruvian smallholder farmers' selling decisions using IV Agricultural Census (IV CENAGRO) of Peru data for the year 2012. Results suggest that internet positively affects Peruvian smallholder farmers' decisions to sell in both national and international markets and tends to have larger impact on decisions to sell in the national market. Mobile phones have smaller impacts compared to internet and only affect farmers' decisions to sell in the international market. Results provide empirical support for policies and social programs that promote internet usage and mobile phone coverage for rural Peru, which are important channels to enhance information access for economically disadvantaged smallholder farmers. Our results also suggest that ignoring endogeneity of information access understates its effects.

Keywords: Information and communication technology; Internet; Mobile phones; Smallholder farmers; Selling decisions; Peru

JEL codes: L86, O13, O18, Q12, Q13

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1. Introduction

The costliness and asymmetry of information could lead to inefficient market outcome and affect market agents' behavior (Brown and Goolsbee, 2002; McAfee, 1995; Stigler, 1961). A lack of information especially in developing countries could negative affect farmers' decisions to sell their agricultural products in the profitable markets. Obtaining information about the market such as prices, marketing strategies, potential buyers and brokers could be costly and difficult for farmers in developing countries. Thus, the public and policymakers have paid close attention to mechanisms that promote information access for economically disadvantaged agricultural producers and sellers. Extending mobile phone service coverage and establishing internet kiosks in rural areas of developing countries are typical social programs and policies that aim to provide marketing channels and price information for farmers.

In recent years, there is a growing number of literature that studies the effects of information access on rural farmers' performance and market efficiency through usage of mobile phones and internet in developing countries (Burga and Barreto, 2014; Aker, 2010; Goyal, 2010; Klonner and Nolen, 2010; Jensen, 2007). While most of these studies focus on price dispersion effect and labor market effect, the role that information plays in farmers' selling decisions is not well documented. Understanding farmers' selling decisions and their market access is important to assess smallholder farmers' performance and could guide policy making in designing appropriate information service and access mechanisms to improve farmers' economic condition and reduce poverty in rural areas.

In addition, there is a lack of literature that investigates the effects of information access on smallholder farmers in Peru.[2] Like many developing countries, farmers in Peru are linked to the market through intermediaries including traders, processors and retailers. Farmers sell their agricultural products to traders at wholesale price. Traders in turn resell the products to processors at higher price, and collusion among traders could cause detriments to farmers. In addition to the market condition, Peruvian smallholder farmers face many challenges including agricultural land fragmentation, low agricultural productivity, climate extremes, and less developed technology (Sanchez-bender, 2013). Due to the disadvantages of the smallholder farmers in Peru, understanding the effects of information access on Peruvian farmers' decisions to sell agricultural products is important, which could provide evidence for policy makings that targets at reducing poverty in rural Peru.

This paper adds to the literature by estimating the effects of accessing information using internet and mobile phone on Peru's smallholder farmers' decisions to sell products at different markets. We test two hypotheses: 1) Mobile phones and internet positively affect smallholder farmers' selling decisions; and 2) The impact of both information and communication technology (ICT) mechanisms will differ depending on the type of the markets analyzed (i.e. national vs international market). We employ seemingly unrelated regression (SUR) to estimate three equations regarding farmers' selling decisions, measured by the percentage of farmers who sell their products—1) sell at both national and international markets; 2) sell only at the national market; and 3) sell only at the international market. Given that information access is likely to be correlated with unobserved economic

[2] Smallholder (or small-scale) farmers generally occupy plots of less than five hectares.

condition and activities, we use geographic variable and electricity usage in distant years as IVs respectively for internet and mobile phone usage.

Results confirm our hypotheses that both internet and cell phones positively affect Peruvian smallholder farmers' selling decisions. Internet positively affects farmers' decisions to sell in both national and international markets and tends to have larger impact on national market participation, while mobile phones have smaller impacts than internet and significantly affect farmers' decision to sell in the international market only. Our results provide empirical support for policies that promote access to internet and mobile phone usage in developing countries like Peru. Importantly, our results show that ignoring endogeneity of information access understates the effects of both internet and cell phones.

The paper is constructed as follows. The next section reviews the literature that studies the effects of information access on rural farmers in developing countries, followed by the theoretical framework. The fourth section describes data, followed by the fifth section where empirical model is presented. The sixth section discusses results and the last section concludes with future directions.

2. Literature Review

An increasing number of studies have examined the effects of mobile phone rollout and internet service provision on price dispersion and economic development in developing countries. Burga & Barreto (2014) employ a difference-in-difference (DD) method to examine the impact of government program that promotes the access to internet and phone usage in Peru. Authors find that the phones have larger mean impacts especially on rural farmers, while internet plays a more important role in increasing working-age population's

employment. Klonner and Nolen (2010) also find positive impacts of mobile phone rollout on non-agricultural employment. Similarly, Beuermann et al. (2012) find that mobile phone coverage significantly reduces poverty rate in rural Peru. In addition to the effects on labor market and economic development, Aker (2010) applies DD approach to Niger in Africa and studies the impacts of mobile phone rollout on price dispersion across markets. The author finds evidence that the mobile phone coverage significantly reduces price dispersion and the effect is stronger in distant markets with unpaved roads. The empirical support for the effects of mobile phone access on price dispersion reduction is also found by Jensen (2007) and Goyal (2010), who use micro-level survey to investigate the agricultural markets in India.

Literature on the effects of information access on farmers' market participation decisions, however, is not well documented. Goetz (1992) models grain farmers' market participation choice and transaction volumes in southeastern Senegal, Africa using a two-stage discrete and continuous approach. Results suggest that information access positively affects farmers' market participation decision, while coarse grain processing technology significantly increases transaction volume. Bellemare and Barrett (2006) employ an ordered Tobit model to examine the effects of price information on farmers' decision making in market participation and find that marketplace choice and quantity sold or bought are sequential process. Famers who make sequential marketing decisions are more responsive to changes in prices thus price information is an essential factor in farmers' market participation decisions. Specific channels used to increase information access are discussed in later studies. For example, Zanello et al. (2012) examine the effects of mobile phones and radios on farmers' choices of marketplaces in northern Ghana, India. Authors

find that information access has larger impacts on farmers' decisions to sell in the local and closer markets, where they could use information to gain bargaining power. Beyond choices of marketplaces, Zanello (2012) suggests that mobile phones have significant impacts on market participation, while radios play a more important role in selling volumes. In contrast, few other studies find insignificant impacts of the mobile phones on smallholder farmers' marketing decisions (Alene et al., 2008; Fafchamps & Minten, 2012).

Given the increasing needs of studying smallholder farmers' marketing decisions, it is important to understand the factors that influence market participation decisions. Transaction costs that include transportation costs, costs of information searching, and sales taxes are one important factor that causes market barriers for smallholder farmers (Janvry et al. 1991; Key et al., 2000; Renkow et al. , 2004). Vakis et al. (2003) use micro-level data in Peru and find that information on market price reduces transaction costs by approximately four times of transportation costs. Hence, improving access to information and reducing information searching costs could improve smallholder farmers' market participation.

This paper adds to the literature on information access and smallholder farmers' marketing decisions in a developing country context. The contributions are threefold. First, we examine the effects of mobile phone and internet on farmers' selling decisions in different markets by capturing transportation costs represented by travel time to central market district. Second, we add to the thin literature that investigates the effects of information access on smallholder farmers in Peru, who face varieties of challenges and market barriers. Third, we address the empirical challenge faced in the previous studies and use geographic variable as instrumental variable for information access.

3. Theoretical Framework

Based on the basic household choice model, we assume that farmers maximize utility given their budget constraint. We specify the marketplace j and modify the conceptual model by Barrett (2008) as follows.

$$\max_{y^a, x, A^a, G} U(y^a, x, A^a, G) \qquad (1)$$

$$s.t. \quad \sum_{k=1}^{K}[M_k^{as} p_k^a f_k^a(A^a, G) - \tau_k^a(Z, A^k, G, f_k^a(A^a, G), D)] + W^{na} = x + M_k^{ab} p^a y^a \qquad (2)$$

where y^a represents the bundled agricultural products; x represents numeraire consumption; A^a represents privately own assets including land, machinery, labor, etc.; G represents services such as roads, electricity, and key variables of our interest—information access (i.e. mobile phone and internet usage); $f_k^a(A^a, G)$ represents the production technology if the agricultural product is sold in market *k* and is a function of privately own assets A^a and services captured in G; p_k^a represents price of agricultural product in market k (e.g. national market and international market); M_k^{as} represents whether farmers sell agricultural products in market k ($M_k^{as} = 1$ if yes; otherwise $M_k^{as} = 0$), and M_k^{ab} represents whether farmers buy agricultural product in market *k*. To simplify the model, we disregard buying decisions and assume that farmers are either net producers or autarkic, hence, $M_k^{ab} = 0$; W^{na} represents non-farm income; $\tau_k^a(Z, A, G, f^a(A^a, G), D)$ represents transaction cost that is a function of household characteristics indicated by Z , which may affect negotiation and searching costs (e.g. educational attainment, gender, age), household privately own assets indicated by *A* (e.g. land size), information access indicated by *G* (e.g.

mobile phone and internet usage), production technology $f_k^a(A^a, G)$, and travel time to the central market district *D* that serves as a proxy for transportation costs.

By substituting equation (2) into (1), we obtain the indirect utility function denoted as $V(M_k^{as}\ ;\ p_k^a, A, G, W^{na}, D)$. Given that price is not observed and we only observe the selling choice and outcome, we write the model as follows:

$$U_{i,k} = \beta_0 + \beta_1 X_{i,k} + \varepsilon_{i,k} \qquad (3)$$

where $U_{i,k}$ represents the utility the farmer obtain by selling their agricultural product in market *k* (*k* is either national or international market). $X_{i,k}$ includes all the observed variables such as *A, G,* W^{na}, D as described under equation (2).

Given the sparse data (i.e. many zeros with the choice of selling agricultural product in the international market), we aggregate individual's choice to the district level and alternatively estimate selling decisions at the district level *j*.

$$Y_j^k = \beta_0^k + \beta_1 X_j^k + \varepsilon_j^k \qquad (4)$$

where Y_j^k represents percentage of individuals who sell their agricultural product in market *k*; the vector of explanatory variables X_j includes the aggregated household-specific characteristics at district level *j* including percentage of farmers who use internet or/and mobile phones to obtain information.

4. Data

The data for the analysis is obtained from the IV Agricultural Census (IV CENAGRO) of Peru in 2012, which covers detailed information of farm household's

characteristics including age, literacy, gender, household size, labor, land size, whether the agricultural producer uses internet or mobile phone to acquire information, travel time to the capital district, etc. This dataset covers 1,723,445 smallholder farmers in Peru, who occupy plots of less than 5 hectares. We aggregate household-level data to district level with a total number of 1,684 observations.[3]

There are three dependent variables based on the percentages of farmers who sell agricultural products in the national market, international market, and both of the markets, respectively. As shown in summary statistics (Table 1), the mean of percentage of farmers who sell their agricultural products in the national market is the highest at 42.3%, while the mean percentage of farmers who sell their agricultural products in both national and international markets is only 0.32% at the district level. The distributions of selling percentage respectively in the national and international markets are shown in Figure 2-1 and Figure 2-2.

The percentage of farmers who use internet to get information is approximately 2%, and the percentage of those who use mobile phones is larger at 4.6%. These two variables serve as the key variables of our interest. Figures 3-1 and 3-2 show the distribution of both ICT in Peru. Mean household size is three and average age is just above 50. Male percentage is above 65%. Mean land size is 0.88 hectare. Average travel time to the capital district is about 1.5 hours. The mean percentage of farmers who have non-agricultural income is only 4%.

[3] There are 1,832 districts in Peru but information access data is available only for 1,684 districts.

District-level elevation measured in meters is used as instrumental variable for internet access. Elevation data at the Census tract level is retrieved from the IV CENAGRO. The district-level elevation is acquired by taking the mean of elevation for all census tracts within a given district. Mean elevation varies substantially across districts, which ranges from 5 to 4,733 meters above the sea level.

5. Empirical Model

Three equations are used to regress percentage of farmers' decisions to sell respectively in national market, international market, and both markets on household characteristics, information access (mobile phone usage, internet usage, or both), land size, non-agricultural income, and travel time to capital district at the district level.

$$\begin{cases} PERCENT_{j,nat} = \beta_0 + \beta_1 INFO_j^k + X_j'\gamma + S_r + \varepsilon_j \\ PERCENT_{j,inter} = \beta_0 + \beta_1 INFO_j^k + X_j'\gamma + S_r + \varepsilon_j \\ PERCENT_{j,nat\_inter} = \beta_0 + \beta_1 INFO_j^k + X_j'\gamma + S_r + \varepsilon_j \end{cases} \quad (5)$$

where $PERCENT_{j,nat}$ represents percentage of smallholder farmers in district *j* who choose to sell their product in the national market only; $PERCENT_{j,inter}$ represents percentage of farmers who sell their product in the international market only; $PERCENT_{j,nat\_inter}$ represent percentage of farmers who sell their product in both national and international markets. $INFO_j^k$ represents percentage of farmers who use ICT *k* to get information, where *k* indicates internet, mobile phone, or both. X_j is a vector of variables including household- and district- specific characteristics such as district-level mean of age, literacy, household size, male percentage, percentage of farmers who hire labor, land size, non-agricultural income, travel time to the capital district. S_r represents region fixed effects.

Given that the error terms of the three equations are likely to be correlated, seemingly unrelated regression (SUR) is used to account for error correlation across equations. An empirical challenge faced in the literature is the endogeneity of information access, which is likely to be correlated with unobserved economic condition and activities. To construct the instrumental (IV) variable, we overlay geographical data with Peru district map to generate elevation and land gradient variable at the district level. Dinkelman (2011) suggests that the geographic variable is correlated with electricity generation—higher gradient raises the average cost of a household connection, making elevation or land gradient an important factor in prioritizing areas for electrification. The less of incline the land has, the fewer hills and valleys and the softer the soil, the cheaper it is to lay power lines and erect transmission poles. On the other side, elevation or land gradient is less likely to be directly correlated with omitted economic activities for each district. Applying the same logic, we use elevation as IV for internet usage since it is likely to be exogenous and is correlated with the internet coverage and thus to the internet usage. For mobile usage, we use electricity data in distant year 1993 and assume this lagged variable is uncorrelated with the economic activities in the current year 2012. Hence, two-stage least squares (2SLS) approach is combined with SUR to estimate the effects of phone and internet on farmers' marketplace choices.

6. Results and Discussions

We respectively estimate the effects of internet, mobile phones, and both information access channels on farmers' marketplace choices and report results are in Tables 2-1, 2-2, and 2-3. Focusing on the effect of internet as shown in Table 2-1, we find

that internet usage has the largest effect on decisions to sell in the national and closer market, while the effect on international and distant market is much smaller. Increasing internet usage by 1% leads to 2.5% increase in the share of farmers who sell in the national market and 0.24% increase in the share of farmers who sell in the international market, while the increase in the share of farmers who sell in both markets is less than 0.1%. One possible reason is that farmers could use internet to obtain information about prices at the national market, which could help farmers negotiate the price with intermediaries or traders at the national level. For the international market, information access may not be the most important factor, but many other factors such as transaction costs, large production scale depending on the production technology, and comparative advantage in production could play more important roles in determining farmers' decisions to sell in the distant market.

Focusing on the second column that shows results from the equation that estimates domestic selling decisions, household size is negatively significant. Perhaps farmers with larger household size are likely to self-consume more agricultural products and less likely to be net producers. Male percentage is positively significant, suggesting that male farmers significantly contribute to agricultural production and are likely to sell the surpluses. Producers who hire labor are more likely to sell their products. Land size positively affect farmers' selling decisions. Non-farm income is negative and significant, suggesting that farmers who have non-farm earnings are less likely to sell agricultural products. Travel time to capital district is negatively significant, which suggests significant travel cost.

Turning to the results shown in Table 2-2, the effect of mobile phone is only significant for the equation that estimates decisions to sell in the international market but the magnitude is smaller compared to the effect of internet usage. Other coefficients are

largely consistent with those shown in Table 2-1. As a comparison, Table 2-3 shows results from the model that includes both mobile phone and internet usages. The effect of internet usage is similar to the magnitude as shown in Table 2-1, and coefficient of mobile phone is not significant as indicated by the model. Among all the marketplace choices, internet tends to play a more important role in selling decisions in the national market.

In order to compare results with those that ignore the endogeneity of information access, we include the results without IV in Appendix A. Although most of the coefficients are largely consistent, magnitudes found for internet and mobile phones are much smaller than those from the SUR-IV model. Ignoring endoegeneity of information access likely underestimates the effect of internet and mobile phones.

7. Conclusions

We employ an instrumental variable (IV) approach and seemingly unrelated regression (SUR) to examine the effects of internet and cell phones on Peruvian smallholder farmers' selling decisions measured as the percentage of agricultural production placed in national market, international market, and both markets, respectively.

Results suggest that both internet and cell phones positively affect Peruvian smallholder farmers' selling decisions. Internet tends to have a larger impact on selling products in the national market and generally have more widespread effect compared to mobile phones. The effect of mobile phones is found to be significant only for selling decisions in the international market. Similarly, Burga and Barreto (2014) suggest that internet seems to have larger impacts on local agricultural activities. Our results provide empirical support for policies that promote access to internet and cell phones in developing

countries like Peru. Importantly, our results show that ignoring endogeneity of information access understates the effects of both internet and cell phones. More caution needs to be taken when interpreting the effect of information access and endogeneity needs to be addressed.

Future directions include analyses that examine household-level market participation decisions using nested structure of decision-making process. While deciding to sell one's agricultural product, an individual household may sequentially select marketplace choice and transaction volumes. Future study will also include net buyers and model both buying and selling decisions simultaneously. In addition, welfare analysis would be helpful to examine the welfare impacts of internet and mobile phone usages in rural Peru.

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Table 1 Summary Statistics at the District Level

Variable	Description	Mean	Std. Dev.	Min	Max
Dependent variables (1,684)					
SELL_NAT_INT	% of farmers who sell in both national and international markets	0.32	1.592	0.0	30.4
SELL_NAT	% of farmers who sell only in the national market	42.30	32.773	0.0	100.0
SELL_INT	% of farmers who sell only in the international market	0.57	3.840	0.0	69.6
Independent variables (1,684)					
INTERNET	% of farmers who use internet to get information	2.08	4.605	0.0	77.8
PHONE	% of farmers who use phone to get information	4.61	7.248	0.0	66.7
LITERACY_50_70	50%-70% of farmers who can read and write (reference)	0.01	0.073	0.0	1.0
LITERACY_70_90	70%-90% of farmers who can read and write	0.19	0.393	0.0	1.0
LITERACY_90_100	90%-100% of farmers who can read and write	0.80	0.398	0.0	1.0
HH_SIZE	Mean household size	3.27	0.567	1.5	5.3
MALE	% male producers	68.06	11.391	33.3	100.0
AGE	Mean age	50.91	5.957	32.4	66.2
AGE_SQ	Age squared	2,627	596	1,047	4,385
LABOR_0_25	0%-25% of farmers who hire labor (reference)	0.32	0.468	0.0	1.0
LABOR_25_50	25%-50% of farmers who hire labor	0.32	0.465	0.0	1.0
LABOR_50_75	50%-75% of farmers who hire labor	0.22	0.415	0.0	1.0
LABOR_75_100	75%-100% of farmers who hire labor	0.14	0.348	0.0	1.0
LAND_SIZE	Mean land size (in hectare)	0.88	0.509	0.0	2.9
NON_AG_INC	% of farmers who have other non-agricultural income	4.23	7.956	0.0	98.7
HOUR_CAPITAL	Mean hours to the capital district (unit)	1.45	1.665	0.0	14.2
ELEVATION	Mean elevation (meters)	2,452	1,356	5	4,732

Table 2-1 SUR Results with IV (Internet Only)

Variables	(1)	(2)	(3)
	$PERCENT_{nat\_inter}$	$PERCENT_{nat}$	$PERCENT_{inter}$
INTERNET	0.075***	2.523***	0.244***
	(2.86)	(6.16)	(3.14)
60-80% LITERACY	-0.147	-8.444	-0.308
	(-1.55)	(-0.96)	(-1.40)
80-100% LITERACY	-0.058	-8.162	-0.237
	(-0.58)	(-0.94)	(-1.10)
HH SIZE	0.032	-7.167***	-0.224
	(0.39)	(-5.04)	(-1.24)
MALE PTG	0.002	0.431***	0.004
	(0.61)	(5.96)	(0.55)
AGE	0.236***	-4.609***	0.407**
	(3.89)	(-3.11)	(2.44)
AGE_SQ	-0.002***	0.040***	-0.004**
	(-3.57)	(2.78)	(-2.17)
25-50% FARMERS WHO HIRE LABOR	0.186***	9.943***	0.461***
	(2.96)	(6.39)	(2.63)
50-75% FARMERS WHO HIRE LABOR	0.028	13.721***	-0.114
	(0.36)	(8.20)	(-0.70)
75-100% FARMERS WHO HIRE LABOR	0.057	6.776***	-0.086
	(0.45)	(3.47)	(-0.24)
LAND SIZE	0.800***	24.967***	2.042***
	(5.13)	(14.10)	(4.38)
NON-AG_INC	0.001	-0.314***	0.001
	(0.29)	(-2.99)	(0.16)
TRAVEL	-0.005	-1.163***	-0.061
	(-0.18)	(-3.02)	(-1.44)
Department fixed effects	Significant	Significant	Significant
Observations	1,684	1,684	1,684
R-squared	0.140	0.587	0.140

z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 2-2 SUR Results with IV (Mobile Phone Only)

Variables	(1) $PERCENT_{nat\_inter}$	(2) $PERCENT_{nat}$	(3) $PERCENT_{inter}$
MOBILE PHONE	0.017	-0.112	0.051*
	(1.59)	(-0.95)	(1.76)
60-80% LITERACY	-0.149	-8.080	-0.310
	(-1.46)	(-0.85)	(-1.22)
80-100% LITERACY	0.001	-5.171	-0.039
	(0.01)	(-0.55)	(-0.16)
HH SIZE	0.143*	-2.792**	0.139
	(1.74)	(-2.19)	(1.01)
MALE PTG	-0.001	0.328***	-0.006
	(-0.14)	(4.88)	(-0.75)
AGE	0.190***	-5.472***	0.265
	(2.68)	(-3.90)	(1.23)
AGE_SQ	-0.002**	0.050***	-0.002
	(-2.42)	(3.55)	(-1.00)
25-50% FARMERS WHO HIRE LABOR	0.203***	10.542***	0.515***
	(3.15)	(7.75)	(2.67)
50-75% FARMERS WHO HIRE LABOR	0.055	15.227***	-0.021
	(0.73)	(8.99)	(-0.11)
75-100% FARMERS WHO HIRE LABOR	0.157	11.432***	0.249
	(1.23)	(5.61)	(0.84)
LAND SIZE	0.782***	28.240***	2.015***
	(5.06)	(15.27)	(3.67)
NON-AG_INC	-0.001	-0.348***	-0.004
	(-0.32)	(-3.57)	(-0.77)
TRAVEL	-0.023	-2.083***	-0.122***
	(-0.71)	(-4.89)	(-2.75)
Department fixed effects	Significant	Significant	Significant
Observations	1,684	1,684	1,684
R-squared	0.138	0.571	0.134

z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 2-3 SUR Results with IV (Both Internet and Mobile Phone)

Variables	(1) $PERCENT_{nat\_inter}$	(2) $PERCENT_{nat}$	(3) $PERCENT_{inter}$
INTERNET	0.091***	2.610***	0.195***
	(2.93)	(5.56)	(2.78)
MOBILE PHONE	-0.031	-0.172	0.096
	(-1.04)	(-0.34)	(1.10)
60-80% LITERACY	-0.130	-8.350	-0.361
	(-1.25)	(-0.91)	(-1.56)
80-100% LITERACY	-0.030	-8.006	-0.325
	(-0.27)	(-0.88)	(-1.37)
HH SIZE	0.035	-7.149***	-0.234
	(0.42)	(-4.47)	(-1.28)
MALE PTG	0.003	0.433***	0.003
	(0.71)	(6.06)	(0.32)
AGE	0.271***	-4.412***	0.297
	(3.31)	(-2.61)	(1.38)
AGE_SQ	-0.003***	0.038**	-0.003
	(-3.16)	(2.34)	(-1.22)
25-50% FARMERS WHO HIRE LABOR	0.184***	9.933***	0.467**
	(2.98)	(7.66)	(2.43)
50-75% FARMERS WHO HIRE LABOR	0.046	13.820***	-0.170
	(0.59)	(8.38)	(-0.99)
75-100% FARMERS WHO HIRE LABOR	0.087	6.944***	-0.181
	(0.68)	(3.54)	(-0.48)
LAND SIZE	0.957***	25.837***	1.555***
	(3.60)	(7.83)	(2.58)
NON-AG_INC	0.002	-0.307***	-0.003
	(0.59)	(-2.93)	(-0.46)
TRAVEL	-0.014	-1.211***	-0.034
	(-0.47)	(-2.61)	(-0.65)
Department fixed effects	Significant	Significant	Significant
Observations	1,684	1,684	1,684
R-squared	0.141	0.587	0.141

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

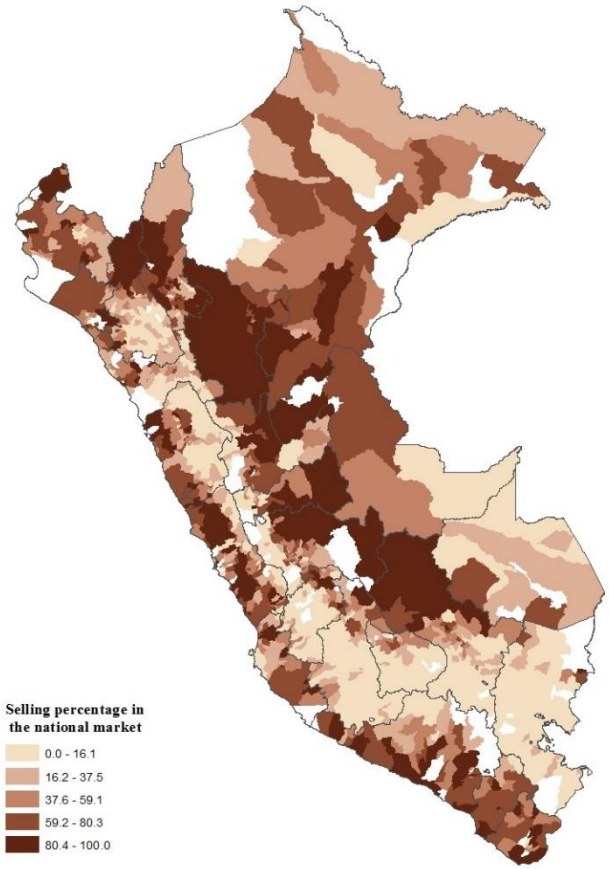

Figure 2-1 Percentage Distribution for Farmers Who Sell Agricultural Products in the National Market

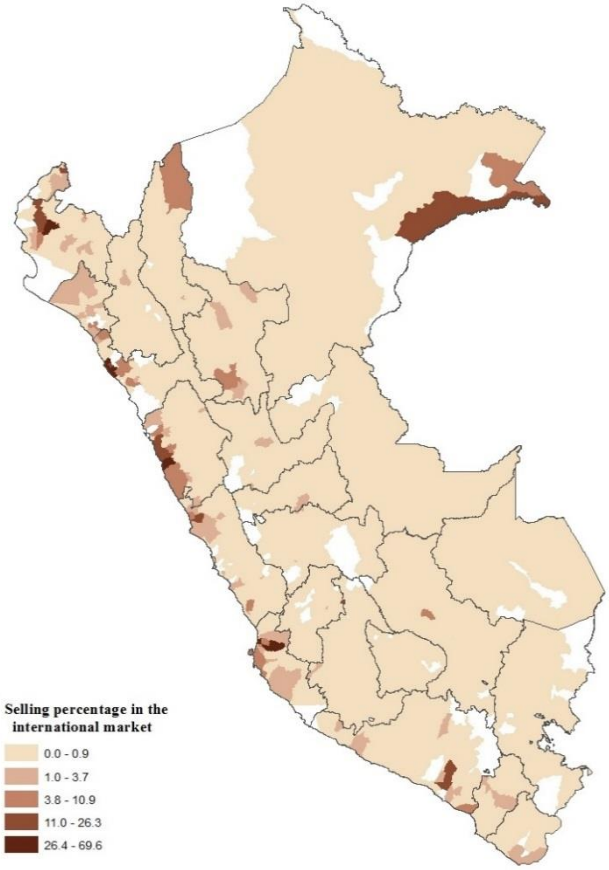

Figure 2-2 Percentage Distribution for Farmers Who Sell Agricultural Products in the International Market

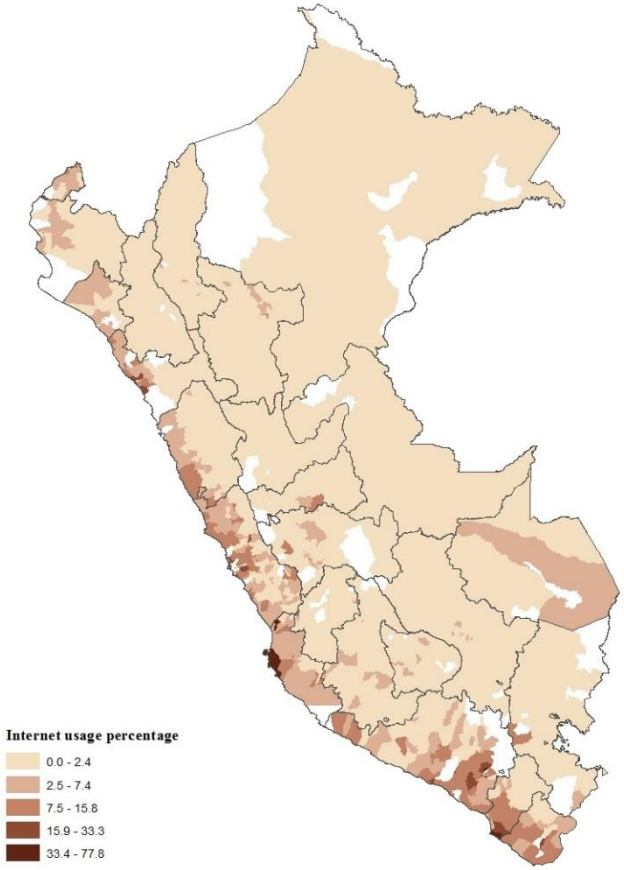

Figure 3-1 Percentage Distribution for Farmers Who Use Internet

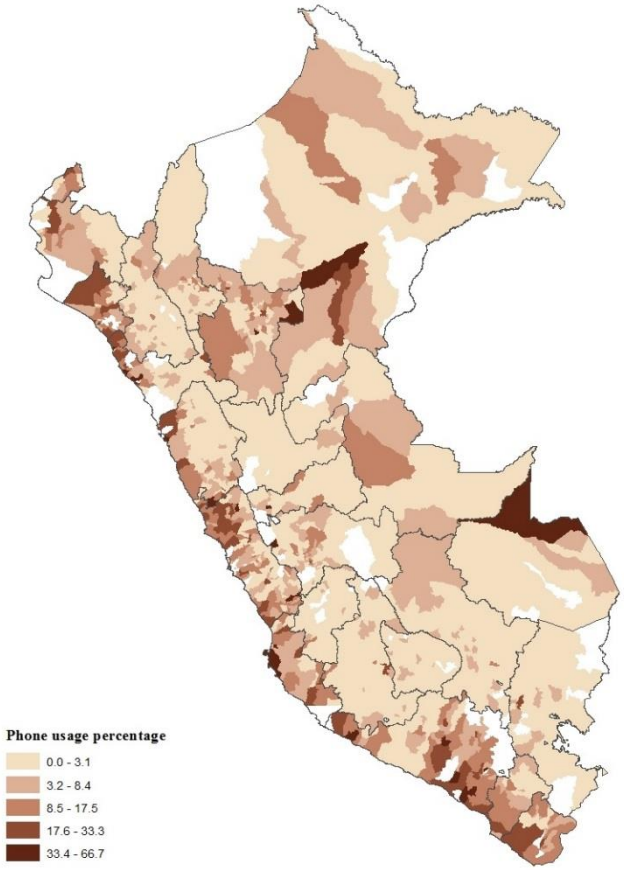

Figure 3-1 Percentage Distribution for Farmers Who Use Mobile Phone

Appendix A

Table A-1 SUR Results Without IV for Internet Only

VARIABLES	(1) $PERCENT_{nat\_inter}$	(2) $PERCENT_{nat}$	(3) $PERCENT_{inter}$
INTERNET	0.005	0.367*	0.079*
	(0.41)	(1.79)	(1.69)
60-80% LITERACY	-0.139	-8.191	-0.289
	(-1.18)	(-0.87)	(-0.99)
80-100% LITERACY	0.021	-5.747	-0.052
	(0.18)	(-0.60)	(-0.18)
HH SIZE	0.152*	-3.520**	0.055
	(1.84)	(-2.48)	(0.39)
MALE PTG	-0.001	0.343***	-0.003
	(-0.14)	(4.80)	(-0.38)
AGE	0.208***	-5.437***	0.344*
	(3.20)	(-3.89)	(1.85)
AGE_SQ	-0.002***	0.049***	-0.003
	(-2.91)	(3.59)	(-1.60)
25-50% FARMERS WHO HIRE LABOR	0.203***	10.449***	0.500***
	(3.01)	(7.39)	(2.63)
50-75% FARMERS WHO HIRE LABOR	0.068	14.926***	-0.022
	(0.91)	(8.50)	(-0.11)
75-100% FARMERS WHO HIRE LABOR	0.181	10.577***	0.204
	(1.52)	(4.74)	(0.73)
LAND SIZE	0.875***	27.231***	2.215***
	(4.71)	(15.48)	(3.64)
NON-AG_INC	-0.000	-0.346***	-0.002
	(-0.10)	(-3.42)	(-0.26)
TRAVEL	-0.030	-1.906***	-0.118**
	(-1.10)	(-4.63)	(-2.55)
Department fixed effects	Significant	Significant	Significant
Observations	1,684	1,684	1,684
R-squared	0.134	0.573	0.134

z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A-2 SUR Results without IV for Mobile Phone Only

VARIABLES	(1) $PERCENT_{nat\_inter}$	(2) $PERCENT_{nat}$	(3) $PERCENT_{inter}$
Mobile Phone	0.017	-0.112	0.051*
	(1.50)	(-1.01)	(1.86)
60-80% LITERACY	-0.149	-8.080	-0.310
	(-1.29)	(-0.90)	(-1.18)
80-100% LITERACY	0.001	-5.171	-0.039
	(0.01)	(-0.58)	(-0.15)
HH SIZE	0.143*	-2.792**	0.139
	(1.90)	(-2.14)	(1.13)
MALE PTG	-0.001	0.328***	-0.006
	(-0.16)	(4.41)	(-0.79)
AGE	0.190***	-5.472***	0.265
	(3.07)	(-3.72)	(1.33)
AGE_SQ	-0.002***	0.050***	-0.002
	(-2.74)	(3.41)	(-1.08)
25-50% FARMERS WHO HIRE LABOR	0.203***	10.542***	0.515***
	(3.14)	(7.56)	(2.67)
50-75% FARMERS WHO HIRE LABOR	0.055	15.227***	-0.021
	(0.65)	(9.07)	(-0.11)
75-100% FARMERS WHO HIRE LABOR	0.157	11.432***	0.249
	(1.33)	(5.77)	(0.86)
LAND SIZE	0.782***	28.240***	2.015***
	(4.82)	(17.30)	(3.79)
NON-AG_INC	-0.001	-0.348***	-0.004
	(-0.35)	(-3.54)	(-0.75)
TRAVEL	-0.023	-2.083***	-0.122***
	(-0.84)	(-5.01)	(-2.73)
Department fixed effects	Significant	Significant	Significant
Observations	1,684	1,684	1,684
R-squared	0.138	0.571	0.134

z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A-3 SUR Results without IV for Both Internet and Mobile Phone

VARIABLES	(1) $PERCENT_{nat\_inter}$	(2) $PERCENT_{nat}$	(3) $PERCENT_{inter}$
INTERNET	-0.003	0.450**	0.062*
	(-0.22)	(2.20)	(1.65)
MOBILE PHONE	0.018	-0.196*	0.039
	(1.62)	(-1.79)	(1.43)
60-80% LITERACY	-0.149	-8.082	-0.311
	(-1.25)	(-0.84)	(-1.11)
80-100% LITERACY	0.003	-5.551	-0.091
	(0.03)	(-0.57)	(-0.34)
HH SIZE	0.147*	-3.472**	0.045
	(1.78)	(-2.43)	(0.28)
MALE PTG	-0.001	0.345***	-0.003
	(-0.18)	(5.32)	(-0.46)
AGE	0.188***	-5.219***	0.300*
	(3.24)	(-3.67)	(1.69)
AGE_SQ	-0.002***	0.047***	-0.003
	(-2.87)	(3.34)	(-1.41)
25-50% FARMERS WHO HIRE LABOR	0.204***	10.441***	0.501***
	(3.52)	(7.40)	(2.84)
50-75% FARMERS WHO HIRE LABOR	0.056	15.048***	-0.046
	(0.77)	(8.96)	(-0.26)
75-100% FARMERS WHO HIRE LABOR	0.161	10.796***	0.161
	(1.38)	(5.49)	(0.52)
LAND SIZE	0.782***	28.239***	2.015***
	(5.13)	(15.63)	(4.14)
NON-AG_INC	-0.001	-0.338***	-0.003
	(-0.38)	(-3.61)	(-0.52)
TRAVEL	-0.024	-1.967***	-0.106***
	(-0.83)	(-4.70)	(-2.61)
Department fixed effects	Significant	Significant	Significant
Observations	1,684	1,684	1,684
R-squared	0.138	0.574	0.138

z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1