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Digital Divide among Low Income People in Colombia, Mexico and Peru

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Abstract

This study examines the determinants of information and communications technology (ICT) use and access of low-income people in three developing countries: Colombia, Mexico and Peru. We focus on cross-country differences and similarities in ICTs use across gender, age, education and income, using two composite indicators of ICT. The main similarity across the countries is that education is by far the single most important factor limiting the digitalization of low-income people. The impact of income was low although positive. There is not apparently a gender gap in Colombia and Mexico but one in Peru. Our findings also suggest that when using a composite indicator that only include the 'advanced ICTs', disadvantage people among the low-income people can be more constrained in the use and access of *more advanced* information and communications technologies.

JEL classification: O30; O10;P59; L86; C24; O52

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Introduction

New information and communication technologies (ICTs hereafter) have generated a relatively new concept, which is digital divide. This term is related to the socioeconomic differences in the access and use of ICTs and it first appeared about 1995, in documents such as 'Falling through the net". The digital divide has been studied at micro-levels, using surveys, and at macro-levels using cross-country data from international agencies like ITU, UNCTAD and others. Some studies have stressed that the access and use of ICTs, despite their positive effects, could increase the gap between developed and developing countries (See ITU, 2006; Ono and Zavodny, 2007).

The purpose of this paper is to assess the relationship between indices of "digitalization" and main socioeconomic indicators for poor people within and across in Colombia, Mexico and Peru. We focus on urban low-income people due to data availability that comes from over 3200 personal surveys. We hypothesize that even for poor people groups the inequalities they face are reflected in the access and use of ICTs.

The main contribution of this study to the line of research in ICTs is twofold. First, it does the *first empirical* evaluation of the digital level of use and access of ICTs in developing countries, *and* for the *very low*-income people in those countries. To that extent we explore the factors that explain the access and use of ICTs in Colombia, Mexico and Peru. Second, to undertake such empirical exercise, we follow the methodology of the digital opportunity index (DOI) calculated by the ITU and construct two related composite indices that try to overcome the limitations of simple measures of 'haves' and 'not haves' of ICTs and these indices let us to undertake basic access and more advanced ICTs.

We find that education becomes the single most important factor determining the level of digitalization of very low-income people living in urban cities in Colombia, Mexico and Peru. Income, directly, or proxied by the level of average overcrowding in a bedroom also was found to be important. There is a gender gap in Peru but neither in Colombia nor in Mexico. Living in the capital city seems to increase the probability of being (more) digitalized.

One important additional result is the relatively differential *increasing* impact of education, income, and age on the digitalization when we *only* include the *more advanced*

ICTs in our indicator. It suggests that diffusion of advanced ICTs is more limited for the less educated, poorer and aged people which imply that public and private institutions must reduce those disadvantages first in order to close the digital gap then.

In the next section, a review of some literature on digital literature is done. Section 3 presents the background of the development of ICT's use and access in the three countries, the data sources, we describe the methodology used in each ICT index that we construct. Section 4 presents main econometric results for the three countries when using the two indicators. Major findings and analysis are summarized in the last section, which also includes suggestions for further research.

2. Literature of Measurement Approaches to Digital Divide.

Since it was first described in 1995, the term digital divide has been approached in many ways. There are many definitions of *Digital Divide* in the literature and the main differences are in the concept of Information and communications technologies they include. For instance, Hargittai (2003) defines it as "the gap between those who have access to digital technologies and those who do not; or the gap between those who use digital technologies and those who do not understood in binary terms distinguishing the "have" from the 'have-nots'". Barzilai-Nahon (2006, p 269) argues that digital divide was first approached "on insfrastructural access" and now "the focus is moving beyond technology to the users" Other international agencies like the OECD define the divide as the "gap between individuals, households, business and geographic areas at different socio-economic levels with regards to their opportunities to access information and communications technologies and to their use for a wide variety of countries" (OECD, 2001, p.p.8-9). More definitions can be provided but as Hargittai (2003), Barzilai-Nahon (2006), Bertot (2002) and Vehovar, et al. (2006) argue, the digital divide should not be seen only in binary terms: i.e., someone either has access to an ICT or not, someone either uses it or not[2]. The bottom line is that the digital gap or *digital inequality* has almost always

[2] Another important and related concept is proposed by Barrantes (2007, p.18) who talks about 'digital poverty' conceptualized as the minimum ICTs use and consumption levels as well as the income levels of the population necessary to demand ICT product"

been measured taking into account a single ICT and the wider dimensions of the concept have been ignored.

Researchers have made use of data available that unfortunately only give the “haves” and the “have nots” of ICTs. Academic research on digital divide have either utilized a *micro*-sample of individuals in a given country, micro-samples of individuals for a group of advanced countries or have looked at large and mixed, in terms of development, *macro*-samples of countries. Furthermore, researcher have mostly used single measures as proxy of the digital level of countries, such as computer per 1000 inhabitants or Internet users, and only a few have made use or have constructed composite measures or indices to proxy digital level and so the digital gap (See for instance, Hüsing and Selhofer, 2002).

Among the papers that use *single* measures and a *micro-sample of individuals* in *developed* countries are Demoussis and Giannakopoulos (2006) who made use of the European Social Survey (ESS) and took 14 countries that belong to the European Union with about 15554 people. Their main indicator for ICT is: use of Internet services given network access at home or at work. One important objective of the paper was to see whether there were differences in use of Internet among southern and northern European countries. Their findings in a ordered Probit regression are that Internet use is primarily influenced by gender, age, education, family size, income, cost of Internet access among other. Using a decomposition scheme proposed by Gomulka and Stern they found that the differences between those two European zones are explained by unobserved factors not taken into account in the regressions. Vicente and López (2006) also used a *micro-sample* data from a survey conducted in 15 European countries in 2002 with 10306 interviews. They took the responses for three different *single* and separate ICTs measures: Internet use, computer use and mobile use. They use a weighted logit model and found that the level of income, education and age, impact positively the likelihood of using any of the three ICTs. Gender variable was found negatively related (female use is lower than male use). They also found that countries above the European average have higher rates of use than countries below that average what resembles the findings by Demoussis and Giannakopoulos (2006).

Ono (2006) studied the digital inequality (computer ownership and Internet use) among three Asian countries, Japan, South Korea and Singapore using individual-level *micro-data* for the period 1997-2000. Observations range from almost seven thousand in Japan to about 950 in South Korea and Singapore. On one hand, he found that Internet use from any location was driven by age, education, income. In Japan and South Korea women were less likely to be Internet's users. Clearly there is a gender divide in those countries. On the other hand, the determinants of computer ownership at home for Japan were education and income that relates positively and gender, being a female, and age in a negative manner. For South Korea and Singapore, age, education and income were the most important factors. In a similar fashion, Ono and Zavodny (2007) examined usage of ICTs in five countries: the U.S., Sweden, Japan, South Korea and Singapore. They replicated the exercises done in Ono (2006) since both ICT measures are ownership of a computer at home and Internet use. Findings are also alike. In general for the Western countries there is no a gender divide. Income is the main factor that drives the five countries computer ownership. Not surprisingly, getting a college degree is also a factor in all countries that explains computer ownership. With regard to Internet use from any location, it is evident that for all the countries, mature people use less Internet. College education level and income are key factors in influencing Internet use. There was no gender gap regarding Internet for the U.S. and Sweden women.

Micro databases are very rare to find but that is not the case for the United States. We like to highlight two papers[3]. The first one by Rice and Katz (2003) who used a telephone survey conducted in 2002 for about 1,800 people. Among several results, they find that the gap between users and not-users of Internet is associated with income and age but not with gender or race. Meanwhile, the gap between mobile users and non users was also associated with income, work and marital status.

The second paper is by Fairlie (2004) who used micro-level data from the Computer and Internet Usage Supplement to the 2000 Current Population Survey in which about

[3] Among other papers studying the US digital divide is the paper by DiMaggio, Hargittai, Celeste, and Shaffer (2004) who do a complete review of the digital inequality in the United States based on the Internet access and use.

50,000 households were interviewed. The sample was censored to working-age (25-55) civilian adults. The statistics, representative of the U.S. population, show some striking differences among races. For instance, about 70.4 percent of white Americans had computers while the proportion of Mexican-Americans who had one was less than half (33 percent). The difference was also high regarding either black or latinos (41.3 percent and 39 percent respectively). The racial gap was also high when using the percent of adults who had access to Internet at home (59% for whites, and 22.1% for Mexican). His econometric findings using logit procedures showed *no gender gap* as in the Ono's studies. Black, latinos, Mexican and Asian-American were less likely to have computer at home. Unsurprisingly education and family income were very decisive factors to have a computer at home. Internet use was also determined by the same factors as ownership computer. Minority groups but Asians were less likely to have computers. However, in this case there was a bit of evidence of a gender gap since the coefficients turned to be negative but not statistically significant. Once more, education and income happen to be determinant factors in having Internet access at home.

On the other hand, researchers have also made use of *macro databases* as, ITU or UNCTAD and the World Bank and they have proceeded to see under different approaches what factors determine the access or use of some ICTs. Among others is the paper by Guillen and Suárez (2005) who from a political science perspective studied how regulatory, socio-political and economics characteristics might have affected Internet use. For that purpose they used ITU database for a *large* sample of 118 countries over the period 1997-2001. They hypothesized that world-system status, privatization of incumbent telecommunications providers, competition in the telecom sector, the degree of cosmopolitanism, and the existence of democracy tend to increase Internet use. Their results, using panel data techniques, were mixed since in effect core and peripheral countries and countries that privatized former public state provider experienced greater Internet use. However, their indices of democracy, privatization, and tourism expenditure (cosmopolitanism) were not statistically significant. Per capita income and the number of phones lines, as expected, were also positively associated. Chinn and Fairlie (2007) used a larger sample of 161 countries around the world over the 1999-2001 period and identified the main determinants of computer ownership and Internet penetration. Their model is a *macro* that also used the ITU database on two ICTs: computer ownership and Internet users per 100 inhabitants. In both specifications, they introduce the same basic set of (macro) regressors like GDP per capita, trade in goods, network telephone density, urban population, illiteracy rate and one variable proxying regulatory quality. Income, level of education, age, telephone line density, and regulatory quality were factors (among others) explaining positively the computer ownership. On the other hand, Internet use was affected also positively by income, age and regulatory quality. However, two shocking results were that telephone density had an opposite sign while education was not statistically significant at standard levels. Again urban population was found to be negatively related to the ICT.

In the same way, Quibria, et al. (2003) used a small sample of Asian countries for the period that seems to be 2000-2001 and tried to determine the factors that explain the use of three broad concepts of ICTs: computing, communication, and Internet. To that effect they ran regression where the dependent variable was the use of: cellular phone, fax machine, Internet, personal computer, telephone mainline and television. They proceeded to run each of these six ICTs against couples of explanatory variables like: population and income; income, education; income and telephones. They found that income was always significantly and positively related to all six ICT proxies. Number of phones was also significant when paired with income only for Internet use and personal computer.

Most research that study the digital gap at micro-levels has been done only for developed countries or at least for high middle-income countries. Some papers do provide accounts about the digital divide or inequality in developing countries (See Fuchs and Horak, (2008), Gebremichael and Jackson, (2006), Cedrós and Ugas, (2007), and Mariscal (2005) among others). However to our knowledge, first, there are no papers using micro-level data about the access or use of ICTs for any developing countries to try to see how the digital divide is within and across, and second, there are not papers building ICT composite indices for developing countries.

3. Background of the Three Countries and Data

3.1 Background

Colombia, Mexico and Peru share many aspects in common given their Spaniard heritage. However there are some differences in their economic development, and more importantly to our paper in their current ICT environment. Table 1 presents the macro level of development in the main ICTs in each country clustered first by types of ICT and then by some international indices. It can be seen that Colombia and Mexico have, on average, a similar *wide* telephone network while Peru lags well behind them (See also Figure 1 and 2 for a long run trend). However, with data from the World Bank Development Indicators, if one looks at what the table names as "advanced ICTs", it is clear that Mexico leads the pack followed by Peru while Colombia is now backwardness, at least until 2005-06.

Figure 1

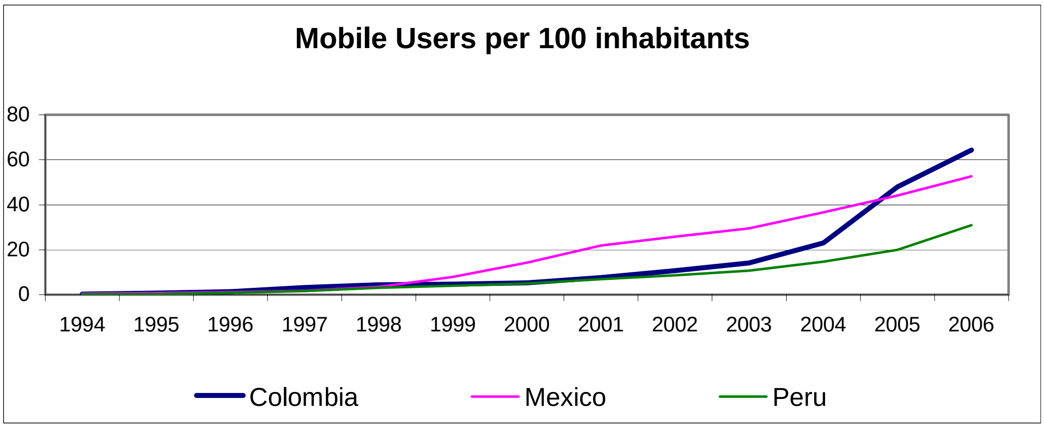
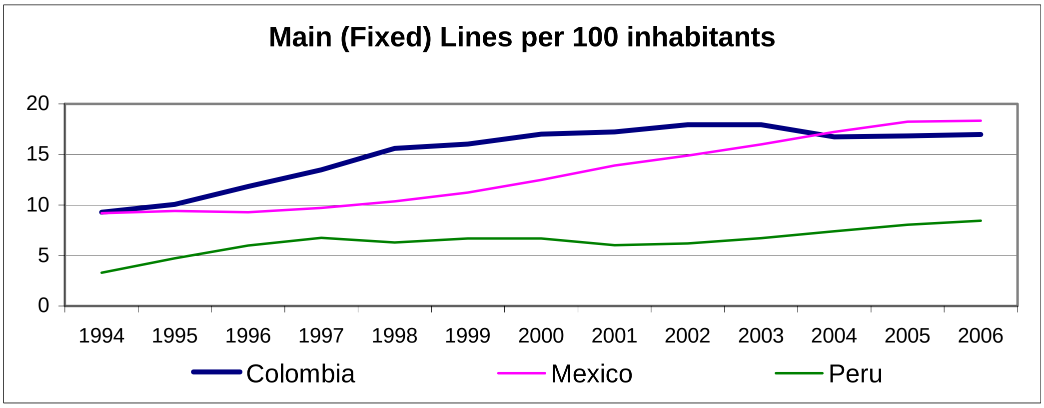


Figure 2



Source: ITU (2006)

On the other hand, International agencies like the ITU, the UNCTAD and the World Economic Forum have calculated some (composite) indices that try to capture the state of ICTs development around the World. The ITU and the UNCTAD elaborated the "World Information Society Report 2007 and there, they present some of the (composite) indices we show in the table 1. First, the *DOI*, "*digital opportunity index*" which is composed of eleven separate indicators in three clusters of opportunity, infrastructure and utilization, is the *reference* of the indices we built since the DOI sums up the eleven indicators and then makes a simple average (See details in ITU-UNCTAD 2007). The DOI index ranges between a maximum of one (for full access) to a minimum of zero (for null access), and the results are similar to the last figure (Mexico obtained 0.47 in 2006, Colombia 0.45 and Peru 0.40). All the three countries increased their DOI indices in twelve points between 2001 and 2006.

Table 1
Information and Communications Technologies Environment

Information and Communications Technologies	Colombia	Mexico	Peru
Basic ICT			
Telephone mainlines per 1000 people [a]			
2000	173	126	66
2006	171	189	80
Mobiles per 1000 people [a]			
2000	54	144	49
2006	643	526	309
Advanced ICT			
Internet Users per 1,000 people [a]			
2000	21	52	31
2006 [d]	145	203	215
Broadband subscribers per 1,000 people [a]			
2000	0,2	0,2	0,0
2006 [d]	14,0	34,0	17,0
Personal computers per 1,000 people [a]			
2000	36	58	40
2005	42	136	100

International Indices (relative to top country)			
Evolution of Networks [b]			
2000	11,86%	19,01%	8,16%
2003	14,14%	21,74%	10,48%
Evolution of Info-density [b]			
2000	37,26%	29,63%	25,26%
2003	40,23%	32,30%	28,77%
Evolution of Info-use [b]			
2000	21,59%	29,44%	22,41%
2003	30,08%	34,16%	26,14%
Digital Opportunity Index [c]			
2001	0,33	0,35	0,28
2005/06	0,45	0,47	0,40
ICT-OI Value [c]			
2001	26,78%	33,45%	27,20%
2005	27,89%	33,01%	27,67%
Network Readiness Index [d]			
2002	56,25%	61,32%	52,36%
2006/07	62,87%	68,48%	60,07%
2007/08	64,19%	67,47%	59,86%

a. World Bank Development Indicators.
b. ORBICOM-ITU 2005.
c. ITU & World Economic Forum and INSEAD 2008
d. UNCTAD 2007

The ITU and other organizations devised another analytical indicator, the ICT-OI value. This tool "relies on ten indicators that capture elements of ICT network, education and skills, uptake and intensity of the use of ICT" and pretends to measure the relative difference in ICT opportunity levels among economies. With respect to the ICT-OI value, the table shows the *relative* percentage of the three countries to the top country (in each year). Once more, realize that Mexico relative position was better than Colombia and Peru but has tended to worsen contrary to the small gains of Colombia and Peru. In general, the three countries are, on average, well lagged with respect to the top countries.

The World Economic Forum and the Insead, in 2002, launched the Network Readiness Index. This index is based on subjective ratings obtained from surveys and other data. "The Networked Readiness Index Framework represents an effort to untangle the underlying complexity behind the role of ICT in a nation's development. As the Insead website states "The framework and its components not only provides a model for computing the relative development and use of ICT in countries, but also allows for a better understanding of a nation's strength and weaknesses wit respect to ICT." In the bottom of Table 1, we found the ratio of each country index *relative* to the top country in the ranking. Once more, Mexico leads the pack but Colombia is closing the gap while Peru is a bit lagged.

On the other hand, Table 2 shows some economic and demographic indicators for the three countries. Mexico has greater income per capita and lower inequality in income distribution than Colombia and Peru. Literacy rate is higher in Colombia though. In Peru, more than one third of the population lives in the capital while the percentage is the lowest for Colombia. As shown, there has been a steady process of urbanization.

Table 2

Economic and Demographic Environment

	Colombia	Mexico	Peru
Economic Development			
GDP per capita, PPP (constant 2000 international $)			
2000	5.974	9.262	4.724
2006	6.886	9.967	5.725
Income share held by lowest 10%			
	5,90	3,99	3,66
GINI index			
	58,6	46,1	52,0
Demographics			
Literacy rate, adult total (% of people ages 15 and above)			
2005	92,8	91,6	87,9
Population in the largest city (% of urban population)			
2005	23,7	24,8	35,4
Urban population (% of total)			
2000	71,2	74,7	71,6
2006	73,0	76,3	72,8

Source: World Bank Development Indicators.

3.1 Data

Data for this paper was taken completely from the micro-data of the project "Mobile Opportunities: Poverty and Telephony Access in Latin American and the Caribbean" carried out by DIRSI (the Regional Dialogue on the Information Society) in 2007 in seven countries: two Caribbean countries, Jamaica and Trinidad and Tobago and five Latin American countries, Argentina, Brazil, Colombia, Mexico and Peru. We chose Colombia, Mexico and Peru because as was shown above, their economic and digital developments are relatively similar. The project consisted of personal interviews to a sample of urban low income people as follows: eight hundred in Colombia, one thousand in Mexico, and around one thousand and two hundred in Peru[4]. A complete questionnaire was designed with questions on socio- demographic factors, family composition, housing data, and most importantly questions regarding use, access and patterns of use, patterns of expenditure in: mobile, fixed, SMS, Internet and public telephony.[5] We extracted for each respondent, information on age, gender, family income, education level, labor status and his or her patterns of use and access to ICTs. We proceed then to build the two indicators that measure the digital level of every respondent.

3.3 The ICT Indicators

This study uses the 'haves' and 'have nots' of ICTs of every respondent to build *two* ICT indicators. We are aware of the methodological implications of using this approach but think that as a first step, our procedure is good enough to try to see how the digital levels of low income people are and what explains them.

We construct two different indexes that aim at measuring *different* but related aspects. Those indices attempt to measure current access to communication technologies including mobile and fixed telephony, short message service (SMS), and Internet. We employ composite indices because as DiMaggio and Hargittai (2004) say, binary divide

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[4] The country reports of the project can be downloaded at http://www.dirsi.net/espanol/content/view/181/71. En each country report, the reader can find the explanations of how the sample and survey were done.

[5] The complete questionnaires that were used in each country can be downloaded at http://www.dirsi.net/english/index.php?option=com_content&task=view&id=120&Itemid=69 .

fails to value the social resources of diverse groups in many fields. The answers were operationalized as shown in Table 3.

Hüsing and Selhofer (2002, 1276) call the attention to one important factor when constructing a digital divide index. They state that "the selection of indicators necessarily reflects what is conceived as state-of-the-art technology in the research context. If, for example the digital divide in developing countries is analyzed, it probably makes sense to include more traditional telecommunications indicators (e.g. access to a telephone at home)." To that effect, our first index, that we call the Digital Index, includes both *use* of and *access* to four types ICTs: fixed and mobile phone, Internet and SMS. To operationalize the index, we follow the way the ITU did to construct the Digital Opportunity Index (DOI). That is for each respondent we add his/her response in each ICT and normalize it to one as follows: $\text{Digital Index}_{i,K} = \left(\sum_{j=1}^{7} ICT_j\right) / 7$, where i = 1…N, represents the number of respondent in country K. To illustrate the reader, a respondent who had access to and used *all* the ICTs presented in Table 3 would get a "digital index" of one[6].

Table 3
Operationalization of the Indices

Variables	Index 1	Index 2
Personal Mobile **Access**	If he/she owns the mobile phone then the variable is equal to 1 and 0 otherwise	
Mobile **use**	If he/she used the mobile phone in the last three months the variable is equal to 1 and 0 otherwise	X
Personal Fixed (main) **access**	If he/she have any fixed line at home the variable is equal to 1 and 0 otherwise	

[6] As the reader can realize we give each ICT the same weight following the ITU's methodology it utilizes for its DOI. We are aware of the subjective nature of the weighting and the criticisms made to that procedure and intend to design indicators free of that potential problem. See Corrocher and Ordanini (2006), and Vicente and López, 2006 for a very rich discussion of the subject and their use of alternate methods like principal components to avoid this subjectivity problem. On the other hand, the DOI gives equal weight to its three categories (Opportunity, infrastructure and Utilization). Within each category, the indicators therein have also equal weight.

Fixed (main) **use**	If he/she make calls from a fixed line at home during the last week then the variable is equal to 1 and 0 otherwise	
Internet **access**	If he/she has access to internet at home then the variable is equal to 1 and 0 otherwise	
Internet **use**	If he/she used internet during the last month the variable is equal to 1 and 0 otherwise	X
SMS **use**	If he/she sent SMS during the last week the variable is equal to 1 and 0 otherwise	X

Researchers in the field of ICTs argue that some information and communications technologies do not need *any* kind of literacy such as using TVs, radio and making or receiving a call in a mainline fixed phone. Therefore, people with low levels of education, low income and aged are expected to use them easily. But, recent and more advanced technologies like mobile telephony and Internet are, par excellence, interactive technologies that demand not only standard literacy but also digital literacy, in particular, Internet that require the know-how of using a computer, and it also probably requires knowing a second language. Therefore, to see whether digital literacy is or not a *more* or *differential* determinant factor, the second index (Interactive Index) only includes those ICTs which require more skills such as mobile, Internet and sending SMS.

The $\text{Interactive Index}_{i,K} = \left(\sum_{j=1}^{3} ICT_j\right) / 3$, for i = 1…N, represent the number of respondent in country K.

Table 4 summarizes the distribution of the sample for the *Interactive Index*. For simplicity, the column named “mean” under the heading of country, shows the average level reached by the complete group of respondents. We can see that in the three countries men had, on average, greater level of digitalization than women. So a gender gap exists in the three countries. But one realizes that the gender gap is relatively greater in Mexico than Peru and Colombia. Unsurprisingly, we notice that for the three countries as older the respondent is, the lower his or her level of digitalization is. As the papers we quoted above found, the higher the education level the greater the degree of connectivity of people.

Again, the three countries show the same pattern. It is interesting to note that young people exhibit more homogeneity than the elder as seen by a less standard deviation. Lastly, the digitalization levels of unemployed people were higher in Mexico and Peru, but in Colombia were the inactive people (students, housewives and people not searching jobs). Hence, it is apparent that even among low income people socio-demographic factors determine their access to ICTs. In the next section, we conduct some empirical econometric exercises.

Table 4
Interactive Index by Socioeconomic Factors

	Mexico			Peru			Colombia		
	N	**Mean**	**Std Dev.**	**N**	**Mean**	**Std Dev.**	**N**	**Mean**	**Std Dev.**
Gender									
Male	274	0,263	0,304	488	0,375	0,327	255	0,441	0,243
Female	726	0,180	0,266	756	0,334	0,312	545	0,413	0,240
Age									
12 -18 years	132	0,298	0,330	179	0,514	0,334	102	0,605	0,280
19- 30 years	320	0,258	0,311	410	0,424	0,336	252	0,493	0,246
31-50 years	409	0,174	0,247	507	0,295	0,275	309	0,361	0,184
> 50 years	139	0,067	0,146	148	0,137	0,216	137	0,292	0,192
Education Level									
Primary	475	0,113	0,205	317	0,163	0,210	282	0,297	0,168
Secondary	492	0,267	0,298	693	0,353	0,308	437	0,465	0,236
Superior	33	0,525	0,409	234	0,595	0,305	81	0,626	0,271
Labor Status									
Occupied	365	0,229	0,285	764	0,355	0,307	360	0,419	0,226
Unemployed	4	0,417	0,319	7	0,428	0,417	28	0,393	0,257
Inactive	631	0,185	0,275	463	0,339	0,335	412	0,426	0,254
TOTAL	**1000**	**0,202**	**0,280**	**1244**	**0,35**	**0,318**	**800**	**0,422**	**0,241**

Besides those two key indicators, we tabulated information of some factors that have been determinants of use and access of ICTs in other studies (See Hüsing and Selhofer, 2002): Family income, education, age, gender, labor status and size of the household. Since the survey in each country was carried out in the country capital and in other smaller cities, we include a dummy variable that takes the value of one if the respondent lives in the capital at the time of the survey, and zero otherwise. The rationale behind this is that the population of the country's capital in developing countries, has much better quality life in the sense it has (more) *points of access* to all public and private services of ICTs and so access and use should be greater. In the case of Peru, it was not possible to get reliable data on family or personal income of the respondents, so we proxy the family income using the variable "overcrowding" or average number of people living in a bedroom. Lastly, some researchers argue that the process of learning and use advanced ICTs by people is smoother and faster when they have relatives or friends who use those ICTs. Dirsi's country reports also found that mobile telephony was mainly used to be in contact with relatives and friends. It was also found in that project that low income households are large in numbers and so there might be greater needs to use ICTs. Therefore we include the number of family members in the household where the respondent lived. [7]

Table 5
Means of Main Variables by Country and Gender

	Mexico			**Perú**			**Colombia**		
	Male	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
Mobile Tel.									
% of Users	49,27	32,51	37,10	63,11	58,86	60,53	92,16	87,71	89,13
% of Owners	39,78	26,03	29,80	42,41	33,8	37,21	69,44	57,80	61,50
Fixed Tel.									
% of Users	30,65	32,78	32,20	13,93	12,56	13,1	55,51	59,80	57,75
% of Owners	39,42	39,26	39,30	15,37	13,49	14,23	60,00	64,59	63,13
Internet									
% of Users	9,12	8,68	8,80	31,35	25,23	27,81	20,0	18,16	18,50
SMS									
% of Users	20,43	12,67	14,80	18,03	15,74	16,63	21,17	17,90	19,00
Mean									
Per capita income in US$	160,2	130	138,3				132,9	88,6	102,73
Age	38,01	36,16	36,67	39,12	35,67	37,02	39,81	37,26	38,07
Overcrowding	2,59	3,00	2,89	1,55	1,91	1,77	1,84	2,16	2,06
Household size	4,12	4,48	4,38	3,85	4,35	4,16	3,93	4,36	4,22
Capital			60%			32,96%			25%

Source: Surveys in the three countries

[7] This is a proxy since we do not know if relatives living in the same household used or had access to all the ICTs.

Table 5 provides a picture of some stylized factors of the population surveyed. First, the percentages of respondents who used fixed and mobile were higher in Colombia than in Mexico with the lowest in Peru. Second, in the three countries, men were more prone to use mobile, Internet and SMS than women. Average monthly incomes for Colombia and Mexico were about US103 and US138. The number of family members was on average similar among the three countries but the level of overcrowding was higher for Mexico, followed by Colombia and then Peru. Although the range for selecting people was from 13 to 65, average age in the three countries was similar and about 37 years old.

4. Empirical Model, Result and Analysis

4.1. Model

We estimate pattern of ICTs with the two indices: the "*digital*" index and the "*interactive*" index using separate logit regressions for each country.[8] In our estimations we are interested in assessing what determines that someone have an index above the average in the population. In consequence, the dependent variable is equal to 1 if the index of the respondent is above the mean in their country-sample, and zero otherwise. We also make some estimation with age and age squared in order to test the no linearity in the relationship but the results were similar

4.2. Results and Analysis

First, we examine patterns of use and access of ICTs with the 'digital index' that includes four ICTs. As we show in Table 6, the estimated marginal effects indicate some commonalities and differences across the countries in the determinants of the ICT index. In the three countries, education level and income happen to be positively associated with the level of digitalization. Education, then, becomes by the size of the marginal effect and the level of statistical significance, the single *main factor* determining the likelihood of accessing and using ICTs in relation to the average of the population. The effect of income on the ICT index was positive for Colombia and Mexico but its effect is almost negligible. It could be a consequence of two factors: First, that income data were not enough reliable

[8] Our model follows Fairlie (2004).

and second, since the survey was focused on the low income households the income variance tends to be small.

To overcome this and since in Peru, income data was not available, we use the level of overcrowding as proxy of income. Clearly, as expected, the more crowded the living conditions, the worse should be the degree of digitalization of the respondent. Indeed it was the result we found for the three countries with high levels of statistical significance. In all cases, the highest and lowest marginal effects are in Colombia and Mexico, respectively.

Table 6
Marginal effects of the 'Digital Index

	México	México	Perú	Perú	Colombia	Colombia
Age						
19- 30 years	-0.039	-0.053	-0,204***	-0,217***	-0,250***	-0,251***
	(-0,71)	(-0,99)	**(-3,93)**	**(-4,31)**	**(-4,37)**	**(-4,43)**
31-50 years	0.025	0.019	-0,307***	-0,305***	-0,273***	-0,252***
	(0,45)	(0,36)	**(-6,22)**	**(-6,33)**	**(-4,68)**	**(-4,32)**
> 50	0.038	0.040	-0.307	-0.274	-0.305	-0.284
	(0,55)	(0,56)	**(-5,15)**	**(-4,54)**	**(-5,29)**	**(-4,79)**
Female	-0.042	-0.055	-0,074**	-0,084**	-0.043	-0.046
	(-1,08)	(-1,43)	**(-2,39)**	**(-2,76)**	(-1,03)	(-1,08)
Education	0,213***	0,209***	0,248***	0,266***	0,217***	0,226***
	(6,26)	**(6,03)**	**(9,96)**	**(10,83)**	**(6,62)**	**(6,8)**
Income		0,0001***				0,0006**
		(4,24)				**(2,66)**
Overcrowding	-0,064***		-0,073***		-0,093**	
	(-4,92)		**(-5,07)**		**(-4,03)**	
Capital city	0,069**	0,083**	-0.002	-0.016	0,088**	0,076*
	(2,07)	**(2,48)**	(-0,06)	(-0,59	**(2,05)**	**(1,76)**
Family members	0,045**	0,029**	0,049***	0,02*	0.016	0.000
	(4,06)	**(3,06)**	**(5,02)**	**(3,2)**	(1,41)	(-0,019
Labor status	0.018	-0.012	0,100**	0,088**	0.059	0.036
	(0,48)	(-0,31)	**(2,99)**	**(2,66)**	(1,43)	(0,879
Log-likelihood	-639.762	-643.172	-725.085	-738.280	-483.808	-489.860
N	1,000	1,000	1,244	1,244	800	800

*** $p < .01$ ** $p < .05$ * $p < .10$. Shown are the marginal effects of the estimated coefficients from logit regressions. *z*-values are in parentheses and are White-corrected for individual heteroscedasticity.

The results for gender and age were mixed. All the regressions for gender that we ran for Colombia and Mexico gave the expected negative signs but their statistical significances were relatively below the standard ones (lower for Colombia than for Mexico). In Peru, however, *there is* a gender gap since for all the regressions there was a negative association. The marginal contribution is fairly low when compared to that of education though. Age was negatively associated with the ICT index for *almost* all regressions but was only statistically significant for Colombia and Peru. People who are older than the group of 12 to 18 years have a less propensity of being above the digital average in their country and as we expected adults are more prone to be less digitalized in those countries. In Mexico, we find the same sign but it is not statistically significant.

On the other hand, the labor status variable did not have good results except for Peru with the expected sign and highly significant. Low-income individuals living in Bogotá and Mexico City are apparently more digitalized what means that disadvantaged population within a country suffers also a geographical divide. But it was not the case for Peru (Lima). More research must be done to disentangle the reasons of this result in Peru. Lastly, the variable number of close relatives living with the respondent was positive for Mexico and Peru but not for Colombia. We cannot say conclusively that there exists a spillover knowledge effect since we do not have complete information on the degree of access and use of all members within the family group. The result does indicate that more research has to be done in this respect.

We next examine the results presented in Table 7 using what we call '*the Interactive Index*'. We are interested in *exploring* how the size and the expected sign of the results are compared with those of the 'digital index'. We realize that there were slightly changes across indicators and countries. For instance the coefficients of education are in most cases higher, although in some are just lightly higher, than with the 'digital index' above. Besides, the *statistical significances* of coefficients for age are higher in particular for Mexico. Income effect tends to be also higher. There are some changes in the expected signs for the dummy of living in the capital cities but the sign of the size of the household coefficient is the expected for Colombia although still not significant.

Table 7
Marginal effects of the ‘Interactive Index

	México	México	Perú	Perú	Colombia	Colombia
Age						
19- 30 years	-0.0388	-0.0427	-0,1842***	-0,1923 ***	-0,2267***	-0,2263***
	(-0,75)	(-0,82)	**(-5,08)**	**(-5,39)**	**(-5,54)**	**(-5,54)**
31-50 years	-0,0876 *	-0,0898*	-0,3086***	-0,3080***	-0,3966***	-0,3871***
	(-1,67)	**(-1,72)**	**(-8,56)**	**(-8,6)**	**(-9,75)**	**(-9,5)**
> 50	-0,2380***	-0,2410***	-0,2462***	-0,2311***	-0,3319***	-0,3271***
	(-4,31)	**(-4,29)**	**(-8,88)**	**(-7,46)**	**(-12,86)**	**(-12,51)**
Female	-0,1151**	-0,1233**	-0.0152	-0.0220	-0.0124	-0.0003
	(-2,86)	**(-3,03)**	(-0,53)	(-0,77)	(-0,33)	(-0,01)
Education	0,2065***	0,1972***	0,3159***	0,3341***	0,2389***	0,2311***
	(6,26)	**(5,85)**	**(13)**	**(13,9)**	**(8,3)**	**(7,85)**
Income		0,0001***				0,0008***
		(4,13)				**(3,36)**
Overcrowding	-0,0297**		-0,0756***		-0,0428**	
	(-2,29)		**(-5,12)**		**(-2,12)**	
Capital city	-0,1087**	-0,1003**	-0.0219	-0.0334	0.0650	0.0588
	(-3,19)	(-2,94)	(-0,76)	(-1,17)	(*1,62*)	(1,45)
Family members	0,0263**	0,0257**	0,0455***	0,0265**	-0.0105	-0.0127
	(2,49)	**(2,62)**	**(5,29)**	**(3,36)**	(-0,98)	(-1,26)
Labor status	0.0452	0.0133	0,087**	0,0767**	0.0301	-0.0006
	(1,2)	(0,34)	**(2,87)**	**(2,55)**	(0,79)	(-0,01)
Log-likelihood	-609.491	-603.428	-594.420	-609.863	-483.808	-489.860
N	1,000	1,000	1,244	1,244	800	800

*** $p < .01$ ** $p < .05$ * $p < .10$. Shown are the marginal effects of the estimated coefficients from logit regressions. z values are in parentheses and are White-corrected for individual heteroscedasticity.

Some findings posed above can be better understood with figures 3 to 5. Figure 3 and 4, shows how the likelihood of having more access to the ICTs relates with the level of income for the cases of Mexico and Colombia. Two things can be noticed. First the greater the income the greater is the digitalization level of people; and second, the probability is greater for the “interactive index” than for the “digital index” that could be a consequence of the initial endowments the people have.

Figure 3
Likelihood of Being Digitalized and Income
Mexico*

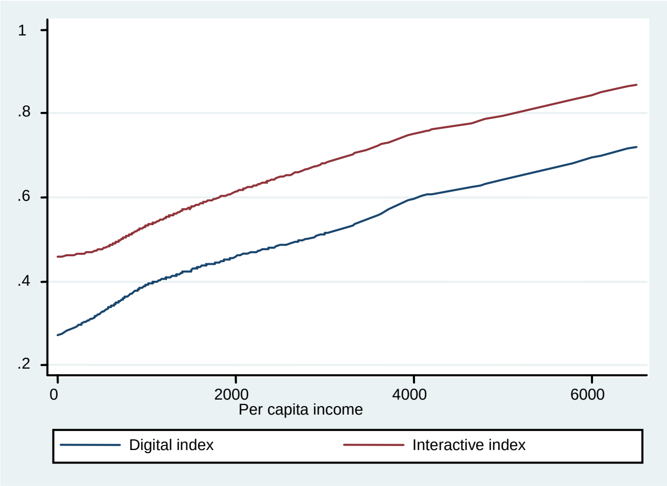
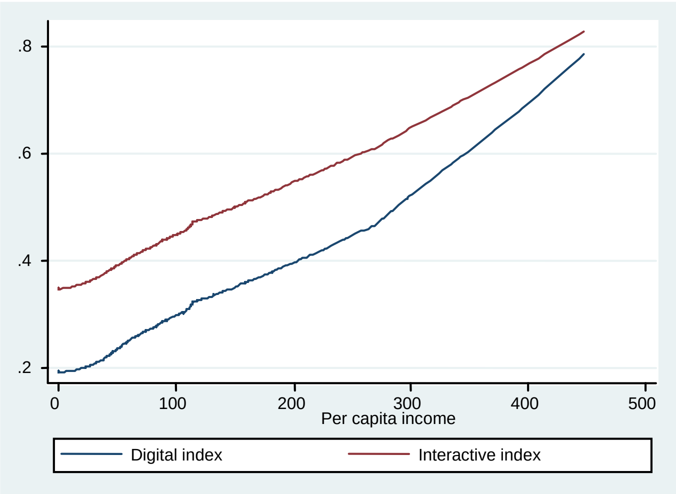


Figure 4
Likelihood of Being Digitalized and Income
Colombia



* Income is measured in Mexican pesos. 10 Mexican peso= 1 dollar

The next three figures show, for the three countries, the probability of accessing and using ICTs given the *age of the respondents*. Clearly, for every country one observes that as the respondent ages the lowest his or her probability of using ICTs. The probability is lower when we use the 'interactive index' what supports our conjecture that more 'advanced'

ICTs tend to be less used by more aged people. Last, the probability seems to decrease faster when people are over 40 years old.

Figure 5
Likelihood of Being Digitalized and Age
Mexico

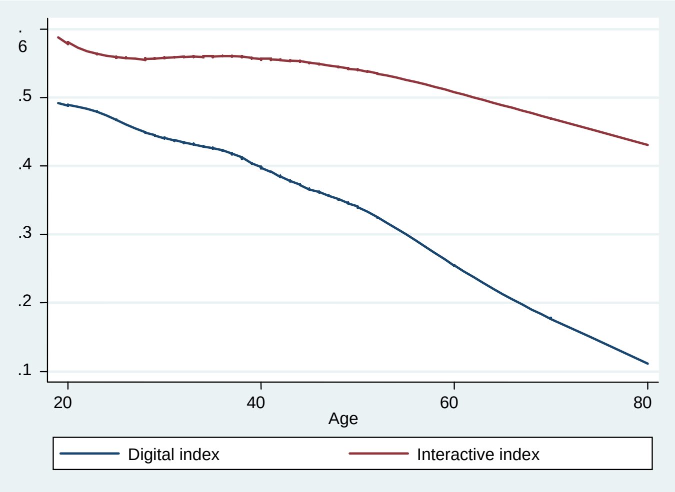


Figure 6
Likelihood of Being Digitalized and Age
Colombia

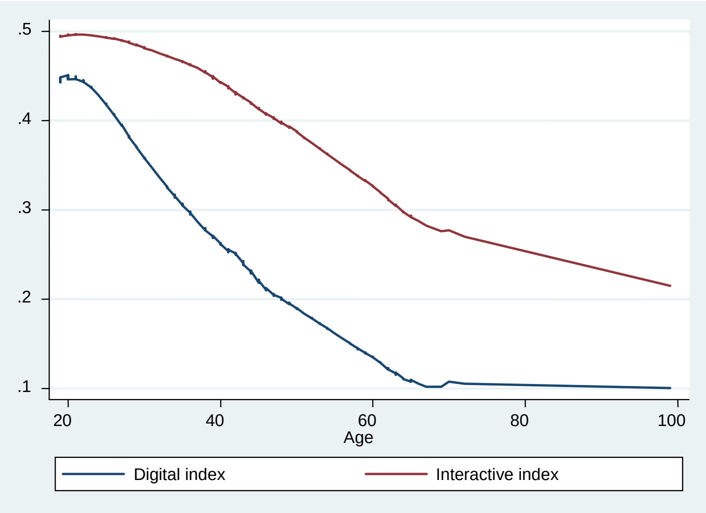
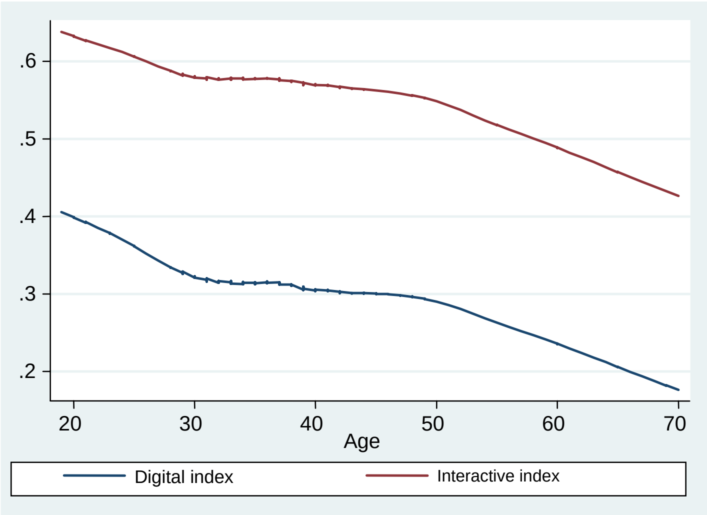


Figure 7
Likelihood of Being Digitalized and Age
Perú



In summary, it all can suggest that the more disadvantaged people among the poor are more limited in the use of advanced ICTs. If so, the policy implication is that governments must close the socioeconomic gaps of low-income people, or provide training courses to empowered people with the tools of ICTs. On the other hand, the finding, although preliminary suggests that researchers should be careful in defining their metric when studying the ICT gap in developing countries. Comprehensive measures that mix standard ICTs with very advanced ones can be misleading. However, we think that more micro-level research in developing country should be conducted in this regard.

Concluding Remarks

The objective of this paper was to identify the factors that shape the decisions of *low-income* people for personal use of various ICTs in three developing countries. It uncovered several findings. First, perhaps unsurprisingly, we confirm the importance of education and income in explaining the gap in the access and use of four main ICTs: fixed phone and mobile telephony, Internet and SMS. Second, we find that in Peru there is a digital gender gap but not in Colombia and Mexico, at least for the population surveyed. More research has to be done to see whether this is due to the specific data. Low-income people who live in capital cities of Bogotá, and Mexico City apparently fare better than low-income people who live in intermediate cities. It implies that a geographical digital gap can be emerging what reproduces the pre-existing socioeconomic inequalities among cities, and also can be explained by the lower competition by operators for users with those inequalities. Again, more research has to be done.

Last, from a methodological perspective, we tried to see whether including different types of ICTs in our composite indicators had any differential on the size of the coefficients' main factors. The findings confirm that when using only the more advanced ICTs, factors already identified as important, become, in general, *more* relevant.

In conclusion and from a policy perspective, the results of the present study suggest that governments in developing countries must try to reduce the socio-economic inequalities and by implementing ICT access programs can generate new opportunities for the low income people. The findings also means that government programs in educating and training low-income people in ICTs tools are of greater importance since they empower individuals. The role of non-government organizations (NGOs) in training low-income people is also very important and must be encouraged and supported.

Lastly, in a companion paper we intend to refine our indices and include the *frequency* of use and pattern of expenditure in fixed and mobile telephony, Internet use and SMS that we hope will allow us to see whether more refined measures of ICT usage and access are more useful in explaining the patterns of usage of low income people, or if new relationship between socioeconomic variables and ICT indicators emerge. Also, as data available allows it, we intend to find indicators of the relative digital poverty like those proposed for Barrantes (2007). Our preliminary results do suggests that more research is warranted.

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Annex

Questions used from the Questionnaires

For the purpose of this study, we use the answers given to:

a. TM3. Do you currently have a mobile phone?

b. TM1. During the past three months have you used a mobile phone to make or receive calls?

c. TM33. During the last month, did you send any text messages from any mobile phone?

d. TF1. Do you have a fixed phone line (landline) at home?

e. TF3. During the last week, have you used the fixed phone line phone (landline) in your home to make or receive calls?

f. INT1. Approximately how many days have you used the Internet during the past month?

g. INT2. Where do you access the Internet from?