Education, mobile phone use and production decisions: a rural case study in Peru

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"Mobile 2.0: Beyond Voice?"

Pre-conference workshop at the International Communication Association (ICA) Conference

Chicago, Illinois

20 – 21 May 2009

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Abstract

In many parts of the world, mobile phones are important devices that have proven to be the first opportunity for many people to have access to telecommunications. Considering the possible impact of this development in welfare, the main purpose of this research is to investigate how important formal education is for using mobile phones in making production decisions. Specifically, we will analyze if this kind of technology is employed for production decisions in rural areas in Puno, a Peruvian department in the southern highlands, bordering Bolivia. In our case, production comprises livestock and agriculture. One of the main results is that no matter how educated people are; if education is of poor quality, it will not have a significant impact on the probability of making an effective use of mobile phones.

Introduction[2]

The importance and the benefits that education has for human development, citizenship and rights entitlement, economic productivity and the resulting increase in competitiveness, as well as for a higher level of social equality and participation have been recognized worldwide. A good example of this recognition is that education is considered a basic human right since 1952;[3] also, the United Nations Millennium Development Goal 2 is to achieve universal primary education.

In most of Latin-American countries, as ECLAC mentions,[4] the achievements have not been evenly spread throughout all spheres of education, and have shown some problems regarding education quality, which in turn depends on social inequality. Peru, in particular, is a highly unequal country, and these inequalities have a strong impact on education, which is considered a major restriction for development.

From another perspective, Peru is a country with steady rates of growth (8% on average for the 2004-2008 period), an acceptable level of net international reserves (approximately 31 billions on average for the 2004-2008 period), relatively high levels of investment[5], many free-trade agreements with key partners, low inflation rates[6], in sum, a country with macroeconomic stability and the best forecasts in terms of economic indicators relative to the region.

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[2] Data for this study was collected as part of the project "Comunicaciones móviles y desarrollo socioeconómico en América Latina", carried out by UOC and financed by Fundación Telefónica. In Peru, IEP implements the case study on the effect of mobile telephony in rural welfare. I also thank Roxana Barrantes and Carolina Trivelli, who provided useful comments and suggestions. The usual disclaimer applies.

[3] In the first Protocol to the European Convention on Human Rights.

[4] Economic Commission for Latin America and the Caribbean. Social Panorama of Latin America (2007)

[5] Accounting for 17% of the GDP for the 2004-2008 period.

[6] Showing an average Consumer Index Price of 3.14 for the 2004-2008 period.

One of the sectors that is showing a high level of growth in the Peruvian economy is the telecommunications sector, specifically, the mobile industry, with more than 20 million mobile phones in 2008, an investment growth of 41% from 2006 to 2007, and 75% of teledensity. This amazing growth has been gradually enabling access to and use of mobile phones. For example, a survey carried on in 2007[7] showed that more than 60% of the respondents were mobile phone users, defining mobile user as a person who had made or received a phone call in the last three months.

As the literature has well documented, in many parts of the world, the mobile phone is an important device that has proved to be the first opportunity for many people to have access to telecommunications. On the one hand, at an aggregate level, it is widely recognized that investment in telecommunications is a relevant source for economic growth[8]. On the other, mobile phones have the potential to improve market functioning, as they enable obtaining valuable information that people take into account in their everyday lives to make decisions of many kinds[9]. Similarly, there is evidence that shows that mobile phones help to enhance productivity[10], to facilitate knowledge sharing, to overcome geographic limitations, to maintain and support social relationships or networks and to be crucial for health, agricultural or government programs.

Considering the potential mobile phones have for development, as well as the wide diffusion and use they have in Peru, the main purpose of this research is to investigate how important formal education is for using the mobile phone in making production decisions. Specifically, we will analyze the influence of education on the probability that mobile phones are employed for agricultural production decisions in rural areas in Puno, a Peruvian department in the southern highlands, bordering Bolivia. This area has 5% of the total national population[11], and its study is of major relevance due to the high poverty rates it shows (67%), and the wide diffusion of agricultural activities[12] that is found.[13] To this end, we used data collected to study the impact of mobile phone use on welfare by households in Puno, as part of the project "Comunicaciones móviles y desarrollo socioeconómico en América Latina".

The paper is organized as follows. First of all, to have a clear idea of how the education system works in Peru and what the main problems are, we give an overview of the sector at the national level. This section also includes the description of mobile phone use in Peru. Section 2

[7] See Barrantes (2007)
[8] See Waverman et al. (2005), Röller and Waverman (2001).
[9] Jensen (2007), Chong et al (2005), Aker (2008).
[10] Bhavnani et al (2008)
[11] This means being in the 5th place among the 24 Peruvian departments.
[12] The aggregate gross income for 2007 of Puno accounts for 2.2% of Peru, and its main component is the one that includes agriculture, hunting and silviculture.
[13] For instance, 66% of the national alpaca meat production comes from Puno and there are also high levels of sheep and cow meat production.

presents the sample analysis of education and mobile phone use. In the third section, we present the determinants of *effective* use of mobile phones. The paper concludes with final remarks.

1. Education and mobile telephony in Peru

1.1 Education

The Ministry of Education is in charge of the direction of the education sector in Peru. The minister executes, supervises and assesses education policies, taking into account the general government policy and the national development plans.

The Peruvian constitution states that education is free and compulsory in public schools[14] for the three levels that the system considers: initial, primary school (6 years or grades) and secondary school (5 years or grades). It is also free in public universities, where studies usually take 5 years.

Primary education is widely available and the majority of the population has attended and completed this level, but secondary education shows a different pattern: 30% of people that should go to secondary schools does not attend, and in rural areas, this figure rises to 50%.[15]

Benavides (2008), in an analysis of the different evaluations on reading comprehension and maths that have been performed in Peru, finds that there are significant quality and inequality problems regarding students' attainment in all of the levels. The majority of Peruvian students do not achieve the expected performance for their grades, and this problem is present not only in rural and public schools, but also in non public and urban schools, in men and women. Poverty is strongly associated with low education attainment: the poorer the student, the worse is the result in the evaluation.

A similar result is found on the National Educational Project to 2021, which states that 16% of the rural population (or in extreme poverty) finishes studying three or five years after their 16th birthday; also, in 25% of villages located in rural areas secondary education is hardly found. There is also a gender and age gap. Illiteracy affects women and old people the most.

Benavides (2007) summarizes the three most important facts regarding education inequality in Peru. First, the education expansion process has focused only in primary education and has created a considerable difference relative to secondary education. Second, poor rural people attribute an implicit value to education and consider it as a means of getting more opportunities, and as an important instrument that will free them from poverty and discrimination. Finally, there is evidence that shows there have been positive economic returns

[14] In general, public schools are considered as having lower quality relative to private schools.
[15] See Benavides (2008).

associated to education, but it has had limited effects on inequality patterns in Peru. The same author mentions that education inequality is mainly determined by the socioeconomic background of students, which indicates that education equality will be difficult to achieve.

The National Living Standards surveys collects information on education. In particular, for household heads, the average years of education is 8 years; the average is more than 9 years in urban areas, while in rural areas, it is just 5 years. In Puno, the average is 7 years, with more than 10 years in urban areas and about 5 years in rural areas.

1.2 Mobile telephony

Mobile telephony has had a significant growth in Peru: teledensity has reached 75% by December 2008 and the same figure for 2007 was 56%.[16]

At the household level, Living Standards Surveys (ENAHOs) also gather information on mobile phone possession, and the most recent and available data is for 2007. Table 1 shows that 42% of households in Peru have at least one mobile phone. Within households who have at least one mobile phone, 10% are located in rural areas, and the remaining 90% in urban areas.

Table # 1: Mobile phone possession in Peru – household level

Do you have a mobile phone?	*%*
Yes	42%
No	58%
Total	100%

Source: ENAHO 2007.

Considering area and region, table 2 shows the distribution of possession according to the main Peruvian regions. In urban areas, the highest percentage of households with mobile phones corresponds to Metropolitan Lima, the capital, while the lowest level is seen in the Northern highlands. On the other hand, in rural areas, the region with the highest percentage of households with mobile phones is the Northern Coast, while the Southern Coast shows only 5% of possession of mobile phones.

Table # 2: Mobile phone possession in Peru by region and area – household level

REGION	**URBAN**		**RURAL**	
	Doesn't have	*Has a mobile*	*Doesn't have*	*Has a mobile*

[16] Teledensity data has been taken from OSIPTEL, the Peruvian telecommunications regulator.

Northern Coast	19%	15%	8%	20%
Central Coast	7%	8%	3%	18%
Southern Coast	2%	3%	1%	5%
Northern Highlands	2%	1%	17%	10%
Central Highlands	10%	6%	27%	16%
Southern Highlands	11%	10%	25%	18%
Rainforest	12%	6%	19%	13%
Metropolitan Lima	36%	50%	-	-
Peru	100%	100%	100%	100%

Source: ENAHO 2007.

It is clear that possession varies significantly across regions, and this pattern is also present across economic levels. Table 3 indicates that the poorer the sector, the lesser is the access to mobile telephony.

Table # 3: Households with mobile phones by level of poverty

Category	*%*
Extremely poor	0.9%
Poor	12.5%
Non-poor	86.6%
Total	100.0%

Source: ENAHO 2007.

The precedent figures have shown that, at the national level, mobile phone use is significantly extended, but also extremely unequal. In Puno, the department under analysis, only 28% of households have access to mobile phones. There is a great difference in this access in terms of areas: in urban areas, 56% have at least one mobile phone at home, while in rural areas, only 10% of households have access to mobile telephony.

Table # 4: Mobile phone possession in Puno by areas – household level

Do you have a mobile phone?	*Puno*	*Urban Puno*	*Rural Puno*
Yes	28%	56%	10%
No	72%	44%	90%
Total	100%	100%	100%

Source: ENAHO 2007.

Another source of information regarding mobile telephony is a recent DIRSI study[17] carried out in three cities of Peru (Lima, Trujillo and Puno). One of the main findings was that mobile telephony is the second most important means of communication for people at the "bottom of the pyramid" in Peru. It also showed that mobile telephony usage exceeds mobile service subscription: while 60% of the respondents were found to be mobile phone users, only 60% of them are mobile service subscribers. All these means that teledensity data underestimates the population's real access to mobile telephony, and this happens because many people use mobile phones borrowed from relatives or friends, or rented on the streets. An additional relevant finding for our study is that in Puno 83% of the respondents are mobile phone users.

The results for all of the countries of the "Mobile Opportunities" project[18] pointed out that mobile telephony is highly valued by the poor as a tool for strengthening social ties and for increasing personal security; mobile telephony is beginning to prove useful for enhancing business and employment opportunities. Galperin and Mariscal (2007) also highlight that users are rarely taking full advantage of the services offered by the mobile platform, since text messaging is the only service beyond voice that is rapidly being adopted. "Many of the applications that could most benefit the poor, such as m-banking and m-government, are still in their infancy in the region".[19]

2. Education and mobile telephony in the sample

The survey we employ for this study was conducted in Puno[20], in July 2008, in urban and rural areas. The main objective was to interview the households that are located in the influence area[21] of two fairs[22], in two different districts: Asillo and Taraco. These two districts are similar in terms of altitude (more than 3500 masl), population, poverty levels and climate. The emphasis was to analyze the mobile use impact on the rural household welfare, considering the latter as consumption and production units.

1105 households were interviewed, including questions about general family members' characteristics, agriculture activity (earnings and expenditure), consumption expenditure, general expenditure, living standards and telecommunications use. For this section, an

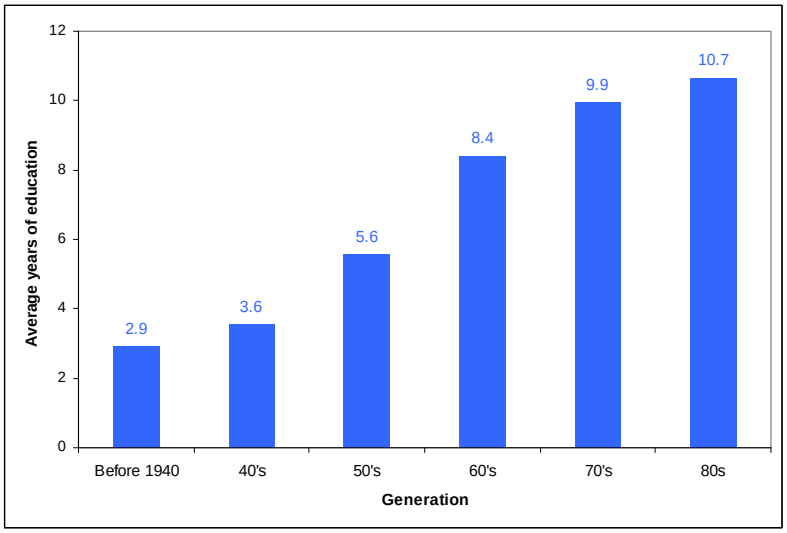
[17] See Barrantes (2007). This study was part of the IDRC financed "Mobile Opportunities" project and also took place in Argentina, Brazil, Colombia, Mexico, Jamaica and Trinidad and Tobago.
[18] See Galperin and Mariscal (2007)
[19] *Ibíd*.
[20] For more details on Puno see the Appendix B.
[21] By "influence area" we mean the villages from which people go to buy and sell in the fair.
[22] The fairs we refer to are informal fairs, set up on the streets once a week (Thursdays in Taraco and Sundays in Asillo), which trade different kinds of products such as livestock, dairy products, clothing, meat, fish, fruits, vegetables, shoes, local production (potatoes in its many varieties, coca leaves, wool, etc.), food, mobile phones, veterinary products, cleaning products, among others.

individual[23] was randomly chosen from each household, for an interview about his/her mobile phone use, ownership, expenditure, affordability perception, quality perception, SMS use, etc.

Concerning education levels in our sample, household head average years of education was found to be 8[24], with a minimum of 0 years and maximum of 16 years of education. In the urban area this average is 9, while in rural areas it is just 6. The average years of education of all of the family members is nearly 7 years, and there is also a difference between urban and rural areas (6 years in the latter and more than 8 in the former). All of the family members, except for the household, on average, have 5 years of education.

The following graph shows that the older the household head, the lower the average years of education. Household heads that were born in the 40's have on average 4 years of education, while those who were born in the 80's have 11 years of education on average.

Graph 1: Average years of education according to generations – Puno sample



The maximum level of education attained in the household, on average, is 4th grade of secondary school. Again, the average is lower in rural areas (3rd grade of high school) and higher in urban areas (5th grade of high school).

In contrast, mobile phone use in our sample is really high: 76% of respondents declare to be mobile phone users, considering that we define "mobile user" as a person who has made or received a phone call in the last three months. As one may expect, mobile use differs among urban and rural areas: only 68% of respondents in rural areas are mobile users, while in urban areas, 85% of respondents are mobile users.

[23] Aged 13 to 70.
[24] The median is also 8 years of education.

As in the DIRSI study, there is a significant difference between use and subscription. In this case, only two thirds (66%) own mobile phones. It is interesting to note that the majority (90%) bought new mobile phones[25] and in 99% of the cases they chose prepaid plans.

Only 39% of the respondents declared they had used text messages (SMS) in the last month. Once again, the analysis of location shows what we expect: only 34% of rural mobile users has either sent or received a text message; in the case of urban areas, we find a higher percentage (45%). When we ask about the reasons for not having used SMS, 70% of the respondents declared they did not know how to use them, and surprisingly, there is no difference between urban and rural areas.

3. Determinants of *effective* use of mobile phones

The role information has for the efficient functioning of markets is well documented in the literature. Systems of information about rural markets have been found to be part of promising innovations in poverty-reduction programs (The World Bank: 2008). In Latin America, Tejo (2000) points out that inequality in rural markets between large landowners and small farmers is partially due to differences in access to information. Reca and Echevarria (1998) mention that the lack of information about prices and other variables is an important barrier to the development of rural communities.

It has been shown that telecommunications have the potential of improving information systems. For instance, Jensen (2007) shows that the use of mobile telephones by fishermen and wholesale merchants in India was associated with a great reduction in price dispersion, the elimination of waste and nearly perfect adherence to the law of one price, improving conditions for both consumers and producers. In Niger, Aker (2008) finds that cell phones improved consumer and trader welfare, due to a reduction in price dispersion across markets. Another example is Myhr et al (2006), which shows that mobile phone use empowers Tanzanian fishermen, both through increased bargaining power and increased control over external events; mobile phones give increased knowledge about market opportunities and a possibility to work more efficiently.

The research papers mentioned above focus on the impact mobile phone usage has on welfare. This study, in contrast, has a different perspective, as it analyzes the factors that determine mobile phone usage, specifically, what is defined here as the *effective* use of mobile phones.

[25] In a poor neighbourhood in the City of Lima, Mujica (2007) shows that the informal market is essential because it is where many people go to buy mobile phones. It is a diagnostic of the informal market structure and the functions of its actors: thieves, collectors of stolen goods and resellers.

It has been previously emphasized that our survey design included a detailed section on agriculture activity. There are specific questions about each crop[26] and its derivatives[27], and about each animal[28] and its derivatives[29]. For the production of each of these, we asked whether they had used information provided by the municipality, the Agriculture Ministry, the National Service of Plant and Animal Health, friends, neighbors, family or clients. In case they said "yes", we asked whether they had used mobile phones to request or receive this information. In particular, we will use this question for the construction of a Logit model[30], where the dependent variable takes the value of 1 if the household made an *effective* use of the mobile phone, in other words, if they used a mobile phone to request or receive information for production decisions.

At this point, we should remember that for the implementation of the telecommunications section of the questionnaire, we randomly chose an individual of the household. In this sense, for the analysis of *effective* use of mobile phones, we will focus on those individuals that happened to be the head of the household (505 observations), as there is relevant information about them in the referred section to include in our estimations. By definition, they are the ones that take the production decisions, taking into account that 67% of these head of households are the ones that have the highest education level among family members.

The variables that explain the probability of using mobile phones effectively are shown in table 5, as well as their expected sign. We intend to measure different dimensions: human capital, physical capital, employment, dedication to agricultural activities, land capital, other ICTs use and rurality.

The variables that refer to education are expected to increase the probability of making an *effective* use of mobile phones. This impact is quite clear. Education is a process which means the development of capacities, skills, knowledge and understanding. Kneller[31] mentions that education refers to any act or experience that has a formative effect on the mind, character, or physical ability of an individual. In consequence, more education will necessarily mean more awareness of the opportunities mobile phones may offer as an information collection means. As a result, more education will predict a higher possibility of giving them an *effective* use.

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[26] Potatoes in its many varieties, barley, oats, etc.
[27] Such as potato flour (*chuño*) in its many varieties.
[28] Cows, pigs, sheeps, hens.
[29] Milk, cheese, wool.
[30] The Logit model is one of the most commonly used binary outcome models. In a binary outcome model, the dependent variable *y* takes one of two values: $y = \begin{cases} 1 \text{ with probability } p, \\ 0 \text{ with probability } 1-p. \end{cases}$. To get a regression model, the probability p is parametized to depend on a regressor vector *x* and a $k_x 1$ parameter vector. The most used models are of single-index form with conditional probability, given by: $p_i \equiv \Pr[y_i = 1 | x] = F(x_i^{'}\beta)$.
[31] See *Introduction to the Philosophy of Education* (New York: John Wiley and Sons, 1971).

In addition, economic theory has always highlighted the role that human capital accumulation plays in a country's growth process; being education a basic component of human capital, more education means more growth as well as an increase in productivity.[32] We understand this productivity rise in terms of the *effective* use of the mobile technology for production decisions.

[32] See Self et al (2003), Lau (1991) o Knowles (2002)

Table # 5: Explanatory variables for mobile phone *effective* usage

Dimension	*Variable*	*Measurement*	*Expected sign*
Human capital	Years of education of the respondent	Number of years of schooling	+
	Years of education of the rest of household members	Number of years of schooling	+
	Age of the respondent	Number of years of age	-
Physical capital	Unsatisfied basic needs	Number of unsatisfied basic needs	-
	Dung employed as fuel for cooking	Dichotomous variable, where 1= household employs dung as fuel for cooking	-
Employment	Worked the previous week	Dichotomous variable, where 1=respondent worked the week prior to the survey	+
Land capital	Plots of land	Number of plots of land	+
Dedication to and investment in agricultural activities	Dedication to agriculture (both crops and livestock)	Dichotomous variable, where 1= household dedicates to agriculture (crops and livestock)	+
	Permanent dedication to agricultural activities	Dichotomous variable, where 1= household dedicates permanently to agricultural activities	+
	Expenditure in training for farm activities	Amount of money dedicated to training for farm activities	+
ICTs use	Internet and Public phone user	Dichotomous variable, where 1=respondent uses both internet and public phones	+
	Mobile subscription	Dichotomous variable, where 1=respondent is a mobile telephony subscriber	+

	Existence of a public phone	Dichotomous variable, where 1=there is a public phone in the village where the respondent lives.	+
Rurality	Location in rural area	Dichotomous variable, where 1= household is located in a rural area	-
	Distance to the district capital	Kms of distance to the district capital	-

Other dimensions that have a direct impact on the use of mobile phones for production decisions are employment and land capital, measuring the latter with the number of plots households use for agricultural activities, whether owned or rented. In the Peruvian highlands, farmers tend to have many plots in different altitudinal ecological zones in order to produce different crops. Figueroa (1989) emphasizes that not only are there various plots in different altitudinal ecological zones, but also within these zones. Farmers are aware of the existence of different microclimates[33] on each zone and as these microclimates offer different plot yields,[34] their strategy is to have a plots portfolio for risk diversification[35]. In this context, more land plots suggests more risk aversion, and it is valid to associate this characteristic with a more careful production process, which in turn implies an *effective* use of all of the inputs. We consider mobile phones as one of these inputs.

The use of other ICTs is also expected to have a positive impact. The variable we include measures both Internet and Public phone use. If the household head employs other communication means, it is more probable that he/she makes an *effective* use of mobile phones because it might be easier for him/her to use the mobile device.

Dedication to and investment in agricultural activities as well are considered to increase the probability of making *effective* use of mobile phones. Households that are related to both cropping activities and livestock, and the ones that are permanently dedicated to agricultural activities, may be more active and may need more information for their production decisions.

In contrast, we expect that the physical capital and rurality dimensions will reduce the possibility of using mobile phones effectively. In the case of physical capital, more unsatisfied basic needs, or using dung as fuel for cooking, indicate more scarcity, and the *effective* use of mobile phones will not necessarily be among the priorities of households with these

[33] The average highest temperature that can be found is 22°C and the lowest 1.4°C.
[34] Some crops may not survive frosts, which are more common nowadays.
[35] Figueroa (1989) points out that this strategy shows risk aversion behaviour.

characteristics. Regarding rurality, a variable indicating whether the household is located in a rural area and another one measuring the distance to the district capital are included. Therefore, if a household is essentially rural, or if it is far from the district capital[36], it will be isolated from the market. In sum, the remoteness from the centre denotes exclusion and fewer opportunities in general.

The results of the logistic regression, having assessed goodness of fit, specification errors and multicollinearity, are presented in table 6.

As the table shows, we included the years of education of the respondent as well as the years of education of the respondent squared. We find that the effect of education is negative until it reaches the value of 8 years, and in this point it changes its effect to be positive and slightly more significant.[37] The average years of education of the rest of the family members also has a positive and significant impact on the probability of making an *effective* use of mobile phones. These results confirm that education has a direct impact on the probability of making an *effective* use of mobile telephony. However, this impact is not as significant as expected. One of the factors that explains our findings is related to education quality. No matter how educated people are;[38] if education is of poor quality, it will not have a significant impact on the probability of making an *effective* use of mobile phones.

[36] A centralized system prevails in Peru, that is the reason why district capitals are so important, and very often they are the only ones that have access to basic services and to markets.
[37] The p-values change from 0.09 to 0.056. A similar pattern is found for age, but these variables are not significant.
[38] Education is understood as the number of years of school attendance.

Table # 6: Results of the Logit model to explain the probability of making an *effective* use of mobile phones

Variables	*Coefficients*		*Marginal Effects*	
Education (respondent)	-0.294380	*	-0.0119988	*
	(0.1736)		(0.0069)	
Education_sq (respondent)	0.019180	*	0.0007818	*
	(0.0100)		(0.0004)	
Education (rest)	0.113734	**	0.0046357	**
	(0.0519)		(0.0022)	
Age (respondent)	-0.108990		-0.44424	
	(0.0918)		(0.0039)	
Age_sq (respondent)	0.001137		0.0000464	
	(0.0010)		(0.00004)	
Unsatisfied basic needs	-0.028693		-0.0011695	
	(0.2059)		(0.0084)	
Dung as fuel for cooking	-0.226250		-0.0095381	
	(0.3639)		(0.0161)	
Worked the previous week	0.460306		0.0169624	
	(0.4030)		(0.01367)	
Plots of land	0.105872		0.0043153	
	(0.1037)		(0.00441)	
Dedication to agriculture	1.020305		0.0367546	
	(0.7243)		(.02387)	
Permanent dedication to agriculture	1.452430	*	0.0477916	***
	(0.8094)		(0.0216)	
Expenditure in training for farm activities	0.008552	***	0.0003486	***
	(0.0027)		(0.0001)	
Internet and Public phone user	0.677440	**	0.0292494	*
	(0.3541)		(0.0170)	
Mobile subscription	1.218579	***	0.0499345	***
	(0.4621)		(0.0198)	
Existence of a public phone	0.492071		0.0193546	

	(0.4510)		(0.0180)	
Location in rural area	1.676725	***	0.0677431	***
	(0.6492)		(0.0290)	
Distance to the district capital	0.012846	*	0.0005236	*
	(0.0073)		(.0003)	
Constant	-5.604157	*		
	(2.2701)			
N° observations	505			
Pseudo R^2	0.1901			

The dependent variable takes the value of one in case the household has made an *effective* use of mobile phones (mobile phone usage for production decisions).

Robust standard errors in parentheses.

*** Significance level=0.01

** Significance level=0.05

* Significance level=0.1

The variables that measure physical capital have a negative but not significant impact on our dependent variable. On the other hand, employment and land capital have a positive impact, but not significant as well.

Positive and significant influences are also found for the permanent dedication to agriculture and the expenditure in training for farm activities, as expected. The same applies for other ICTs use.

Contrary to our expectations, the variables measuring rurality were found to have a positive and significant impact on the probability of using mobile phones effectively. We presume that, considering that more rural households are more isolated, they are almost in the obligation of or they really need to integrate themselves to the main villages and markets, and the *effective* use of mobile phones may help them for this integration. It is important to mention that in 86% of rural areas we find mobile phone coverage, while there are public phones in only 30% of rural areas, which shows that mobile phones are probably the only communication means in these places.

4. Conclusions

Serious problems in terms of inequality in Peruvian education have been described in this study, and the impact it has for the *effective* use of an ICT has been found. The initial hypothesis considered that, being education such an important tool for development in general,

it would significantly increase the probability of using mobile phones for production decisions in Puno, an essentially agricultural department. However, our results show that, due to the low quality it has, more education does not significantly increase the likelihood that households will make an *effective* use of mobile phones. Despite the fact that most of household heads have completed the secondary school level, which indicates a considerable number of education years, this does not permit to establish the expected positive and significant relationship between education and *effective* mobile phone usage.

Besides education, the analysis has considered other factors that determine the probability of making an *effective* use of mobile phones. The use of both public telephony and Internet, as well as being a mobile subscriber increase the probability of using mobile phones effectively, as these indicators denote to a certain extent, familiarity with ICTs.

Surprisingly, the more rural the household, the more probable it will be to use mobile phones for production decisions. This is attributed to the necessity of integration to the market and to the fact that it is highly probable that this communication means is the only one available in rural locations.

The use of mobile phones for production decisions is low (around 10% of the household head sub-sample), while use in its broader sense includes 73% of household heads. A simple analysis of the type of crops produced indicates that households that make an *effective* use of mobile only produce potatoes; crop derivatives, in consequence, include potatoes' flour. In the case of livestock, it is mainly based on cows, with milk as the most important derivative. This poor production composition may be an indicator of the low usage of this technology, as well as of the critical quality of education: more education cannot guarantee the *effective* use of mobile phones.

Along the same line, the main reason for not having used SMSs during the last month offers some insight. There is ignorance about its functioning, which shows that beyond voice applications cannot be completely exploited yet.

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Appendix A

Descriptive statistics for the sample (505 household heads)

Variables	*Mean*	*Median*	*SD*	*Min*	*Max*
Years of education of the respondent	7.70	8	4.66	0	16
Years of education of the rest of household members	5.32	5.33	3.89	0	16
Age of the respondent	44.80	43	13.39	18	70
Unsatisfied basic needs	1.42	1	1.11	0	5
Dung employed for cooking	0.66	1	0.48	0	1
Worked the previous week	0.75	1	0.43	0	1
Plots of land	3.50	4	2.68	0	11
Dedication to agriculture (both crops and livestock)	0.67	1	0.47	0	1
Permanent dedication to agricultural activities	0.71	1	0.45	0	1
Expenditure in training for farm activities	4.73	0	34.77	0	560
Internet and Public phone user	0.43	0	0.50	0	1
Mobile subscription	0.54	1	0.50	0	1
Existence of public phone	0.60	1	0.49	0	1
Location in rural area	0.56	1	0.50	0	1
Distance to the district capital	41.39	13	47.05	2	140

Appendix B

The department under study, Puno, is located in the South Peruvian highlands, bordering Bolivia. There are about a million inhabitants, which mean 5% of the total Peruvian population. Urban and rural areas of Puno have almost the same population, as table B.1 shows.

Table B.1: Population in Puno

Population in Puno	
Total	1,268,441
Urban	629,891
Rural	638,550
Source: 2007 National Census	

One of the main issues in Puno is poverty. For the 2001-2007 period, as table B.2 shows, Puno is the second Peruvian department with the highest percentage of poor households, after Huancavelica.

Table B.2: Percentage of poor households – department level

Dpto	2001	2002	2003	2004	2005	2006	2007	Prom. 2001-07
Huancavelica	78%	76%	82%	79%	82%	82%	77%	79%
Puno	71%	74%	72%	72%	70%	70%	62%	70%
Huanuco	74%	77%	73%	70%	68%	68%	58%	70%
Apurimac	72%	70%	57%	58%	64%	68%	62%	64%
Cajamarca	71%	70%	67%	59%	59%	56%	56%	63%
Ayacucho	65%	63%	58%	53%	68%	69%	61%	62%
Amazonas	65%	73%	64%	58%	60%	50%	46%	60%
Pasco	57%	54%	51%	58%	64%	62%	53%	57%
Loreto	61%	56%	59%	59%	60%	55%	46%	57%
Ucayali	60%	61%	55%	48%	46%	46%	36%	50%
Piura	54%	56%	55%	52%	51%	45%	38%	50%
Cusco	67%	53%	45%	45%	47%	42%	49%	50%
San Martin	56%	47%	52%	45%	46%	47%	36%	47%
Junin	51%	54%	48%	42%	47%	40%	35%	45%
Ancash	54%	46%	49%	45%	41%	37%	35%	44%
Lambayeque	53%	55%	37%	35%	34%	32%	33%	40%
La Libertad	44%	44%	44%	41%	35%	38%	30%	39%
Arequipa	37%	34%	30%	28%	21%	21%	19%	27%
Moquegua	23%	30%	29%	32%	25%	22%	23%	26%
Lima	26%	29%	28%	25%	25%	20%	15%	24%
Ica	33%	31%	25%	20%	18%	18%	12%	22%
Madre de Dios	27%	38%	24%	19%	22%	15%	11%	22%
Tacna	26%	24%	24%	21%	23%	16%	17%	22%
Tumbes	38%	32%	21%	18%	12%	12%	14%	21%

Source: ENAHOs 2001-2007