CHAPTER 2

Analysis of ICT Demand: What Is Digital Poverty and How to Measure It?

Roxana Barrantes [1]
Instituto de Estudios Peruanos

Abstract

This paper discusses the notions of poverty, information needs and information and communication technologies (ICT) to offer a concept of digital poverty and estimate the digital poverty level in Latin America and the Caribbean. The paper is composed of two sections. The first section contains the conceptual discussion of digital poverty, its types and possible levels. ICT are defined based on their use and the conditions for such use. Digital poverty is therefore defined as a lack of ICT and might be a feature of any population segment, whether or not economically poor. In the second section of this paper the concept of digital poverty and its resulting classifications are validated by using data from a household survey (ENAHO) carried out in Peru. Lastly, the conclusions and future research lines are presented.

[1] This research was developed at the Institute of Peruvian Studies, as part of the institutional activities on the development of the Information Society. The research is part of the first stage of the Regional Dialogue on the Information Society (REDIS-DIRSI). Comments by Ramón Díaz, Natalia González, Carmen Montero and Carolina Trivelli, IEP members, and by Leonardo Mena and Jorge Dussán from REDIS-DIRSI, contributed to this paper. We acknowledge Tilsa Oré Mónago for her research assistance. Errors and omissions are my responsibility.

1. Introduction

This paper is the first step of a more comprehensive study, which intends to analyze the demand for Information and Communication Technologies (ICT) to design policies aimed at obtaining a more effective growth in access and fostering successful efforts to increase coverage and a productive use of ICT. It is developed as one of the works included in the Regional Dialogue on the Information Society (REDIS-DIRSI), which gathers researchers from Latin America and the Caribbean (LAC), under the coordination of the Institute for Connectivity in the Americas (ICA-IDRC). This work is part of a larger effort to design regulatory and public policies to increase ICT access by the region's marginalized sectors.

Demand analysis cannot be separated from digital poverty. Economics tell us that only those people with enough buying power can be part of the goods/services demand, and that this will happen only when the benefits of such good or service are known. Demand is therefore restricted by two main factors: the lack of income and the lack of information regarding the benefit associated with the consumption of the good/service.

Several topics need to be defined and discussed when posing this issue. Some of them are issues related to an economic understanding of demand, which requires resorting to traditional economic theories -briefly revised in this paper-, to set a framework for the subsequent discussion. This review requires a definition of the product demanded; thus, a definition of ICT is also pertinent to this analysis.

Considering the issue from the perspective of ICT demand, we must undertake an in depth study of one of the key factors of market demand for the service: income levels and their distribution. The approach allows us to extend the discussion to the relationship between poverty and ICT, towards a concept that has not been sufficiently discussed: "digital poverty" -the lack of goods and services based on ICT.

This lack of goods and services can at the same time be analyzed from two different perspectives. One is ICT demand by the marginalized sectors, and digital poverty measures, or low income/economically poor people's lack of ICT. This is the most common point of view (Nyaka, 2002) and leads us to study the role played by ICT in overcoming economic poverty and including the traditionally marginalized sectors.

However, from another perspective, it is relevant to analyze how much the demand for the service is affected by a set of joint or sequential consumption variables, which define "digital illiteracy"[2] or digital poverty, as we will refer to it in this paper. This is an aspect of measuring digital poverty at the general population level, which includes paying attention to all individuals who, for different reasons, neither use nor demand ICT.

[2] ETS (2002).

At this point, we decided to apply the conceptual framework proposed. We used the National Survey of Living Standards in Peru (ENAHO), which allowed us to focus on one ICT aspect –connectivity-, based on data obtained from households, not individuals.

This essay is organized in two parts. The first part includes basic concepts such as demand, poverty and information needs to define the concept of digital poverty. The application of the conceptual framework is included in the second part of this article, and shows interesting results, despite database limitations such as measuring household aspects and a single feature of digital poverty. This paper ends with conclusions and research areas for further study.

2. Economic Concept of Demand[3]

Demand, as understood by economists, is defined as the amount of a good/service people are willing to buy at a certain price. Demand is therefore a concept affected by buying power -without it, a person may have needs but not demand. Buying power is, in turn, affected by the consumer's income. With insufficient income, demand can be null or reduced, even if the need is urgent.

Demand or buying power for a good/service arises from the consumer's preferences for specific goods. Thus, two issues become relevant in the analysis: defining a good and studying how the consumer orders his/her preferences for such good in relation to other available goods.

The definition of a good plays a vital role when establishing consumer preferences. Defining a good means knowing it, knowing its use, and the disadvantages (or costs) associated with its consumption; that means knowing the full benefits of its consumption. Defining a good means to define the group of attributes or features of such a good that fulfill a consumer's need. Demand arises, then, from a previous knowledge of the good and a subjective evaluation of its advantages (benefits) and disadvantages (costs).

Those who do not know the good/service or who do not have the necessary buying power will not have demand. Hence the importance of advertising when introducing new products. We might enter a vicious circle: the most excluded within marginalized sectors, those with no access to information, will never have demand, because they will never know the benefits of the service.

The theory of consumer demand leads us to pose several questions regarding our research, among which we would like to mention only three. A first question refers to the definition of ICT: what they are, what type of good they are, the set of attributes that

[3] Concepts discussed within this section are part of an introduction to economic theory course, for which ample bibliography is available. Among a wide variety of references, I cite Varian (2002).

can be associated with ICT, the possibility of identifying a hierarchical order within this set. An additional question will explore the income level needed for ICT demand. Finally, the concept of digital poverty is discussed, with regards to the lack of ICT.

3. Service definition: Information, Communication and ICT

In order to talk about digital poverty, we will first discuss digital media for information and communication, known as "Information and Communication Technologies" or ICT.[4] This essay will discuss this definition based on a variety of attributes associated with ICT use and consumption.

- **Connectivity**. A means of communication is necessary. This includes end user equipment and fixed or wireless networks. These will meet connectivity needs for radio receivers, television devices, fixed or mobile telephone services, computers, which will be supported by the capacity to transmit information, be it content (broad band vs. fixed phone voice lines) or distance (television or radio).
- **Communication.** It may be one-way or two-way communication. This defines the type of connectivity and the usage of the information involved. For instance, television gives information but does not allow for information exchange, unless another means is used.
- **Information.** At the same time, information is divided into creation, storage, broadcasting, exchange and consumption. It is important to note that information has both private and public components. As a public good, information - once available - generates benefits that are not exclusive, that is why we tend to make less information available than would be efficient.

In this paper, ICT demand will be understood as the demand for these attributes, which may be fulfilled through the consumption of all goods and services having such attributes, or through the consumption of a subcategory of such products. The demand for ICT reflects the demand for the information and communication they offer. Therefore, they simply mediate the human need for information and communication.

[4] For ICT definitions, please check World Bank (2002), Nayki (2002), or Orbicom (2003), among many other references.

4. Conceptual Framework of Digital Poverty

The concept of "digital poverty" does not frequently appear mentioned in discussions[5]. "Digital divide" is the most frequently used concept, generally understood as measuring the inequalities in ICT access and in the use of ICT at the household or country levels[6]. Contrary to the concept of digital divide, the digital poverty concept tries to find the minimum ICT use and consumption levels, as well as the income levels of the population necessary to demand ICT products.

When introducing the concept of digital poverty, we are stating that the concern is not focused on any type of information or communication, but on the data that can be stored, made available, used and consumed by digital media. Hence, we are introducing a specific dimension: the use of computers or digital communication technologies that broaden the equipment's functionality, such as mobile phones, in order to facilitate information and communication.

In this approach, digitally poor individuals lack the information and communications enabled by digital technologies due to a lack of knowledge on how they are used, or a lack of income –demand considerations–. Technologies are the means but, at the same time, their availability is the most visible component of the demand that can be estimated.

Therefore, digitally poor individuals are not only low-income persons or people with unfulfilled basic needs, with no access to ICT nor usage of them; digitally poor individuals may also include people who, otherwise, could not be called poor. Thus, there are several types of digitally poor people:

- Low income or economically poor individuals, who do not have the minimum abilities required to use ICT and to whom services are not offered. There is a double restriction for ICT use: supply and ability restrictions.
- Low income or economically poor individuals with no service available, although they have the minimum abilities required to use ICT. There is only a supply restriction for ICT use.
- Economically poor individuals who do not demand, although they have the minimum abilities required to use ICT. It is precisely their lack of income that does not allow them to take part in ICT demand. There is a demand restriction for ICT use.
- Individuals who are not economically poor but have no demand because they do not have the minimum abilities required. This poverty appears more clearly as a generational gap.

[5] A simple search in Google of the phrase had no hits for those words combined in Spanish, and only one reference in English, related to the "digital divide". Search conducted on May 14th, 2005.

[6] Please see Orbicom (2003), ALADI (2003), NTIA (1999) and UIT (2003).

Taking into account this approach, marginalized sectors with low income levels are not the only digitally poor individuals. Digitally poor individuals may be those who do not use ICT due to lack of services provided or to the lack of abilities to use them.

Our discussion states that digital poverty can be studied from two different perspectives:

1. The traditional approach, as we call it, which analyzes ICT access of low income individuals or economically poor people with unfulfilled basic needs. Economically poor individuals may be digitally poor people due to supply or demand characteristics:

    a. If it is a supply problem, we will try to identify economically poor people who lack connectivity. This is the most studied problem in the literature, which focuses on how to eradicate the connectivity or digital divide, and which aims at making transmission means, telephones, computers and Internet connections available to population centers.

    b. If it is a demand problem, we will try to identify the economically poor individuals having supply sources. This will basically be an urban problem, as cities in our countries have supply sources such as telecenters, and therefore it is not necessary to have a computer in every household. The issue of public policy lies in how to broaden the use of ICT.

2. An approach that studies the lack of ICT, or the lack of ICT literacy. This concept of literacy would be equivalent to the inability to read and write and, in absence of a better term, "ICT illiterate" could be used. This lack may be a characteristic of both the economically and non-economically poor people. In the case of economically poor people, an ICT illiterate individual will clearly be illiterate, with no exposure to modern electrical appliances or to cable television; someone without an immigrant relative to be in contact with. Nevertheless, an ICT illiterate individual can be a person whose needs are completely fulfilled, as is the case of an elderly person whose daily activities do not expose or require him/her to be familiar with computers, appliances or modern technology in general.

We will then use four variables to define digitally poor individuals:

1. **Age.** The hypothesis states that the older the person, the higher the likelihood that he/she will be a digitally poor person. It is a way of measuring human capital.

2. **Education.** The hypothesis states that the higher the educational level, the less likely it is that he/she will be a digitally poor person. It is the most common way of measuring human capital.

3. **Available Infrastructure.** Radio, open television, fixed and mobile telephone services, cable television, computers, and Internet access are taken into account.

4. **Functionality Accomplished.** Functionality refers to the uses given to technology: from the mere reception of information to the full interaction involved in electronic government procedures or purchases, as well as the creation of contents.

It is possible to suggest the classification of digital poverty or digital wealth observed in Table 1, where the above types of digitally poor people are related to the different ICT attributes: the higher the level of connectivity, the lower the level of digital poverty. We have identified four levels, classified from 0 to 3.

Table 1: **Digital Poverty**

Connectivity Level	Functionality	Infrastructure	Educational Level	Age
III.	Digital Interaction (Electronic Government and Business)	Internet Broad Band	High	Youths
II.	Electronic Messaging	Internet / Mobile Telephone Services	Middle	Young and Not-So-Young People
I.	Communication and Reception of Information	Telephone Services (Fixed or Mobile)	Low But Not Illiterate	Elderly
0	Reception of Information	Radio or Television	Illiterate	Elderly

Extremely digitally poor people are, according to this diagram, those with a digital connectivity level equal to 0. The extremely digitally poor person will typically be someone who uses technology for the reception of information. This may be due to lack of knowledge of ICT use or lack of communication services. However, even when services are available, the person's age and learning ability may hinder his/her knowledge to fully use the equipment.

Digitally poor people have a connectivity level equal to 1. Digitally poor people have communication media available, so they can receive information and can communicate. However, the use of digital media is limited due to a lack of supply or of human capital, a low educational level, a high degree of illiteracy or older age.

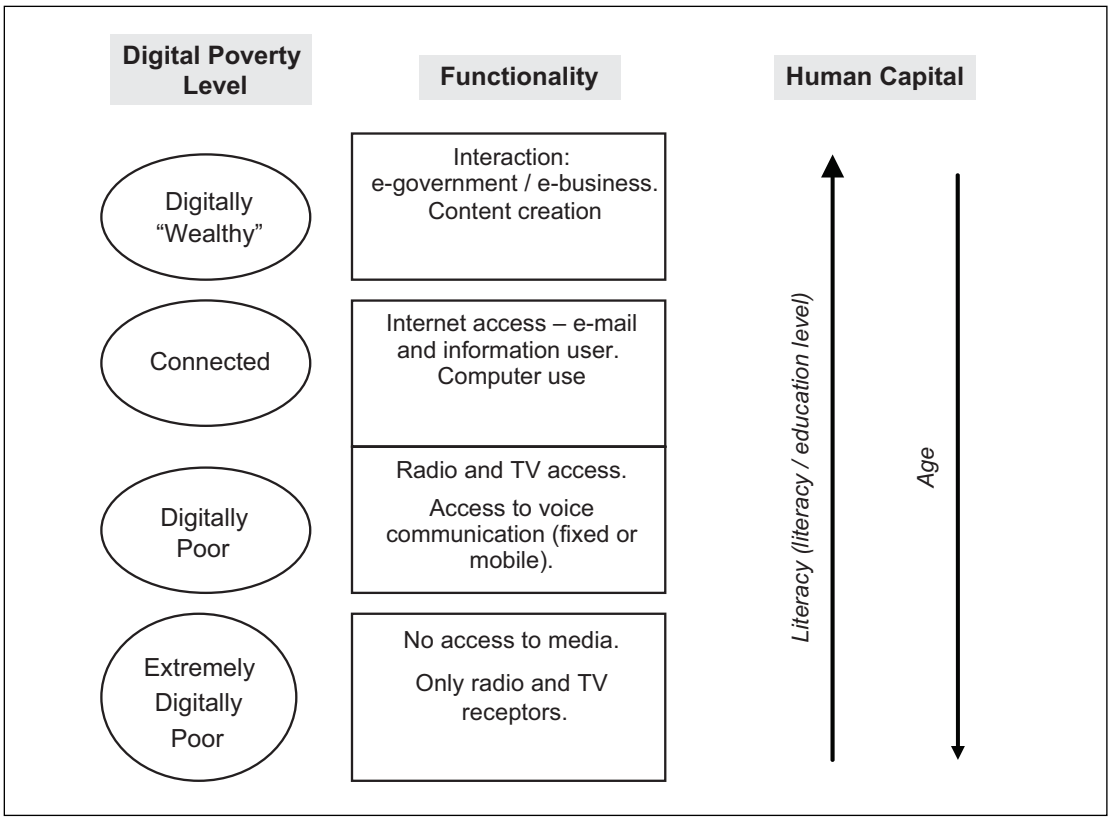
Those individuals with connectivity levels II and III are not digitally poor people. In

these cases, there is Internet access, but the difference between the two groups is the functionality of their Internet access. At level II, there is a passive use, whereas at level III, active use is observed, since the individuals in this group have the knowledge needed to make transactions or to take advantage of electronic government applications.

Taxonomy cannot be rigid if it intends to be useful. Two variables allow for a more flexible taxonomy: age and economic poverty. On the one hand, the economically poor, young people living in areas with no connection (supply problem) will not belong to level III. On the other hand, it will be difficult to classify elderly people, even if they are not poor, in level III.

This discussion can be summarized in the following figure, which introduces some considerations taken into account when classifying variables related to human capital, by using the arrows located at the right. People show greater digital wealth the higher their educational level, and lower digital wealth the higher their age.

Figure 1: **Digital Poverty Level**



The approach used for measuring digital poverty has more similarities with the one used for estimating unfulfilled basic needs than with the one used to find the deficit when purchasing a basic family food basket. Therefore, an individual who does not fulfill his/her communication and information needs through digital

means will be considered an extremely digitally poor person.

The approach presented in the conceptual framework requires researching ICT use in order to determine, not only the connectivity component, which is the most studied one, but also the connectivity use. In other words, if ICT demand is understood as a demand for connectivity attributes, information consumption, and information and communication availability, the measurement of digital poverty should estimate the dimensions of each attribute for every individual, and determine the person's lack in each aspect.

5. A Measurement Exercise of Digital Poverty

In order to illustrate the possible applications of this conceptual framework, we use the Peruvian National Survey of Living Standards (ENAHO) of 2003. It should be noted that ENAHO gathers socioeconomic household information, while the conceptual framework proposed can only be applied to individuals, since not only access, but the type of Internet usage is important to determine a certain individual's placement within the gradient of digital poverty. Therefore, the outcomes of this exercise are merely illustrative of the type of analysis enabled by the conceptual framework, as we can only observe the ICT connectivity attribute, but not the reception/broadcasting attributes of information and/or communication.

After clarifying that point, let us examine the results obtained. For the classification we will only select households with complete answers regarding having and accessing ICT, a total of 17,680 households. This universe will be known as a "selected sample." We think it advisable to describe the household groups according to their poverty level. The total sample, as well as the selected one, were classified according to the poverty level by expenditure deficit. Classification outcomes are shown in Table 2. The selected sample reproduces poverty results found at the national level: about 48% of the households qualify as poor households, and 18% of the households in the nation are considered extremely poor households, since they do not have the resources to purchase a family basic food basket.

Table 2: **Poverty in Peruvian Households**

Poverty Level	Selected Sample		Total Sample of ENAHO	
	Nº. Obs.	(%)	Nº. Obs.	(%)
Extremely Poor	3 328	18.82	3 424	18.1
Not Extremely Poor	5 024	28.42	5 158	27.27
Not Poor	9 328	52.76	10 330	54.62
Total	17 680	100	18 912	100

Source: ENAHO 2003

We then classified the selected sample households depending on their digital poverty level, only according to the connectivity attribute discussed in the previous section. The extremely digitally poor households are those that neither have access to voice communication nor to Internet in telecenters. Digitally poor people do not have access to Internet but do have access to voice communications. Connected people have Internet access only in telecenters, and digitally wealthy people are those who have Internet access in the household and own a personal computer.

When applying the instrument, we found that the strict application of the criteria could make us lose sight of an important group of households[7]. Particularly, the conceptual framework proposes a classification with increasing connectivity and ICT use, but Peruvian households show more Internet access in telecenters than phone use. Therefore, if the connected people group had included only those who have a telephone but access Internet only in telecenters, we would have missed the information of more than 10% of the households participating in the survey, which have Internet access in telecenters but do not have a telephone[8].

Taking this into account, we defined a pair of subgroups within connected households, considering whether they have any kind of telephone service or not. Connected households 1 are those that do not have a telephone and that have access to Internet only in telecenters. Connected households 2 are those that have any kind of telephone, fixed or mobile, and have access to Internet only in telecenters. The criteria for the selection of the groups are shown in Table 3.

Table 3: **Household classification criteria according to their digital poverty level**

	Owns radio	Owns television	Owns telephone	Uses Internet in telecenters	Computer and telecenters household
Extremely Digitally Poor			✗	✗	✗
Digitally Poor				✗	✗
Connected					✗
Connected Households 1			✗	✓	✗
Connected Households 2			✓	✓	✗
Digitally Wealthy					✓

The analysis of Table 4, which shows the results of the grouping, presents relevant information. The first fact that attracts attention is the impact of extremely digitally

[7] The document that describes in detail the way such application was made, and further analyzes the description of households according to each group is available from the author upon request.

[8] It should be noted that ENAHO does not gather data on household access to public telephones.

poor people, since over 68% of households are basically receptors of information, in terms of new technologies. The second observation is the reduced number of households with Internet connection, which is less than 1% of the sample. Thirdly, it is important to notice that only one out of four households has Internet access through any means. In fourth place, even if there is a strong connection between economic and digital poverty, there is no exact correspondence. Among the extremely digitally poor households, 40% are not economically poor households; and among those who do not have Internet access through any means (digitally poor people) there is a predominance of non economically poor households (83%). Finally, the characteristics of "connected households 1" attract attention, as the proportion of economically poor households with no telephone but with Internet access is greater (33,45%) than among the digitally poor households (16,07%). Later on, we will return to these observations.

Table 4: **Digital and Economic Poverty Level in Peruvian Households**

Digital Poverty	Nº of Obs.	(%)	Economic Poverty			
			Extremely Poor Household	Not Extremely Poor Household	Not Poor Household	
Extremely Digitally Poor Households	12 198	68.99	26.37	32.64	40.98	100
			96.66	79.26	53.59	
Digitally Poor Households	1 375	7.78	0.58	15.49	83.93	100
			0.24	4.24	12.37	
Connected Households	4 020	22.74	2.56	20.62	76.82	100
			3.09	16.5	33.1	
Connected Households 1	2 281	12.9	4.47	28.98	66.55	100
			3.06	13.16	16.27	
Connected Households 2	1 739	9.84	0.06	9.66	90.28	100
			0.03	3.34	16.83	
Digitally Wealthy Households	87	0.49	0	0	100	100
			0	0	0.93	
Total	17 680	100	3 328	5 024	9 328	
			18.82	28.42	52.76	100
			100	100	100	

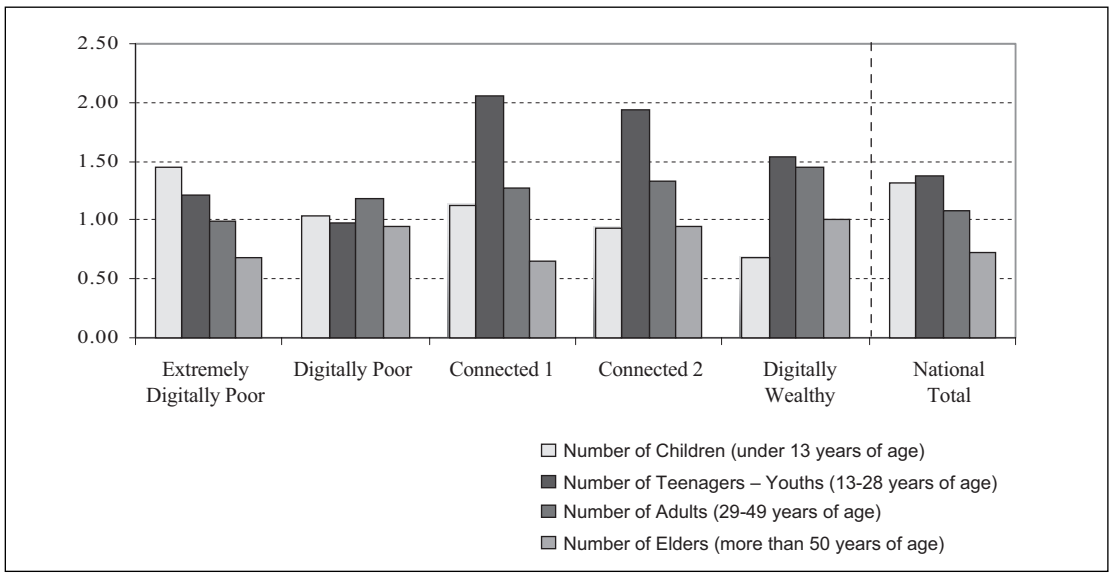
Source: ENAHO 2003

It is important to take a closer look at the characteristics of the different groups. Firstly, we will observe the demographic characteristics of the households and their members. Afterwards, we will examine the characteristics related to infrastructure and geography; and finally, the economic characteristics.

DEMOGRAPHIC CHARACTERISTICS

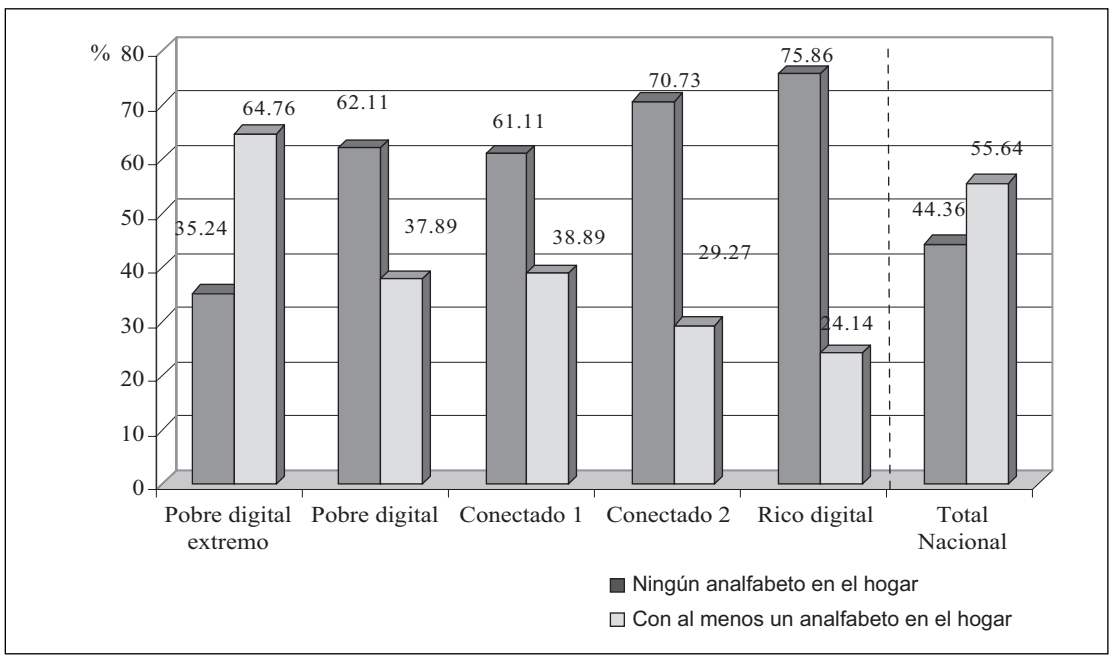
Figure 2 shows the household constitution per age group. It is important to note that among connected people, youths between the ages of 13 and 28 are above the national average and above the average for digitally wealthy people.

Figure 2: **Average number of household members by age group**



Source: ENAHO 2003

Figure 3: **Illiteracy in households**

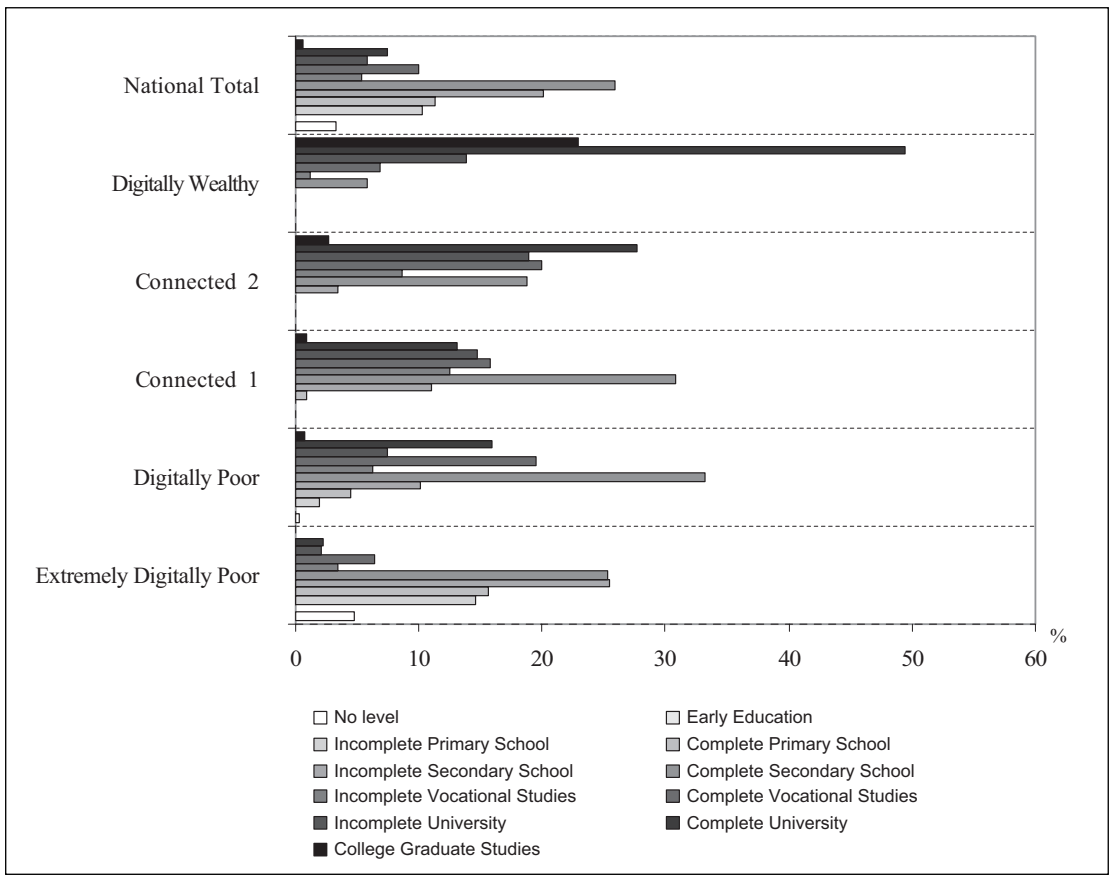


Source: ENAHO 2003

The presence of illiterate individuals in the household constitutes a factor that creates an important difference between groups. Firstly, notice that more than half of the Peruvian households have at least one illiterate member. Among the groups, the gradient is clearly negative: the less connected the household, the higher the proportion of households with at least one illiterate member, as can be seen in Figure 3.

In contrast to the data related to illiteracy, Figure 4 shows the maximum educational level reached by any of the household members. The most interesting fact is that there is practically no difference between digitally poor households and connected households 1, where the maximum educational level attained by any member is complete high school. Households that have completed superior education predominate in connected households 2 and among digitally wealthy people.

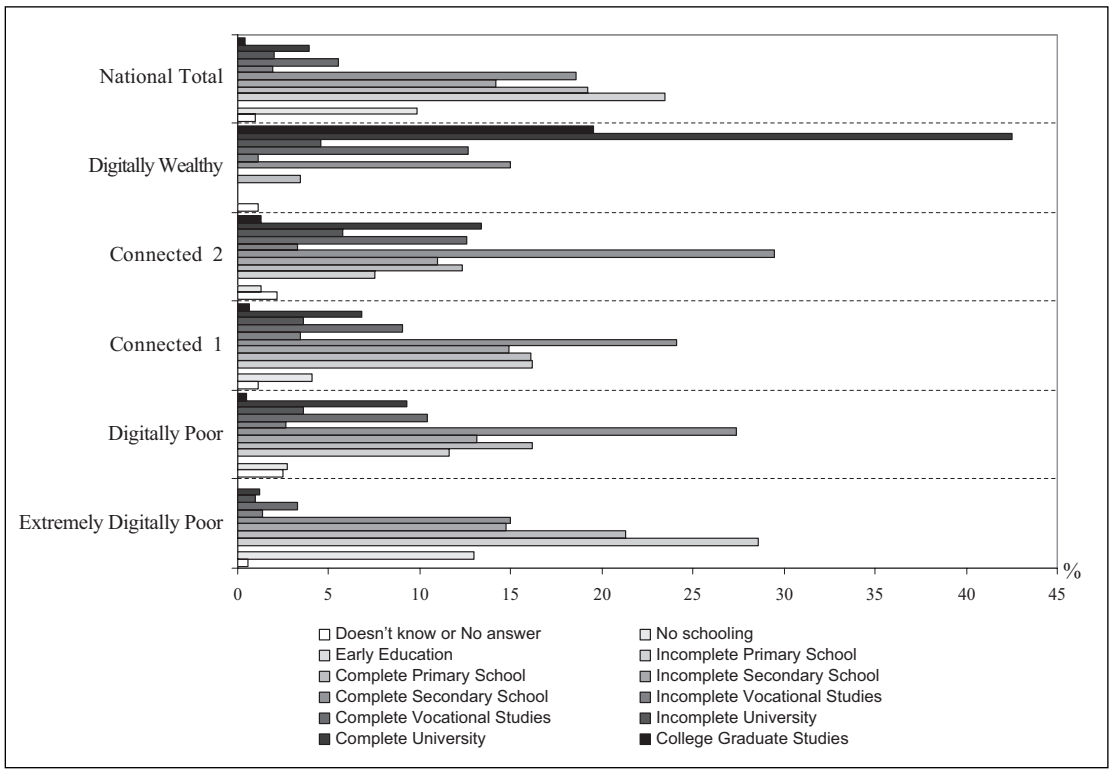
Figure 4: **Maximum educational level attained by any household member**



Source: ENAHO 2003

The educational level attained by the head of the household also differs between the groups, as shown in Figure 5. Even though the majority of members of Poor and Connected Households have completed their high school education, among Connected Households1 many heads of the household have only attended primary school or have completed some grades.

Figure 5: **Educational Level Attained by the Head of the Household**



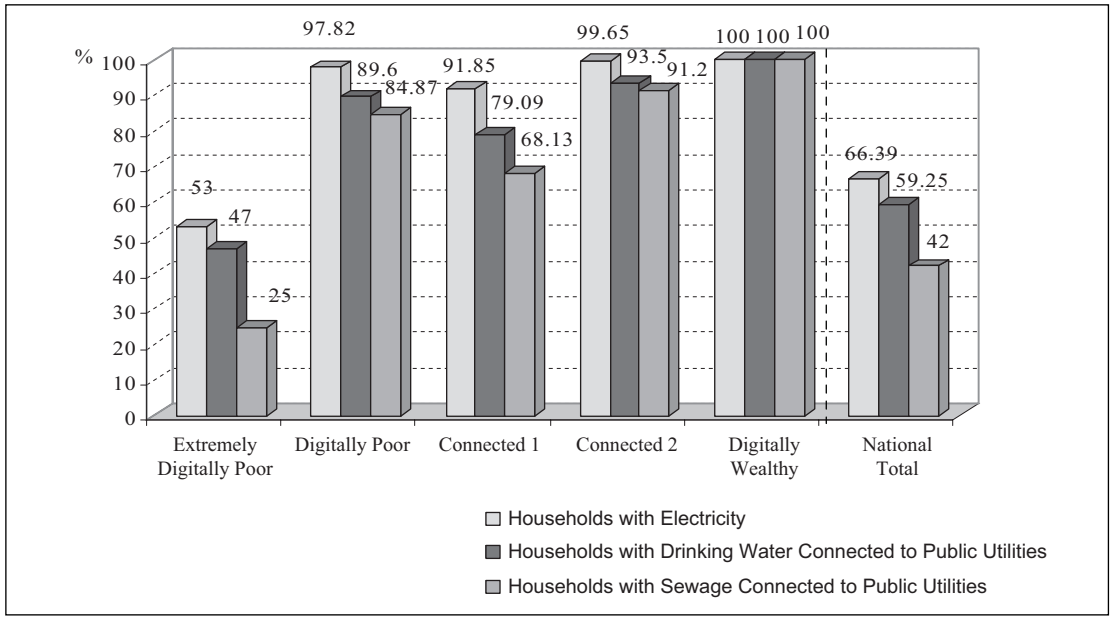
Source: ENAHO 2003

INFRASTRUCTURE AND GEOGRAPHY

This analysis shows the relevance of supply conditions in the digital poverty level.

The level of access to public services in general is quite limited among the extremely digitally poor people. The connected people are worse in average than the digitally poor people, while the digitally wealthy people have total access to all other public services. Figure 6 includes these comparisons.

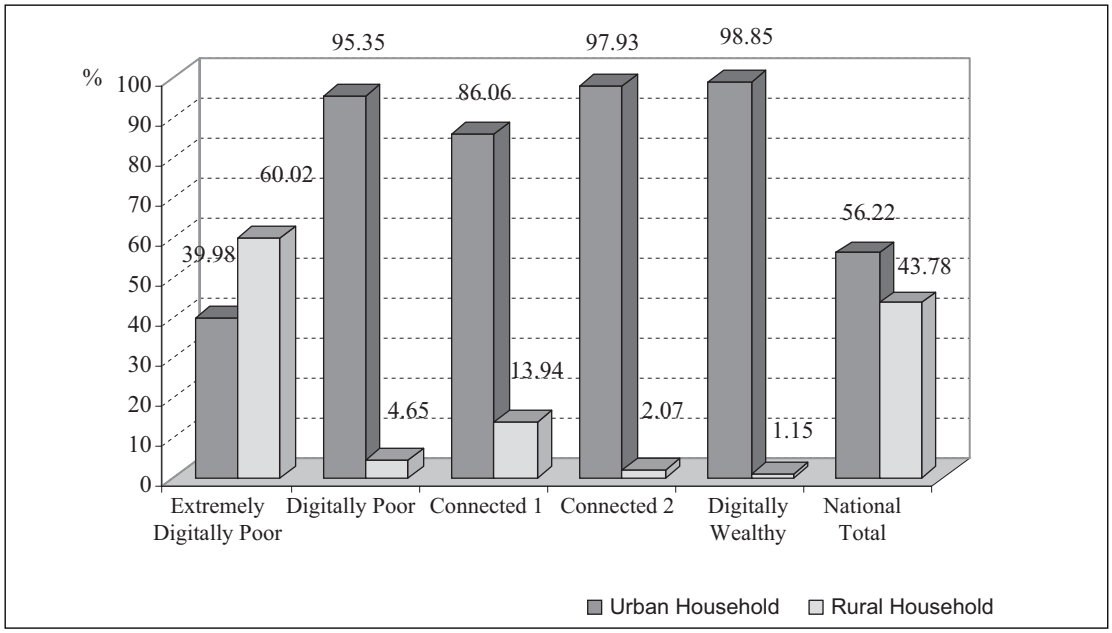
Figure 6: **Household access to Public Services**



Source: ENAHO 2003

Regarding the urban-rural composition shown in Figure 7, we highlight two characteristics. On the one hand, urban households predominate within digitally poor people. On the other hand, in Connected Households 1, more than 10% belong to rural areas.

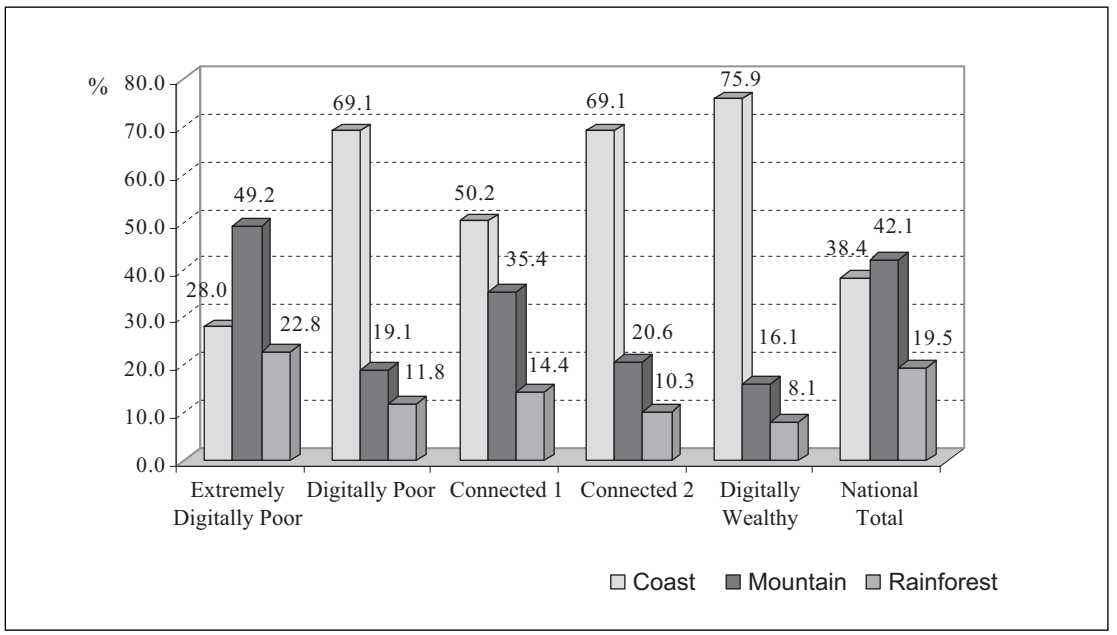
Figure 7: **Households by zone: urban and rural**



Source: ENAHO 2003

Geographical regions are strongly marked in Peru: the Coast, the region with the highest relative development, the Mountains, and the Rainforest, the largest region with the greatest communication difficulties. Extremely digitally poor people live mostly in the Mountains, while digitally poor people are concentrated on the Coast. More than half of the Connected People 1 live on the Coast, but over a third live in the Mountain. Connected People 2 and digitally wealthy people again show the expected gradient, with a high predominance of households being located on the Coast.

Figure 8: **Households by geographical location**



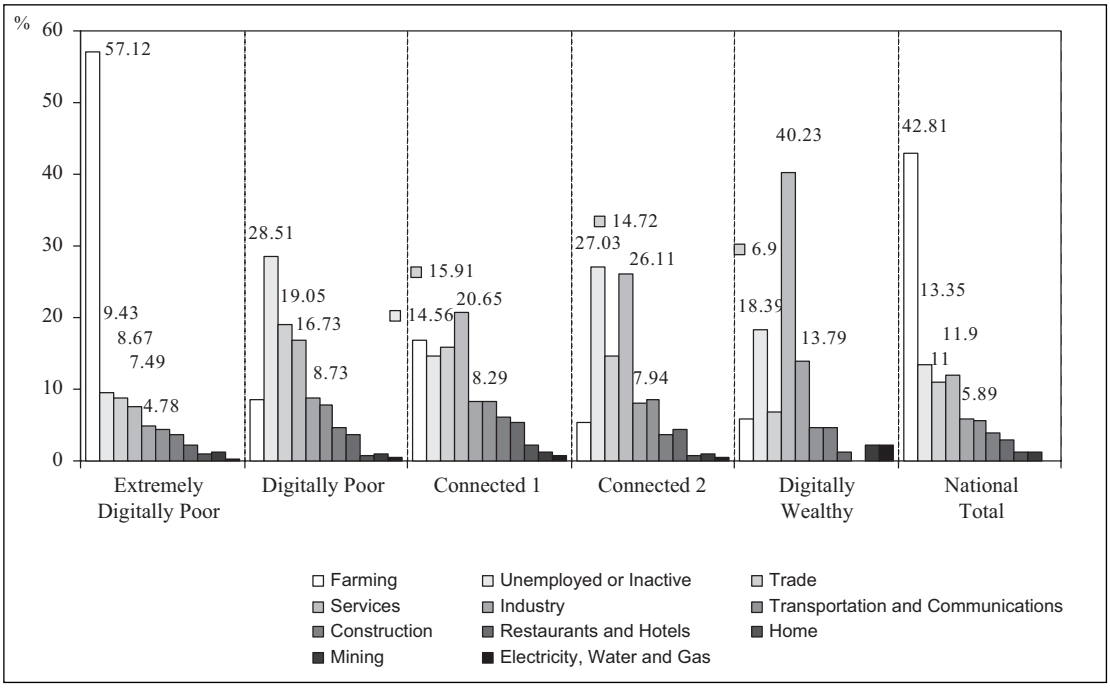
Source: ENAHO 2003

ECONOMIC CHARACTERISTICS

Concerning the main activity of the head of the household (Figure 9), extremely digitally poor people undertake agricultural or farming activities, while wealthy people undertake service activities. It is important to note that unemployed people prevail among the digitally poor individuals, while heads of the households who undertake service activities prevail among the connected people. Among Connected People 2, there is a large number of households where the head of the household is unemployed.

Figure 10 shows the average income level per group, and the portion of expenses committed to transportation and communications. The outcomes for extremely poor people and for wealthy people are obvious: higher income levels are associated with greater amounts committed to transportation and communication expenses.

Figure 9: **Main Economic Activity of the Head of the Household**



Source: ENAHO 2003

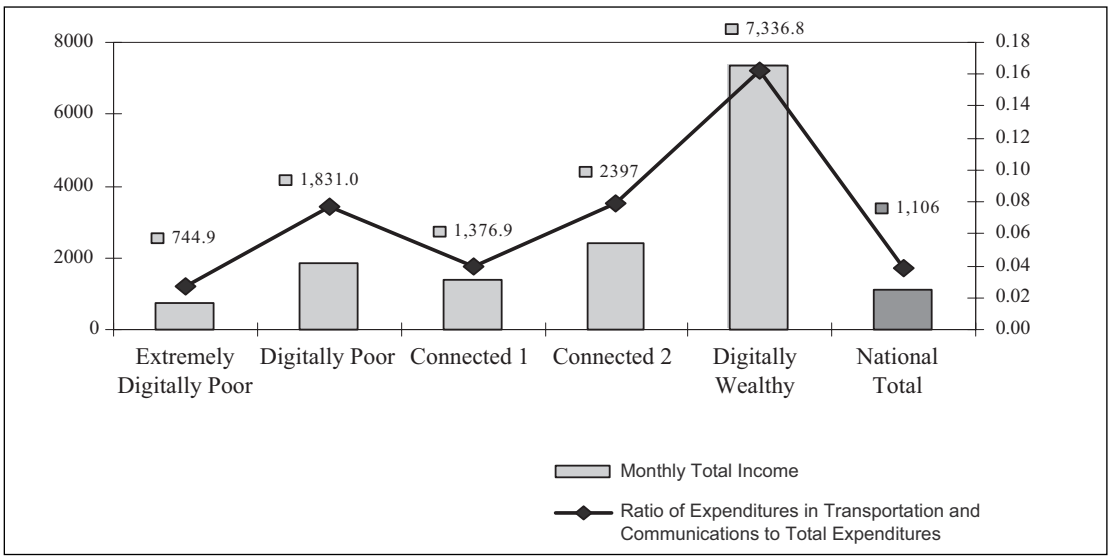
The similarity between poor people and Connected People 2 is important, as they show higher income levels and expense portions than the national total.

ECONOMETRIC ANALYSIS

The analysis of the data described above shows that differences between extremely poor people and wealthy people are very clear and can be attributed to factors that explain economic poverty: educational level, income, main economic activity, urban condition, etc. What is interesting about the data on Peruvian households is the difference between poor and connected people, who are very similar except for Internet access. For that reason, we try to explain the probability of a household belonging to any of those groups, according to the set of variables analyzed that belong to the conceptual framework.

The listing of the variables considered in explaining this fact, the way of measuring them, and the expected sign are shown in Table 5. The economic poverty level is approximated by variables based on the households' monthly income and the number of members of the household who earn an income, as well as whether or not the head of the household undertakes on service-related activities. We expect that the lower the poverty level, the higher the likelihood of the household having Internet access.

Figure 10: **Average Total Monthly Income and Ratio of Transportation and Communication Expenditures to Total Expenditures per Household**



Source: ENAHO 2003

The conceptual framework considers the educational level to be one of the most important variables in explaining an individual's connectivity level. In addition, this is one of the components of the individual's human capital. In this exercise, we approach the human capital of the household by including variables that indicate its different dimensions. As indicated, the estimation of human capital will take into account the size of the family, the educational quality and level attained by the most educated member, and the presence of illiterate individuals. Within the conceptual framework, age is also important to explain the digital poverty level. This is why we used two variables: the ratio of the number of youths in the household (members between 13 and 28 years of age and the age of the head of the household. Finally, we also included the predominant gender through the male ratio. Human capital variables have a positive influence on the probability of having Internet access, except for the age of the head of the household.

Internet supply is indicated in two ways: on the one hand we separated rural from urban households. The hypothesis is that urban households have a vaster supply of telecommunication services than rural households. On the other hand, we classified the household location: Coast, Mountains or Rainforest, where the Coast is the region with the highest supply of public utilities in general. We do not have a reliable variable to indicate whether the household has Internet access[9].

[9] An exercise was carried out to identify whether or not the household district had a telecenter by assigning such requirement to the capitals of districts, provinces, and departments. As the condition was assigned but not verified, and the results were very poor, it was decided not to include it in the final model.

Finally, we introduced three control variables in order to consider the effect of the lack of a telephone in households with Internet access in telecenters. The data collected shows that Connected People 1 are poorer than Connected People 2, and than the digitally poor. In addition, there are other differences regarding demographic characteristics, such as the number of youths and the age of the head of the household. These differences had a negative influence over the model specification, so it was necessary to control them[10].

Table 5: **Summary of Variables, Indicators and Expected Sign**

Theoretical variable	Variable	Indicator	Expected sign
Explained variable			
Connected household	Probability of a household being "connected"	0 = Digitally poor household 1 = Connected household	
Explanatory variables			
Economic Poverty	Income level	Household's monthly total net income	+
Human Capital	Economic Activity	Services as main economic activity of the head of the household	+
	Number of Income Earners	Number of income earners in the household	+
	Stock Size	Number of household members	+
	Age	Age of the head of the household	-
		Ratio of number of teenagers and youths (13-28) to total number of individuals living in household	+
	Gender	Ratio of number of males to total number of individuals living in household	+
	Quality	Illiterate individuals in household: 0 = Household with no illiterate members 1 = Household with at least one illiterate member	-
		Maximum educational level attained by any household member	+
Supply	Zone Region	0 = Rural 1 = Urban	+
		1 = Forest 2 = Mountain 3 = Coast	+
Control Variables	Income level of household with a mobile telephones		-
	Income level of household with a fixed telephone		-
	Zone (Urban or Rural) given that household is on the Coast and has any kind of telephone		-

[10] Instead of two groups clearly defined -poor and connected people, both with telephones- , there was a third group that had not been taken into account: They were the individuals who have access to Internet in telecenters, but do not have telephones.

Table 6: **Correlation Matrix**

	Total monthly net income	Services as head of household's main economic activity	Number of income earners in household	Number of household members	Age of head of the household	Ratio of number of teenagers and youths to total number of individuals living in household	Ratio of male to total number of individuals living in household	Illiterate members in household	Maximum educational level attained by any household member	Zone	Region	Income level of household with a mobile telephone	Income level of household with a fixed telephone	Zone if there is any kind of telephone in the Coast region
Total monthly net income	1													
Services as head of household's main economic activity	0.1827	1												
Number of income earners in household	0.3385	0.0434	1											
Number of household members	0.1557	-0.0184	0.5068	1										
Age of head of the household	0.0596	-0.1264	0.1738	-0.0653	1									
Ratio of number of teenagers and youths to total number of individuals living in household	0.0591	0.0176	0.2084	0.1525	-0.2676	1								
Ratio of male to total number of individuals living in household	-0.0188	0.0007	-0.0194	-0.0589	-0.0599	0.1201	1							
Illiterate members in household	-0.1724	-0.1285	-0.0057	0.2739	0.024	-0.1581	-0.1014	1						
Maximum educational level attained by any household member	0.4833	0.3382	0.3289	0.1842	-0.0921	0.1976	-0.0007	-0.3247	1					
Zone	0.3289	0.2099	0.2176	-0.0057	-0.0139	0.0918	-0.0426	-0.2954	0.4737	1				
Region	0.2039	0.0364	0.1524	-0.0331	0.0713	-0.0078	-0.0323	-0.1385	0.1804	0.3029	1			
Income level of household with a mobile telephone	0.7238	0.1126	0.1208	0.0226	0.0198	0.0116	-0.0185	-0.086	0.2495	0.1482	0.13	1		
Income level of household with a fixed telephone	0.8105	0.1334	0.2233	0.0642	0.0954	0.015	-0.0466	-0.1538	0.3891	0.258	0.1657	0.6496	1	
Zone if there is any kind of telephone in the Coast region	0.394	0.1089	0.1907	0.0345	0.088	0.0179	-0.0464	-0.1847	0.3365	0.3365	0.4332	0.3315	0.5008	1

Table 6 shows the correlation matrix between variables. The relationships between variables are quite weak, except for a high correlation between the control variables and the income; however, this does not affect the assumption of the model's lack of multicolineality[11].

The econometric results of the Probit model, which explains the probability of a household being connected, reflect what was expected, and are exhibited in Table 7[12]. The most interesting information appears in the last column, which shows the marginal effects: that is, how much the probability of being connected increases, if the value of the explanatory variable increases by 1%. The greatest marginal effect is caused by the relative importance of youths living in the family, immediately followed by one of the supply indicators, the geographical region. The existence of illiterate members in the household reduces the probability of being connected, as does the importance of the males in the family, which results counterintuitive. The sign of the control variables is negative, which indicates that, if the household has a telephone, the probability of having Internet access in telecenters is lower as the income increases. In other words, it seems that the supply characteristics in Peru show that connectivity for economically poor people is obtained through Internet access in telecenters as a substitute for telephones.

6. Conclusions and Perspectives

The concepts of poverty and ICT have been discussed in this document to offer a definition of digital poverty that would in turn enable to measure the level of digital poverty. Our final objective is to design effective policies to reduce digital poverty, as we have defined it. The role played by ICT in the development and reduction of economic poverty has been taken into account.

Our discussion began with basic notions regarding consumer demand, focusing our analysis on income availability and the knowledge of the product/service to calculate its demand. Therefore, it is essential to understand ICT as multidimensional products and services with three basic attributes: connectivity, communication and information. Each one of these attributes may, at the same time, be analyzed through different variables, which will be useful when trying to measure digital poverty.

Digital poverty is therefore defined as a lack of ICT with regards to access and use of the information and communications allowed by the technology. Digital poverty, as here defined, might be a feature of every population segment, whether or not

[11] It was proved through partial regressions among explanatory variables.

[12] A simple explanation of the model can be found in Kennedy (1994).

Table 7: **Probability of a Household Being "Connected" and Not "Digitally Poor" (0 = Digitally Poor Household and Connected Household 1)**

Variables	Coefficient	Marginal Effect dF/dx
Household's monthly total net income	0.0002166 (0.0000284)	0.0000568
Services as main economic activity of the head of the household	0.2002463 (0.0566007)	0.0497319
Number of income earners in the household	0.1040731 (0.023945)	0.0272861
Number of household members	0.1162496 (0.0137486)	0.0304786
Age of the head of the household	-0.0043565 (0.0016341)	-0.0011422
Ratio of teenagers and youths to total number of individuals living in household	1.412318 (0.0932168)	0.3702852
Ratio of males to total number of individuals living in household	-0.3174351 (0.0904497)	-0.0832259
Illiterate members in household	-0.2428592 (0.0488157)	-0.0656798
Maximum educational level attained by any household member	0.1463263 (0.0131151)	0.0383642
Zone	0.2003845 (0.0890014)	0.0565429
Region	0.5498609 (0.0448043)	0.1441639
Household income level with a mobile telephone	-0.0001654 (0.0000217)	-0.0000434
Household income level, with a fixed telephone	-0.000204 (0.0000233)	-0.0000535
Urban zone in the Coast region with any kind of telephone	-1.309092 (0.0713144)	-0.378221
Constant	-2.245768 (0.195478)	
Number of Observations	5,395	
Pseudo R2	0.2678	
Rate of Model's Predictability	80.59%	
Goodness-Of-Fit Tests	0.806	

Standard errors are indicated in parenthesis.

economically poor. Three types of causes for digital poverty are determined: lack of supply, that is, lack of connectivity access –one of ICT's attributes–; lack of demand, a problem clearly related to inadequate income; and lack of need or capacity, which is the problem of non-poor people with no access or use due to age or inadequate literacy. Each kind of digital poverty will require a different public policy.

The approach used for measuring digital poverty has more similarities with the one used for estimating unfulfilled basic needs than with the one used to find the deficit when purchasing a basic family food basket. To that extent, those individuals who neither have access to ICT nor use the digital means enabling information and communication will be considered digitally poor people. In turn, those who do have access and use such means will be connected at different levels.

The approach presented in the conceptual framework requires identifying the uses assigned to ICT to determine not only the connectivity component –which is the most studied one-, but also the component that indicates the types of usage related to connectivity. In other words, if ICT demand is understood as the demand for the attributes of connectivity -information consumption, making information available, or communication-, the empirical exercise we carried out with the Peruvian ENAHO explored only one of the ICT demand attributes -the connectivity attribute.

In this application, the term "digital" has been summarized as Internet access, considering it the digital means of information transmission and communication par excellence. The access to and the use of digital mobile telephone services has remained unanalyzed due to data limitations, as well as digital television due to limitations in supply.

Based on Peruvian data, it is important to note that two-thirds of the households qualify as extremely digitally poor households, in contrast to 18% of the households considered extremely economically poor households. It is also interesting to note that extreme digital poverty is an important phenomenon among non economically poor people, which demands developing new ways to actively integrate these groups.

One of the most interesting results of this research study is the importance of households with no telephones, but with access to Internet in telecenters. There is a comment to add in this regard to the gradient shown in the conceptual framework.One possible explanation is Peru's low telephone service penetration, which seems to make telecenters that offer Internet access a natural substitute for providing communication and entertainment to the public, particularly the youngest members of the household. This is especially relevant to economically poor people, who resort to telecenters as a means of overcoming their lack of communication. Replacing tele-

phones for telecenters to access Internet is valid when there is a majority of young members living in the household and a relatively young head of the household. The effect is reduced if there are illiterate individuals living in the household.

A variety of research areas for further study have sprung from this exploratory exercise. On the one hand, using household data may allow for a more detailed study of each group's characteristics, particularly of the extremely digitally poor group of individuals, to identify policies focused on the specific restrictions that would need to be overcome to effectively reduce digital poverty. On the other hand, the ad hoc application of the conceptual framework, by carrying out a survey to determine different "digital" uses among individuals through Internet or mobile telephone services. An in-depth study of the purpose, time, applications, individual learning mechanisms, and the demand for information and communications reflected by the different uses would be a step towards designing policies to overcome digital poverty.

References

ALADI. (2003). *La Brecha Digital y sus Repercusiones en los Países Miembros de la ALADI [The Digital Divide and Its Impact on ALADI Member Countries]*, Asociación Latinoamericana de Integración [Latin American Association for Integration] – ALADI, 194 pp. Retrieved from http://www.aladi.org/nsfaladi/titulare.nsf/5c424a97a14f01e0032568e00046db1b/fa8db613acb8beee03256d74004dcd3a/$FILE/157Rev1.doc.

World Bank. (2002). *Information and Communication Technologies: A World Bank Group Strategy.* Retrieved May 3, 2005, from http://info.worldbank.org/ict/assets/docs/sp_ExecSum.pdf

World Bank. (2003). *ICT and MDGs: A World Bank Group perspective, World Bank Group's Global ICT Department.* Washington D.C. 39 pp. Retrieved April 30, 2005, from http://info.worldbank.org/ict/assets/docs/mdg_Complete.pdf

ETS. (2002). *Digital Transformation. A Framework for ICT Literacy. A report of the International ICT literacy panel.* Retrieved May 16, 2005, from http://www.ets.org/research/ictliteracy/ictreport.pdf

INEI. (2003). Encuesta Nacional De Hogares sobre Condiciones de Vida y Pobreza [National Household Survey on Living Standards and Poverty] - ENAHO 2003, Instituto Nacional de Estadística e Informática [National Institute of Statistics and Computer Science] - INEI, Data Base.

Kennedy, P. (1994). *A Guide to Econometrics.* Third Edition.. Cambridge, M.A.: MIT Press.

Nyaki, C. (2002). *ICT and Poverty: A Literature Review*, International Development Research Center-IDCR, 58 pp. Retrieved May 27, 2005, from http://network.idrc.ca/uploads/user-S/10541291550ICTPovertyBiblio.doc. http://network.idrc.ca/ev.php?URL_ID=24718&URL_DO=DO_TOPIC&URL_SECTION

ORBICOM. (2003). *Monitoring the Digital Divide…and Beyond.* Orbicom, Canadian Agency for International Development, InfoDev and UNESCO, 161 pp. Retrieved May 10, 2005, from http://www.infodev.org/files/836_file_The_Digital_Divide.pdf.

ITU. (2003). *New Digital Access Index.* International Telecommunications Union, ITU. p. 6-17. Retrieved May 29, 2005, from http://www.itu.int/ITU-D/ict/dai/material/DAI_ITUNews_s.pdf.

Varian, H. (2002). *Intermediate Microeconomics.* Spanish Edition. Barcelona: Antoni Bosch.