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**The Access and Welfare  
Impacts of  
Telecommunications  
Technology in Peru**

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## Abstract

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This paper attempts to assess three main issues on Peruvian telecommunications technology: what are the main variables that explain the demand for access to telephone services; how important is access to telephone services in explaining the transition out of poverty, and what are the consumption and welfare impacts of the significant increase in the supply of telephone lines since the divestiture in 1994 of the Peruvian telephone services.

To accomplish our goal we will use two methodologies. Firstly, we will concentrate on residential telephony based on a countrywide representative consumer expenditure survey (The World Bank's Living Standards Measurement Survey). With this household survey the demand for access to telephone services was modeled and the effects of access to a telephone on poverty was analyzed. The main result showed that access to a telephone is important in explaining why low income households do not drop into poverty, but that it is not significant in explaining the transition between poor and non-poor status. Additionally, the presence of these surveys for 1985, 91, 94 and 1997, allowed us to estimate the welfare impacts at different socioeconomic levels of the various institutional changes in telephone services before and after privatization.

The second methodology takes advantage of a panel of households for Metropolitan Lima allowing us to estimate partial demand equations of access to telephone services in order to evaluate consumers' welfare pre and post divestiture showing the presence of an important positive consumer surplus of access to a residential telephone. Both methodologies measured how welfare gains coming from more people having access to telephone lines might have compensated for higher usage rates as the result of privatization.

The main objective of these methodologies is therefore to assess which types of households, classified according to their observable characteristics, bear a greater portion of the burden or enjoy most of the benefits of the changes brought about by privatization.

## Kurzfassung

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Die vorliegende Studie beschäftigt sich mit drei Problemen, die im Zusammenhang mit Veränderungen auf dem Gebiet der peruanischen Telekommunikationsdienste stehen. Diese Probleme sind: erstens die Frage nach den wichtigsten Variablen, die die Nachfrage nach Telefondiensten bestimmen; zweitens, die Rolle des Zugangs zu Telekommunikationsdiensten in Abhängigkeit verschiedener Stadien materieller Armut; drittens stellt sich die Frage, inwieweit sich die – seit der Teilprivatisierung des Telekommunikationsmarktes im Jahre 1994 andauernde – stetige steigende Anzahl an Telefonanschlüssen auf Konsum- und Wohlfahrtskriterien auswirkt. Zur Untersuchung dieser Fragen werden zwei verschiedene Methoden angewendet.

Zum einen werden Daten herangezogen, die im Rahmen einer repräsentativen und landesweiten Konsumentenbefragung erhoben wurden. Diese Daten erlauben auf der Haushaltsebene eine Modellierung der Nachfrage nach Telekommunikationsdiensten sowie des potentiellen Einflusses der Telefonnutzung auf materielle Armut. Die Ergebnisse zeigen, dass der Zugang zu Telefonen, insbesondere für Haushalte mit niedrigem Einkommen, wichtig ist, um ihren ökonomischen Status zu erhalten bzw. zu verbessern. Andererseits ergab sich aber kein signifikanter Zusammenhang zwischen der Nutzung der Dienste und der Überwindung von Armut.

Datensätze aus den Jahren 1985, 1991, 1994 sowie 1997 wurden genutzt, um die Wohlfahrtseffekte, die die institutionellen Veränderungen auf dem Telekommunikationssektor mit sich brachten, auf verschiedenen sozioökonomischen Niveaus für den Zeitraum vor bzw. nach der Privatisierung des Sektors zu untersuchen. Schließlich konnten mit Hilfe von Erhebungen in Lima partielle Nachfragefunktionen vom Zugang zu Telekommunikationsdiensten vor und nach der Privatisierung geschätzt werden. Die so gewonnenen Erkenntnisse bezüglich der Konsumentenrenten lassen den Schluss zu, dass insbesondere die Nutzer von privaten Hausanschlüssen von den Veränderungen profitieren.

## 1 Introduction

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Information and communication technologies have clearly reached star-status on every developed country's agenda. The growing demand in developing countries finds expression in long waiting lists for telephone connection, growing use of cellular systems and the rapidly expanding number of Internet users. To meet this demand, consideration of information and communications technologies is increasingly becoming an integral part of national development agendas. In fact, there is currently a phone frenzy in the developing world. The planned increase in telephone lines within the Third World for the next five years will require some US\$ 200 billion in investments [Hammelink; (1997), Bar; (1987)]. This is expected to be achieved largely through a massive inflow of foreign capital. For this purpose, countries are deregulating and opening their markets for equipment manufacturers and service providers. A rapidly increasing number of developing countries have already started or are scheduling the privatization of their telephone companies (examples include Peru, Bolivia, Cape Verde, Cote d'Ivoire, India, Indonesia, Sri Lanka, Thailand, Uganda, Ghana, Guinea, Nicaragua, Panama, Paraguay, Zambia, El Salvador and Honduras) [see Hammelink; (1997)].

In Latin America there is also growing support from private and public institutions for developing national and regional information infrastructures. The countries of the region are privatizing quickly and developing very sophisticated networks. In the Americas Blue Book: Telecommunications Policies for the Americas Region (released in April 1996 by the Telecommunications Development Bureau of the ITU and the CITELE of the Organization of American States) much emphasis is placed on the joint development of a telecommunications policy and the expansion of telecommunication services. A country-by-country survey shows that the Brazilian National Congress voted in August 1995 to allow privatization of the state monopoly Telebras, to begin in 1997, and plans an expansion of the telephone network from the current level of 6.83 to 9.49 lines per 100 inhabitants in the year 2000. Chile plans a telephone expansion from 8.92 per 100 inhabitants to 19.71, Mexico from 7.54 to 12.49, and in Peru the number of lines per 100 inhabitants increased from 2.4 in 1992 to 6.7 in 1997<sup>1</sup> as a consequence of the privatization of the telecommunication services<sup>2</sup>.

The potential of digital technologies to improve the livelihood of people is great. In remote regions, the disadvantages that arise with isolation can be significantly lessened through access to rapid and inexpensive communication. Like-minded people can cooperate across great distances to defend human rights or promote other projects of common interest. Remote sensing

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<sup>1</sup> In 1995 it was 4.7 lines per 100 inhabitants and in 1996 was 5.9. It is expected that the growth rate will decrease by the year 2000.

<sup>2</sup> The privatization of telecommunications services took place on the 28<sup>th</sup> of February of 1994 and it was sold for 2,002 Million US\$ and paid for by May of the same year.



can be used to protect the natural environment. The list of possible contributions to human development is long indeed [see for example Weld(1997)]. Yet there are also obvious dangers in the current highly charged competition to gain control over digital technologies. Already existing trends toward polarization in the world economy can clearly be worsened. Development can be concentrated in regions where the information infrastructure is most developed, to the detriment of areas that are not endowed with the most modern capabilities. And within societies, a growing “knowledge gap” can separate individuals who have access to the latest equipment, and have been trained to use it, from those who do not.

This paper attempts to consider the implications for Peru of the Global Information Revolution by analyzing the access to telephone services as a pre condition to information and communication technologies. It highlights a number of important advances in the Peruvian telecommunications capabilities and argues that this foundation will support the development in the country of a full range of information technologies. Not only will new technologies stimulate economic growth and increase competitiveness reducing transaction costs, they can also help meet the continent’s most basic needs. The challenge facing policy makers is to harness these technologies and mobilize resources and partnerships to accelerate the economic, political and social development [Weld; (1997)].

The Peruvian telecommunication market is currently undergoing a period of fundamental changes. The driving forces behind these changes are, amongst others, liberalization, privatization, technical progress and demand shifts. These forces have direct and lasting effects upon consumers and suppliers. It is therefore essential to evaluate and further our scientific knowledge of the effects of these changes.

This paper is divided into three main sections. The first section consists of a description of the telecommunications sector in Peru and the major changes that have occurred since the privatization of *Compañía Peruana de Teléfonos (CPT)* and *Empresa Nacional de Telecomunicaciones (ENTEL)* to *Telefónica de España*. It highlights the situation of access to and usage of the telecommunications services comparing it pre and post divestiture. In the second section the LSMS household surveys for 1985-86, 1991, 1994 and 1997 are used to measure access by households to residential telephone services both in the rural and urban areas as well as the importance of having telephone in the transition between income classes. Finally, and only for Lima Metropolitana where the major changes in privatization took place, we aim to measure the welfare effects of the access by households to telephone services given the new institutional changes.

## 2 The Peruvian Telecommunications Market

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In August 1990, Peru embarked upon a harsh stabilization and structural reform process that has included a vast privatization program of state owned enterprises. In the telecom sector, the Peruvian government sold both *Compañía Peruana de Teléfonos* (CPT) and *Empresa Nacional de Telecomunicaciones* (ENTEL). CPT was the company that provided basic telecom services in the Lima area while ENTEL was the national and long distance carrier as well as the provider of local telecom services in the rest of Peru. Divestiture took place in 1994, after an auction to the highest bidder. Using a first-price sealed bid mechanism, approximately 35% of CPT and ENTEL common shares (the minimum required to give the buyer control of the merger) were sold to the Spanish based venture *Telefónica de España*, which was no stranger to acquiring Telecom providers in Latin America (other companies bought by *Telefonica* include the former *Telefonos de Chile*, currently known as CTC, and Argentina's ENTEL). The outcome of the auction was overwhelming: Telefonica paid US\$2,002 million, an amount by far larger than the second highest bid (US\$800 million) which was actually closer to the base price set by the government.

Shortly after buying both companies, Telefónica de España S.A. merged them and created Telefónica del Perú S.A. (TdP). TdP was granted, initially for a five year period,<sup>3</sup> the national monopoly for the provision of lines, local calls, national long distance (NLD) and international long distance (ILD) throughout the country.

Almost five years after privatization took place, the impact on development is not obvious. Although more people, mainly from low socio-economic levels, currently can access a telephone, several are reluctant to do so because they are not able to pay the monthly bill. Table 1 shows some of the changes that occurred between December 1993 and December 1997 according to OSIPTEL (*Organismo Supervisor de la Inversión Privada en Telecomunicaciones*), the Peruvian telephone regulatory agency.

Unlike other experiences, the Peruvian case will allow us to measure the impact of a strong increase in the penetration ratio of phones and how welfare gains coming from more people having access to telephone lines might be so large as to compensate for higher usage rates. Our main hypothesis is that providing more access to basic telephone services will improve the welfare of the households and at the same time will be a key factor in the yet to be determined success of this particular privatization program.

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<sup>3</sup> Although the monopoly, according to the contract, was initially scheduled to expire in June 1999, the TdP reduced the term, to expire August, 1st, 1998.

In order to understand the welfare impact of the telecom privatization process in Peru it is necessary to briefly describe the initial conditions of the telecom industry. One of the most striking features of the Peruvian Telecommunications Sector during the period of public ownership was the high level of unmet demand for access to basic telephone services. Maps 1 and 2 show how small access to telephone services was in both absolute levels and in terms of teledensity and how there was an overall increase by 1995 which was mainly dominated by the increase in lines in Lima, the capital of Peru. This too is reflected in Graph 1, which clearly shows the dramatic increase in the number of lines in service since divestiture.

Table 1: Some Indicators of Telephone Services

Indicators of Telephone Services	December 1993	1997
Lines /100 inhabitants.	2.94	6.70
Installed Lines	673,021	1,918,691
Lines on Service	673,021	1,645,000
Average Waiting time	118 months	45 days
Average bill	S/. 140	S/. 142
Access Cost of Residential Line	US\$ 1500 (re-sale)	US\$ 272
International Long Distance Tariff	US\$ 1.83	US\$ 1.25
Basic Residential Rent	US\$ 2.33	US\$ 13.19
Public Phones Tariff	S/. 0.49	S/. 0.30
Average Distance to the closest Public Phone	26.7 km.	10 km.

Source: OSIPTEL web page, 1998.

Privatization was supposed to close the gap between regions, introduce efficiency gains in the sector, and allow for the development of a competitive market in the future. Indeed, given its degree of development, Peru should have had a 6% penetration ratio (i.e. 6 of every 100 households should have a telephone). By 1993 the penetration ratio in Peru was 2%. The distribution of telephone lines was also very uneven, being concentrated both in Lima and in rich households (see Maps 1 and 2).

The other main trait of the Peruvian telecom sector was a distorted tariff scheme. Indeed, while installation charges were considerably high for international averages (around US\$ 1,000 for a residential line in 1993), the monthly rental payment was quite low. In contrast, long distance and local call tariffs were quite high. As in other countries, there was the presumption that only rich, price-inelastic consumers use international long distance and hence there was a cross subsidy from that service to local telephony. With the privatization agreement the government decided to have a five year period to “rebalance” tariffs in such a way that would resemble the marginal cost of providing the service. The alternative, adjust tariffs

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instantaneously, was considered too shocking for consumers' welfare. Indeed, monthly rental payments should have increased from around US\$1 to US\$17. Table 2 illustrates the rebalancing tariff schedule for all services that were granted in monopoly to TdP. During the five year rebalancing period, declining cross subsidies were allowed, and by the end of the rebalancing period subsidies among services were scheduled to disappear.

Graph 1: Evolution of Access to Telephone Services in Peru

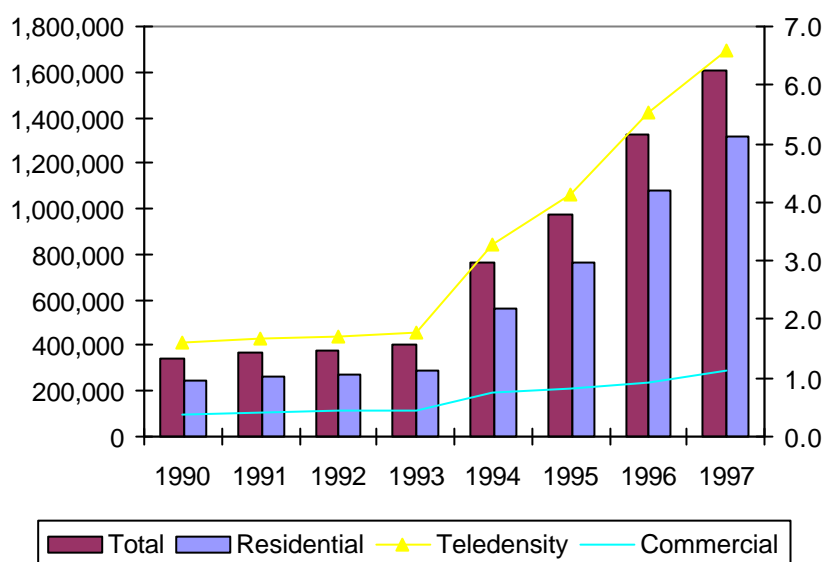
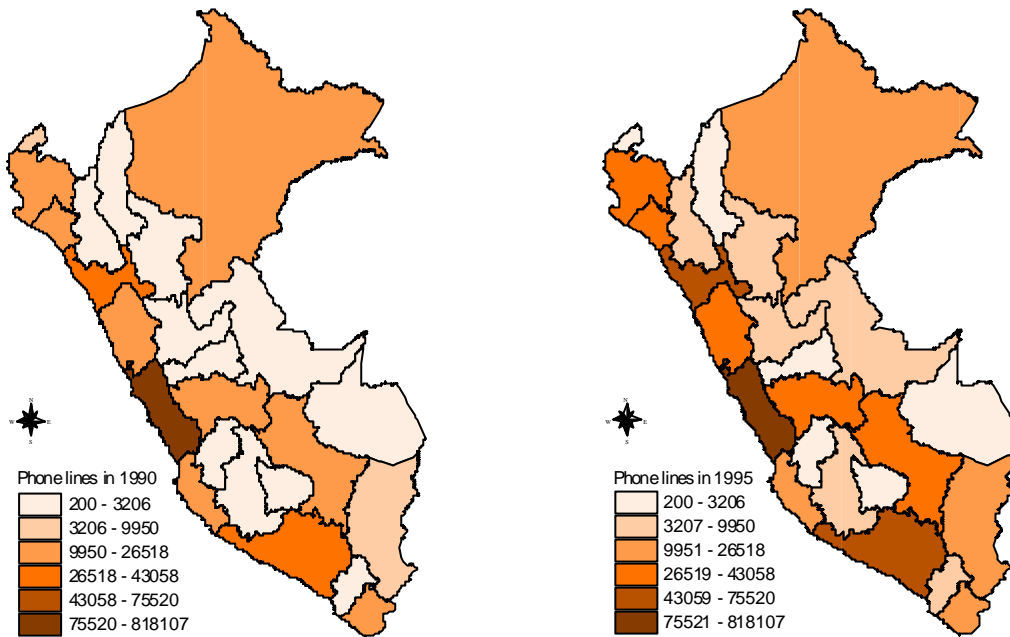


Table 2: Maximum Tariffs Rebalancing Plan: December Weighted Average Tariff (in Soles of 1994)

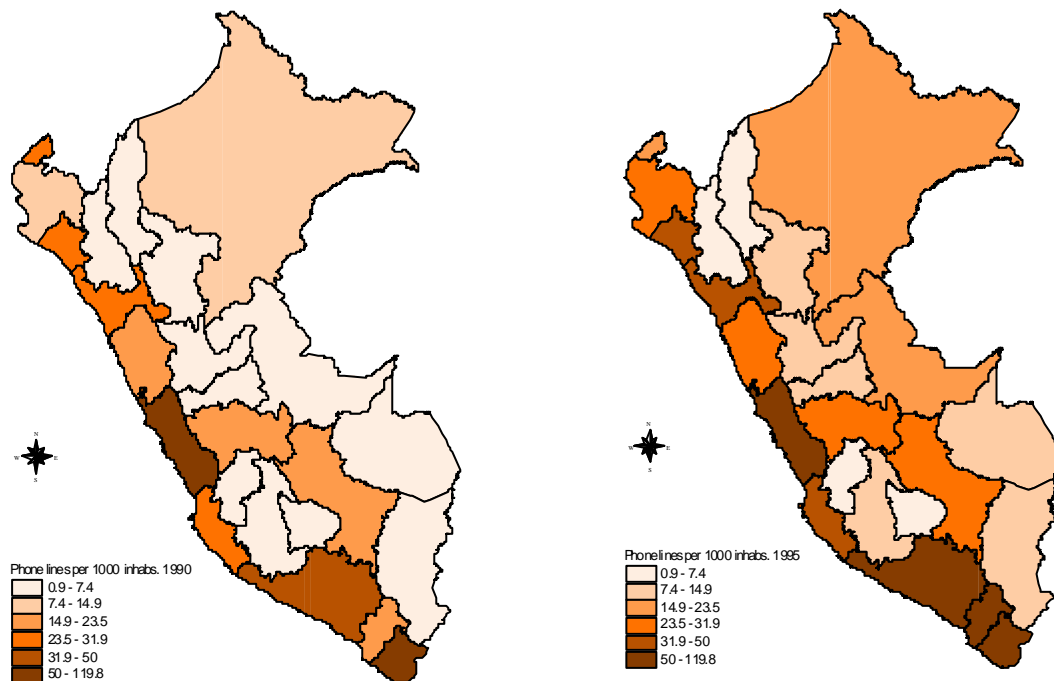
Services	1995	1996	1997	1998
Connection of Fixed Local Telephone Service – monthly rent (Residential)	14.06	18.64	25.29	31.93
Connection of Fixed Local Telephone Service – monthly rent (Commercial)	25.99	29.43	30.52	31.93
Local Telephone Calls (per call)	0.140	0.135	0.128	0.120
National Long Distance Telephone Calls (per minute)	0.519	0.458	0.416	0.371
International Long Distance Telephone Calls (per minute)	3.205	2.834	2.398	2.035

Source: OSIPTEL (1995).

Map 1: Number of Lines by Departments



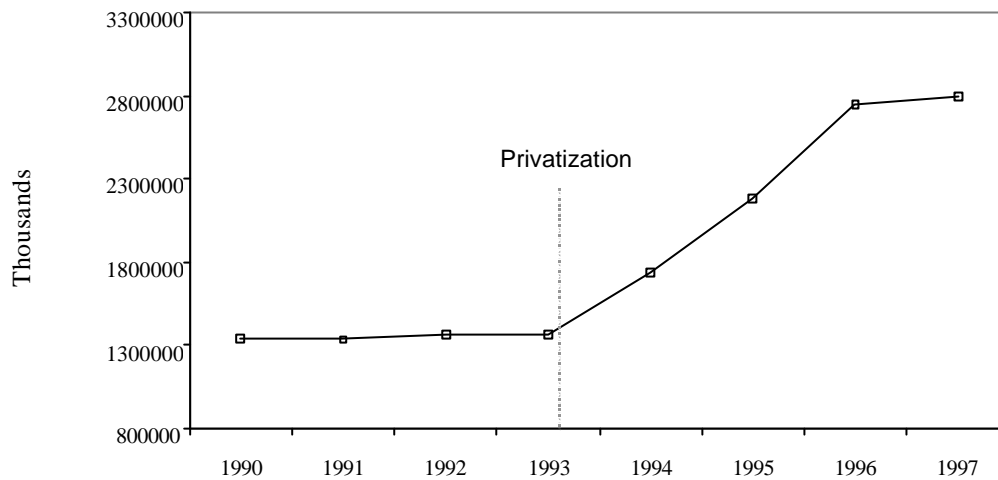
Map 2: Number of Lines per 1000 Inhabitants



## The Access and Welfare Impacts of Telecommunications Technology in Peru

After almost five years of privatization, TdP has invested aggressively more than doubling the number of telephone lines. Also, by August 1998, the rebalancing schedule was considered completed, eleven months ahead of the date initially planned. An example, and as shown in Graph 2 for Lima Metropolitana, of the rebalancing schedule can be clearly appreciated in the way the number of 3 minute calls stopped growing after 1996 when the rebalancing schedule started.

Graph 2: Number of 3 Minute Calls in Metropolitan Lima



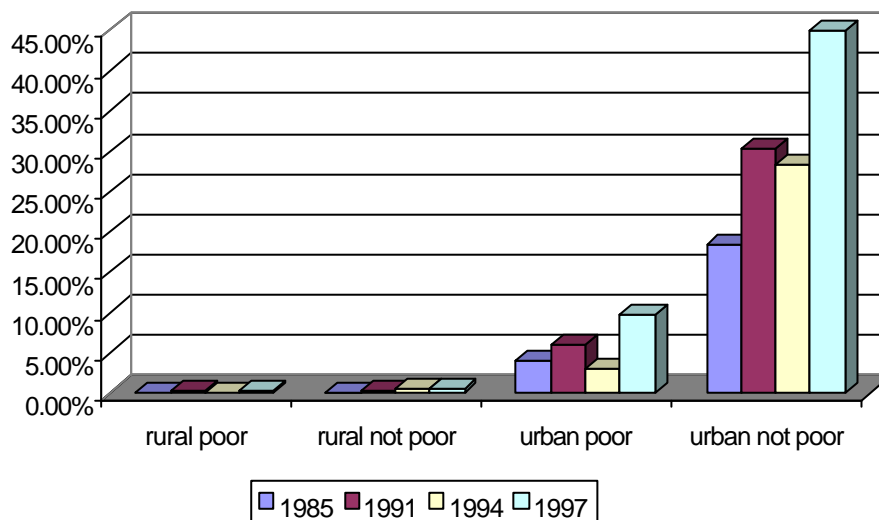
Given these two main initial conditions we plan to assess what the impact on consumer welfare has been as a result of more telephone lines while simultaneously increasing the monthly cost of using them. With this purpose in mind, we will model the demand to access telephone services and use measures of changes in consumer welfare and productivity efficiency that we present and discuss briefly below.

### 3 Access to Telephone Services

#### 3.1 Access to Residential Telephone Services by Poverty Level

As mentioned previously, the distribution of telephone lines is very uneven, being concentrated in Peru's capital, Lima, and mainly in rich households. Graph 3 and Table 3 show how little access poor and rural households had to residential telephone services before and after privatization (see Appendix 1 for access by quintiles of income)<sup>4</sup>. This is a relevant piece of information for development strategies given the proven importance that telephone access has in terms of returns to education and in explaining the transition from poor to non-poor income status, as it will be shown later.

Graph 3: Percentage of Households with Access to Telephone Services



<sup>4</sup> All the poverty calculations are based on a poverty line calculated by Instituto Cuanto, based on a normative basket of consumption. For details see Instituto Cuanto (1994).

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**Table 3: Distribution of Access to Telephone Services by Poverty Level**

	Rural areas			Urban areas			Nation wide		
	Poor	Not Poor	Total	Poor	Not Poor	Total	Poor	Not Poor	Total
<b>A. 1985</b>									
Telephone	0.00%	0.10%	0.10%	4.00%	18.50%	14.70%	2.00%	12.70%	9.10%
No telephone	100.00%	99.90%	99.90%	96.00%	81.50%	85.30%	98.00%	87.30%	90.90%
<b>Total</b>	<b>553,845</b>	<b>693,737</b>	<b>1,247,582</b>	<b>536,214</b>	<b>1,485,747</b>	<b>2,021,962</b>	<b>1,090,059</b>	<b>2,179,485</b>	<b>3,269,544</b>
<b>B. 1991</b>									
Telephone	0.20%	0.40%	0.20%	5.90%	30.30%	19.80%	4.20%	25.90%	15.50%
No telephone	99.80%	99.60%	99.80%	94.10%	69.70%	80.20%	95.80%	74.10%	84.50%
<b>Total</b>	<b>448,537</b>	<b>240,386</b>	<b>688,923</b>	<b>1,067,259</b>	<b>1,410,995</b>	<b>2,478,254</b>	<b>1,515,796</b>	<b>1,651,381</b>	<b>3,167,176</b>
<b>C. 1994</b>									
Telephone	0.00%	0.50%	0.20%	3.10%	28.30%	19.80%	1.80%	22.70%	14.00%
No telephone	100.00%	99.50%	99.80%	96.90%	71.70%	80.20%	98.20%	77.30%	86.00%
<b>Total</b>	<b>772,674</b>	<b>526,625</b>	<b>1,299,299</b>	<b>1,053,669</b>	<b>2,076,399</b>	<b>3,130,068</b>	<b>1,826,343</b>	<b>2,603,024</b>	<b>4,429,367</b>
<b>D. 1997</b>									
Telephone	0.20%	0.50%	0.30%	9.60%	45.00%	32.20%	6.10%	34.40%	22.80%
No telephone	99.80%	99.50%	99.70%	90.40%	55.00%	67.80%	93.90%	65.60%	77.20%
<b>Total</b>	<b>751,164</b>	<b>668,439</b>	<b>1,419,603</b>	<b>1,226,173</b>	<b>2,157,750</b>	<b>3,383,923</b>	<b>1,977,337</b>	<b>2,826,188</b>	<b>4,803,526</b>

Source: Living Standards Measurement Survey (LSMS) 1985-86, 1991, 1994, 1997.

Notwithstanding the restricted access to a telephone, the poorer households expend a significant amount of their resources in it. When we look to the expenditure in telephone services in Table 4, it can be seen that for those households with telephones, the ones in the lower deciles expend more as a percentage of their total expenditure compared to households in the higher deciles. A possible explanation could be that alone the fixed cost of the telephone represents a significant percentage of their total expenditure.



Table 4: Distribution of the Expenditure in a Telephone in Metropolitan Lima in 1997

Decile of Total Expend.	All Households			Households with Phone		
	Expend. in Phone	Total Expend.	%	Expend. in Phone	Total Expend.	%
I	14.14	5143.78	0.26	450.62	5432.69	8.18
II	48.87	7373.09	0.67	776.57	7392.45	10.57
III	136.97	8828.08	1.5	873.83	9121.84	9.54
IV	145.5	10256.02	1.44	708.93	10123.09	7.03
V	307.32	11701.07	2.63	760.33	11622.14	6.51
VI	376.45	13653.75	2.74	825.16	13742.36	6.0
VII	471.5	15821.57	2.96	843.85	15892.50	5.31
VIII	664.17	19055.68	3.47	851.56	19114.53	4.45
IX	744.83	24440.81	3.02	952.01	24670.60	3.86
X	1624.18	43910.40	3.85	1676.39	44281.96	3.97
Total	451.94	15986.68	2.25	1027.63	22904.99	5.12

Source: Fuente: ENNIV 1997

Note : All expenditure is in constant Soles of June of 1994

### 3.2 Modeling Access to Telephone Services

With the purpose of trying to understand what the main variables are that explain the access to telephone services, this research will model the access to residential telephone services at the household level using the LSMS surveys. Following Mitchell (1978) and Wolak (1995) we are going to estimate the household demand of telephone services concentrating in the access estimation. The model will initially assume that a single consumer has constant marginal utility of income and a separable utility function for telephone calls  $q$  and other goods  $x$ :

$$U(x, q) = x + V(q) \tag{1}$$

The consumer will maximize utility in equation (1) subject to his budget constraint:

$$y = x + \partial(L + pq) \tag{2}$$

where  $y$  is income measured in units of  $x$ ,  $L$  is the fixed monthly charge for telephone service, and  $p$  is the vector of prices of local and long distance calls. The parameter  $\partial=1$  if the consumer subscribes to telephone services; if he does not,  $\partial=0$ .

As mentioned by Mitchell(1978) we can recast the optimization problem as one of maximizing the differences between the utility of a telephone service and its cost, that difference being the net economic gain of having a telephone:

$$\underset{\partial, q}{\text{Max}}[V(q) - \partial(L + pq)] \quad (3)$$

In this way the demand for access or connection will be stated as:

$$\begin{aligned} \partial &= 1 \text{ if } R(p) \geq L \\ &= 0 \text{ if } R(p) < L \end{aligned} \quad (4)$$

where the consumer's reservation price or surplus( $R(p)$ ), is given by:

$$R(p) = \max_q [V(q) - pq] \quad (5)$$

Econometrically the access will be measured using a qualitative variables model, specifically each household will realize a cost benefit analysis of having access or not to a telephone comparing the consumer surplus  $R(p)$  with the cost of access,  $L$ . This variable,  $z^*$  can't be observed and can be expressed as:

$$z^* = \beta'x + e \quad (6)$$

where  $e$ , is normally distributed with mean zero and variance 1. Given that we only observe the households that have access or not to a telephone, our observation will be:

$$\begin{aligned} z &= 0 \quad \text{if } z^* \leq 0, \\ z &= 1 \quad \text{if } z^* > 0 \end{aligned} \quad (7)$$

and given symmetry then the probability of  $z=1$  will be:

$$\begin{aligned} \text{Pr ob}[z^* > 0] &= \text{Pr ob}[\varepsilon < \partial'x] \\ &= \Phi(\partial'x) \end{aligned} \quad (8)$$

As can be seen in Table 5, income and being in urban areas are the most important variables influencing access to telephone services. By 1997 about 64% percent of the surveyed families in the upper quintile for urban areas of the income distribution had access to a telephone, while only 3% of the lower quintile had access. (see Appendix 1). Also it can be seen, that income (which was also found to be closely correlated to education) may be related to urban residential telephone use not only as a factor in, and indicator of, the intensity, complexity and range of the family's communication pattern.

**Table 5: Probit of Access to Telephone Services**

Variables	Probit Coefficients				Marginal Effects (dF/dX)			
	1985	1991	1994	1997	1985	1991	1994	1997
Constant	-5.83 *	-11.504 *	-12.192 *	-17.167 *				
	(0.3744)	(0.6922)	(0.7236)	(0.6919)				
Ln(percapita household expenditure)	0.203 *	0.99 *	0.841 *	1.624 *	0.005 *	0.098 *	0.014 *	0.161 *
	(0.0334)	(0.0757)	(0.0621)	(0.0772)	(0.0016)	(0.0126)	(0.0057)	(0.0188)
Years of Education of Household Head	0.069 *	0.068 *	0.062 *	0.037 *	0.002 *	0.007 *	0.001 *	0.004 *
	(0.0069)	(0.0097)	(0.0086)	(0.0075)	(0.0005)	(0.0012)	(0.0004)	(0.0008)
Household Head is migrant	-0.239 *	-0.083			-0.007 *	-0.008		
	(0.0754)	(0.0798)			(0.0032)	(0.0079)		
Access to water	1.167 *		1.653 *	0.625 *	0.038 *		0.028 *	0.052 *
	(0.1430)		(0.3005)	(0.1079)	(0.0079)		(0.0084)	(0.0094)
Owner of house	0.482 *	0.511 *	0.507 *	0.5 *	0.011 *	0.042 *	0.007 *	0.041 *
	(0.0671)	(0.0901)	(0.0810)	(0.0709)	(0.0030)	(0.0080)	(0.0030)	(0.0069)
Financial savings	0.275 *	-0.039	0.007	0.218 *	0.009 *	-0.004	0.000	0.024 *
	(0.0643)	(0.1026)	(0.1000)	(0.0754)	(0.0032)	(0.0096)	(0.0016)	(0.0098)
Family size	-0.007	0.09 *	0.045 ~	0.236 *	0.000	0.009 *	0.001 ~	0.023 *
	(0.0127)	(0.0191)	(0.0180)	(0.0174)	(0.0003)	(0.0021)	(0.0004)	(0.0030)
Urban	1.33 *	1.629 *	1.867 *	1.451 *	0.041 *	0.104 *	0.032 *	0.107 *
	(0.2034)	(0.2662)	(0.3382)	(0.2128)	(0.0066)	(0.0094)	(0.0087)	(0.0091)
R-sq	0.323	0.306	0.386	0.448				
N	5068	2308	3623	3843				

Note: Standard deviation in parenthesis and p<0.01=\*, p<0.5=~

Another interesting finding is, at a given income level, the aggregate demand for access to residential telephone services was significantly higher among households that already had access to drinkable water and were house owners. Finally, the household size seems also to be positively correlated with access to a telephone.

To try to understand what explains the decision of obtaining a telephone a panel between the LSMS surveys of 1994 and 1997 was constructed. This panel allows us to be able to divide households into two groups, according to their access to residential telephone services in the initial state (1994) and the final state (1997). The first group consisted of "households in transition" (change their initial state of access to a telephone) and the second of "stayers" (households which didn't change their initial status of access to a telephone).

The results again show the importance of income (and education) as the main variable explaining the transition from not having, to having a telephone (see Table 6). Not only was the initial income significant, but the change in income was also the second most important variable in

## The Access and Welfare Impacts of Telecommunications Technology in Peru

explaining the transition to access to residential telephone services. Again, family size and the change in it were also important and significant in explaining the transition to access to a telephone. Consistently in Table 7, it is shown how the households that acquired access to a telephone in 1997 increased their level of income as well as their access to financial savings and credit.

Additionally, income (and education) also shows to be extremely important in explaining why a household will continue having access to a phone and why if the income is too low it didn't get a phone between 1994 and 1997. This result confirms what is shown in Appendix 1, where it is clear that the families of the lower quintile of the distribution had the lowest access to telephone services, this being even worse for the rural areas where there is practically no direct access to telephone services. It is important to mention, on the other hand, that the LSMS household surveys do not capture access to public telephone services which is the way most of the rural households had access to telecommunications. In this sense, this could be a possible explanation for having such small numbers of access in rural areas and is something on which we are currently working in developing a survey to comprehensively capture the access by rural areas.

**Table 6: Multinomial Analysis of Transition between Access to Telephone States  
- Marginal Effects**

I. IN TRANSITION	No Telephone to Telephone		Telephone to No Telephone	
	Coefficients	z	Coefficients	z
ln(income)	0.3662	9.6370	0.0184	1.9700
Education of Househod Head	0.0091	3.1160	-0.0001	-0.1950
Family size	0.0571	7.8380	-0.0001	-0.0530
$\Delta(\ln(\text{Income}))$	0.2857	9.4420	0.0014	0.2070
$\Delta(\text{Family Size})$	0.0487	6.4370	-0.0027	-1.3600
Owner of house	0.0329	1.2140	-0.0033	-0.4950
Constant	-3.3449	-10.6140	-0.1735	-2.0860
II. STAYERS	Telephone to Telephone		No telephone to No Telephone	
	Coefficients	z	Coefficients	z
ln(income)	0.1716	6.3390	-0.556	-12.145
Education of Househod Head	0.0026	2.1150	-0.012	-3.254
Family size	0.0206	5.1610	-0.078	-8.779
$\Delta(\ln(\text{Income}))$	0.1042	5.7860	-0.391	-10.823
$\Delta(\text{Family Size})$	0.0131	3.8160	-0.059	-6.414
Owner of house	0.0175	1.4780	-0.047	-1.424
Constant	-1.5402	-6.5000	5.059	13.291
Pseudo R2	0.3370			
N	908.0000			

Source: Author's own computations

**Table 7: Some Characteristics of Households that Moved from Not Having to Having Residential Telephones between 1994 and 1997 – Urbana Peru**

	<b>No phone in 1994</b>	<b>With phone in 1997</b>
Family Income (in ln)	7.89	8.01
Education of the Household Head	10.10	10.18
% of migrants in Household	32.0%	33.3%
Financial Savings	16.2%	28.6%
Households with credit	18.8%	53.9%
Family size	5.28	5.45
Households of quintile 1	3.2%	1.3%
Households of quintile 2	13.6%	9.1%
Households of quintile 3	24.7%	18.2%
Households of quintile 4	28.6%	31.2%
Households of quintile 5	29.9%	40.3%
Households under the poverty line	18.8%	13.6%

### 3.3 Impacts of Access to Telephone Services on Poverty

As mentioned by Saunders (1994), telecommunications are increasingly recognized as a key component in the infrastructure of economic development. Telecommunications professionals and development experts have observed individual cases in which specific benefits of improved telecommunications have improved the living conditions of households. In remote regions, the disadvantages that come with isolation can be significantly lessened through access to rapid and inexpensive communications improving appropriate actions in emergency situations. Market information for buying and selling, transport efficiency and regional development, are also other benefits of access to telecommunications.

Consistent with these findings, in this section we try to model the importance of access to residential telephone services as part of the public capital households can access. Escobal et.al (1999) showed that access to human capital, physical capital, financial capital and public or organizational capital not only increases the rentability of private assets but also has an effect via the process of accumulation of original assets. In this way, the accumulation process and the existence of external shocks will be at the same time determinants of the process of transition of households through the scale of income classes.

Under this criteria we can derive an equation that represents the transition of a household from one level of expenditure to another, or alternatively between poverty and non-poverty in the following way:

$$\Delta P = P(A_{\text{hum},0}, A_{\text{Phys},0}, A_{\text{fin},0}, A_{\text{pub \& org},0}, \mathbf{h}) \quad (9)$$

where the subscript indicates the type of asset in the initial state, and  $\mathbf{h}$  represents a vector of short run shocks that affect the income (approximated by current expenses) of the household<sup>5</sup>. A telephone will be part of the assets and the objective is to try to see, once controlling for other assets, whether having access to a residential telephone is significant in explaining the transition of the household through the scale of income.

To be able to evaluate the transition between states a panel between the LSMS surveys of 1994 and 1997 was constructed. The estimation of equation 8 required the construction of a discrete variable that indicated the changes between different states<sup>6</sup>. Additionally, a multinomial logit was used to estimate the effects of the different types of assets over the probability that a household will stay in poverty or could move out of that status.

From the results obtained, it is clear that human capital (years of education of the household head, potential labor experience, migratory experience and family size), financial assets (financial savings), physical capital (cattle) and public assets (access to a telephone) are crucial in explaining why certain households stay in poverty or in non-poor status. Even more so, access to a telephone has the largest marginal effect compared to all the other assets (see Table 8). On the other hand, changes in some human capital assets (change in migratory experience) and family size, as well as the positive shock associated with changes in the labor market status, are the main variables explaining the transition from and to poverty. Specifically, the coefficient of change in access to a telephone is with the correct sign for the transition status (positive for transition from poor to not poor, and negative from the transition from not poor to poor) but is not significant.

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<sup>5</sup> Specifically to measure these shocks, two variables were included: the expenditure of the social fund of compensation and development (FONCODES) which are direct transfers to the extreme poor; and the changes in the labor status (the difference of the rate of occupation of the household, the last obtained by the number of members of the household that currently work divided by the total number of members of age 14 or older).

<sup>6</sup> The same poverty line as in the previous section was used to define a household as poor or not poor. See Escobal, et.al. for details.

Table 8: Multinomial Analysis of Transition between Poverty States - Marginal Effects

I. IN TRANSITION	POOR TO NOT POOR		NOT POOR TO POOR	
	Coefficients	z	Coefficients	z
Education of Household Head	-0.002	-0.519	-0.006	-2.500
Gender	0.018	0.433	0.006	0.241
Δ(Education of Household head)(1)	0.007	1.489	-0.120	-4.098
Δ(Potential Labor Experience)	-0.002	-1.623	-0.002	-2.127
Δ(Migration)	0.146	2.486	-0.078	-2.053
Δ(Land)(1)	0.021	1.552	-0.003	-1.384
Δ(Access to drinkable water)	0.017	0.310	0.063	2.218
Δ(Access to sanitary services)	0.021	0.290	0.000	-0.007
Δ(Access to electricity)	0.029	0.324	-0.063	-0.938
Δ(Access to telephone)	0.051	0.670	-0.100	-1.174
Δ(Family Size)	-0.034	-5.124	0.028	6.842
Δ(Financial Savings) (1)	-0.014	-0.068	0.045	0.345
Δ(cattle)	-0.001	-0.882	-0.001	-1.796
Δ(Communitary Capital)	-0.062	-0.799	-0.003	-0.075
Δ(Labor Mkt Status)	0.052	1.806	-0.057	-3.184
FONCODES	0.000	0.304	0.000	-0.864
Constant	-0.058	-0.922	-0.063	-1.870
II. STAYERS	POOR TO POOR		NOT POOR TO NOT POOR	
	Coefficients	z	Coefficients	z
Education of Household Head	-0.032	-7.047	0.049	8.713
Potential Labor Experience	-0.005	-4.193	0.008	5.416
Gender	0.031	0.883	-0.086	-1.668
Migration	-2.020	-3.569	0.137	1.992
Number of days sick	-0.002	-0.147	-0.003	-0.232
Family Size	0.062	8.357	-0.092	-10.011
Financial Savings	-0.466	-2.842	0.315	3.450
Durable Goods	0.000	1.186	0.000	-0.682
Land	0.000	0.008	0.001	0.347
Access to drinkable water	-0.018	-0.520	-0.056	-0.988
Access to sanitary services	-0.003	-0.104	0.077	1.607
Access to electricity	-0.049	-0.906	0.101	1.148
Access to telephone	-0.446	-4.417	0.418	6.016
Communitary Capital	0.448	1.845	0.063	0.179
Cattle	0.002	2.234	-0.004	-2.333
Labor Mkt.Status	0.077	3.397	-0.102	-2.918
FONCODES	0.000	-0.003	0.000	-0.085
Constant	0.181	2.162	-0.156	-1.239
<b>Pseudo R2</b>				<b>0.195</b>

Note: (1) These variables had been instrumentalized to correct possible endogeneity bias  
 Source: Escobal, Saavedra, Torero (1999)

## 4 Welfare Effects of Privatization on Access to Telephone Services: An Exercise for Lima Metropolitana

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Cost-benefit analysis can be used to help determine not only the amount of resources that should be devoted to telecommunications but also the best way to allocate those resources within the sector [see Saunders, et.al. (1994)]. The concept of consumer surplus has been relied upon extensively in attempts to supplement that internal rate of return as an indication of the benefits of proposed telecommunications investment. Three methodologically different, but in practice interrelated, approaches have generally been taken at the level of a project investment program to measure the portion of the consumer surplus [Saunders, et.al. (1994)]:

- a) Methods based on observing the consumption effects of price changes;
- b) Methods based on comparing the difference between the cost of carrying out a given activity using telecommunications and the cost of the best-alternative means of communicating; and
- c) Methods based on estimating more completely the costs that telecommunications users actually incur when communicating.

This research concentrates on the first measure and tries to analyze how consumers were affected by relaxing what was the most significant constraint in the Peruvian Telecommunications market: the huge waiting list for access to basic telephone services. In fact, the Peruvian case is different to others in the sense that for almost twenty years the public monopoly, which provided access to telephone lines, could not meet the demand it faced given the cross-subsidized tariffs.

Our approach to assess the welfare impact of selling ENTEL and CPT is in many aspects different to that one used by Galal et al. (1994) or Martin and Parker (1997). We don't pretend to construct welfare measures for every interest group involved in the privatization and then add them, each with their appropriate weight, to obtain one indicator of aggregate welfare variation<sup>7</sup>. Even though we follow many guidelines suggested by these authors, we specify a different model for the valuation of consumers' welfare before and after divestiture. Basically, our goal is much more specific and directed towards measuring the net effect on consumers of access to telephone services.

To accomplish our goal of measuring the net effect on consumers our methodology will consist on the estimation of a partial demand equation of access to and usage of telephone services

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<sup>7</sup> See Jones et al. (1990), pp. 21-51 for a detailed discussion on the construction of these indicators.



provided by TdP. The advantage of this methodology is that it will allow us to evaluate the consumer welfare effects of the privatization on telephone services provided by TdP. This will be done using a specific panel of households surveyed *ad-hoc* in 1997 by the regulatory agency OSIPTEL, on their use and consumption of telecommunications services in the last year for Metropolitan Lima.

The procedure we intend to follow will consist of the following steps:

- 1) model telephone access market under the pre-privatization and the post privatization scenario;
- 2) identify changes in access and usage and measure consumers surplus variation in each stage.

Escobal et.al (1996) modeled for Metropolitan Lima the demand for a specific telecommunications service as a two-stage decision rule. Given a usage price, consumers compare their surplus with the rental charges they have to pay to decide whether or not to request a line. This study will supply us with a good set of estimates of key parameters whose value would otherwise have to be taken arbitrarily from studies in other countries. Using these estimations we intend to compare pre and post-divestiture situations.

The estimated demand functions by Escobal et.al (1996) already identify all factors which are relevant for determining the position in the demand curve, given an observed set of price and quantity, and in the case of access, given waiting list statistics. As they were estimated from a panel of households observing variation in prices, income and demographic characteristics, we can directly calibrate the position of each curve at different points in time without the need of further assumptions on unobserved variables.

Moreover, our calibration can be less arbitrary than that used by other authors in the sense that linearity is not necessarily assumed for the demand curves. In fact, the choice of the functional form for demand curves was based on goodness of fit criteria rather than algebraic simplicity<sup>8</sup>. In this study we want to find welfare changes that were *caused by* the privatization alone and not by other changes that would have happened even in the event of the continuation of public ownership and control. For that purpose we will use price changes that were introduced in order to bring tariffs closer to their marginal costs, in particular, the prices observed during the first five years of the concession.

Figure 1 illustrates the effect in consumers' welfare of simultaneously increasing the lines installed and reducing access charges. The figure depicts a particular case in which the average monthly rental charge (a sum of the basic rental service charge and the once-and-for-all installation charge allocated on a monthly basis) has fallen from  $rp_0$  to  $rp_1$ . Our demand function  $q^{da} = q^{da}(\mathbf{p}, y, \mathbf{x})$ , where  $\mathbf{p}$  is a vector of all relevant prices (average monthly rental charge, substitutes and

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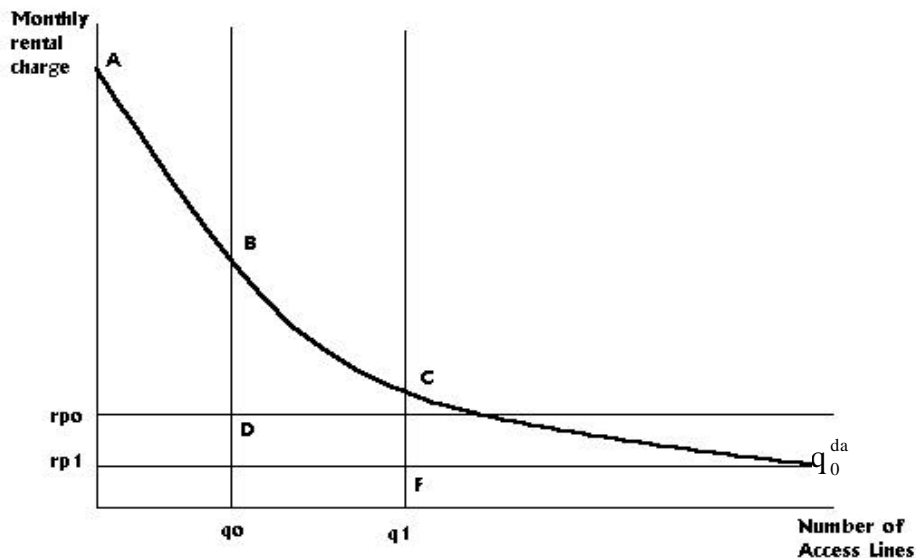
complementary goods),  $y$  is income and  $\mathbf{x}$  a vector of other explanatory variables, can also be expressed in inverse form  $rp^{da} = rp^{da}(q, y, \mathbf{x})$  to reflect the maximum price a household given by the pair  $(y, \mathbf{x})$  is willing to pay for access to a telephone line. Given these charges and a binding supply restriction,  $q_0$ , we have a waiting list given by the difference  $q^{da}(rp_0, y_0, \mathbf{x}_0) - q_0$ . Given an increase in the access lines installed to a level of  $q_1$ , the new waiting list is given by  $q^{da}(rp_1, y_1, \mathbf{x}_1) - q_1$ .

From the graph, the components to be estimated in this variation would be the areas  $ACFr_1$  and  $ABDr_0$ . The difference between them would give the increase in consumers surplus for more households having access to residential lines<sup>9</sup>. Given our knowledge of the demand function and the calibration of its position, this increase is directly computed by:

$$\int_{q_0}^{q_1} p(q, x_0, y_0) + rp_0 \cdot q_0 - rp_1 \cdot q_1 \quad (10)$$

After calibrating our demand functions to match the observed outcome using the data on access lines, rental and installation charges and the number of potential subscribers on a waiting list we measured consumers welfare before and after privatization. It is clear that the reduction in installation charges and the progressive reduction in the waiting list for installation will largely contribute to a significant increase in consumers' welfare after the privatization.

**Figure 1: Welfare Effects of Relaxing Supply Constraints and Changing Regulated Prices in the Market for Access to Telephone Lines**



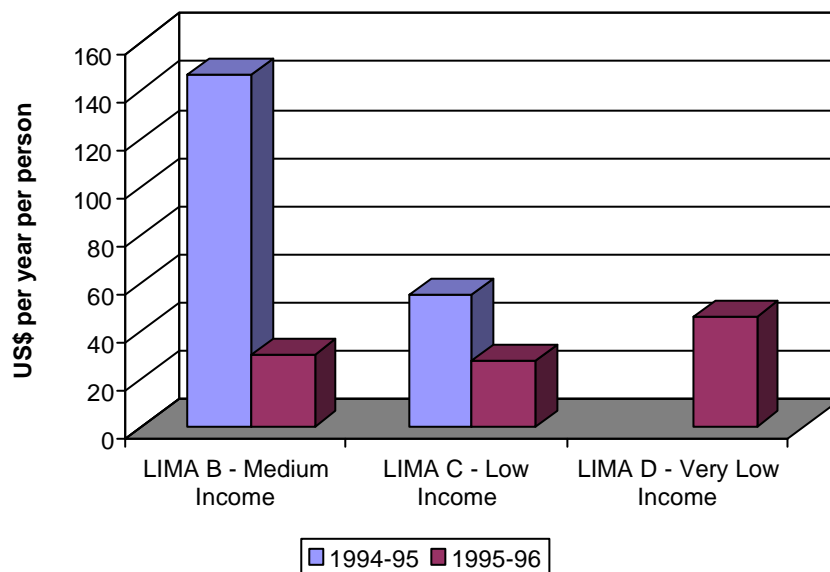
<sup>8</sup> See Escobal, et.al (1996).

<sup>9</sup> Naturally, for commercial users the methodology of estimation is the same.

Graph 4 shows the percapita consumer surplus of access to residential telephone service since privatization. The consumers were grouped in four sub-groups according to their income level. Lima A represents consumers in Lima with the highest income while Lima D represents consumers in Lima with the lowest income. Given that for Lima A practically all of the demand for access was satisfied previously to the privatization there was no use in estimating the consumer surplus for this group. As shown in Graph 4 the consumer surplus goes from 146 US Dollars between 1994 and 1995 for Lima B to around 28 US Dollars for Lima C in 1995-1996, being the highest amount close to what a minimum wage will be in Peru.

Finally, it is important to mention that this paper just concentrates on the welfare effects of access to telephone services and therefore is not conclusive of the total welfare effect on consumers of access to and use of telephony services. A complete measure of the change of consumer surplus for any of the basic telephony services will have to add up the welfare gains in access with possible reductions in consumer surplus derived from the increment of tariffs of the local service. This measure will therefore require an estimation of both access and usage demand equations which we plan to do in future research<sup>10</sup>.

Graph 4: Percapita Consumer Surplus of Access to a Telephone since Privatization



<sup>10</sup> In fact, as a result of the elimination of cross-subsidies during the first five years of the concession, as access charges were lowered, local usage tariffs were risen. For international long distance, however, the opposite happened.

## 5 Conclusions

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In the last years the Peruvian telecommunication market has undergone a period of important changes. This paper has aimed to analyze partially the implications of these changes by analyzing access to residential telephone services. The results shown clearly describe how uneven the distribution of telephone lines in Peru is and how most of them are concentrated in Peru's capital, Lima, and in rich households. This high level of concentration clearly explains why income and being in urban areas are the crucial variables in explaining why a household has access to a residential telephone. It is important to mention, on the other hand, that specially for the rural areas there is still a need to be able to identify access to public telephones given that they are the main source of telecommunications in those areas. The LSMS surveys don't have adequate information on this and therefore a more detailed rural survey is required.

Despite the high concentration of the residential telephone services this paper makes a first attempt to show the importance of access in explaining the transition of the households through the scale of income expenditure showing that it is important in explaining why households stay in non-poor status.

Similarly, the consumer surplus on access for Metropolitan Lima, showed that for residential telephone access there is an important positive surplus from privatization. As already mentioned, this result is just for access and therefore it can't be used to evaluate general effects of privatization. To evaluate privatization, which is not the objective of this paper, a complete measure of consumer surplus will have to add up the welfare gain in access with possible reductions in consumer surplus derived from the increment of tariffs of the local service.

Finally, and as mentioned by Saunders (1994), the relation between telecommunications and investment and economic activity and development is highly complex. A more specialized and detailed survey is required to be able to identify all the effects of telecommunications especially in rural areas where the reduction of transaction costs and the access to better information could be of crucial importance in improving their welfare. This is also crucial for policy makers given that we are currently in a global information revolution and they have the challenge to harness these technologies and to mobilize resources and partnerships to accelerate the economic, political and social development.

## Appendix

Table A1: Access to a Telephone by Quintiles - 1985

	Telephone			No telephone			Total Number of Households
	Number of Households	Row %	Column %	Number of Households	Row %	Column %	
<b>Nation wide</b>							
1	9466	2%	3%	526708	98%	18%	536175
2	11905	2%	4%	533765	98%	18%	545670
3	31234	5%	11%	589494	95%	20%	620728
4	54059	8%	18%	647722	92%	22%	701781
5	190713	22%	64%	674477	78%	23%	865190
Total	297377	9%	100%	2972166	91%	100%	3269544
<b>Rural</b>							
1	0	0%	0%	207212	100%	17%	207212
2	0	0%	0%	212428	100%	17%	212428
3	0	0%	0%	237763	100%	19%	237763
4	0	0%	0%	247080	100%	20%	247080
5	661	0%	100%	342439	100%	27%	343100
Total	661	0%	100%	1246922	100%	100%	1247583
<b>Urban</b>							
1	12251	4%	4%	311621	96%	18%	323871
2	16996	5%	6%	328078	95%	19%	345073
3	36039	9%	12%	353099	91%	20%	389138
4	60334	14%	20%	381707	86%	22%	442041
5	171096	33%	58%	350742	67%	20%	521838
Total	296716	15%	100%	1725247	85%	100%	2021961

Source: Living Standards Measurement Survey (LSMS) 1985-86.

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Table A2: Access to a Telephone by Quintiles - 1991

	Telephone			No telephone			Total Number of Households
	Number of Households	Row %	Column %	Number of Households	Row %	Column %	
<b>Nation wide</b>							
1	3004	1%	1%	516180	99%	19%	519184
2	18066	3%	4%	524416	97%	20%	542482
3	56613	9%	12%	553004	91%	21%	609617
4	117494	17%	24%	558741	83%	21%	676235
5	296947	36%	60%	522711	64%	20%	819658
Total	492124	16%	100%	2675052	84%	100%	3167176
<b>Rural</b>							
1	0	0%	0%	117114	100%	17%	117114
2	0	0%	0%	118950	100%	17%	118950
3	855	1%	50%	123845	99%	18%	124700
4	0	0%	0%	145023	100%	21%	145023
5	855	0%	50%	182280	100%	27%	183135
Total	1710	0%	100%	687212	100%	100%	688922
<b>Urban</b>							
1	4526	1%	1%	383076	99%	19%	387602
2	30587	7%	6%	399130	93%	20%	429717
3	65117	14%	13%	413037	86%	21%	478154
4	114596	22%	23%	410970	78%	21%	525566
5	275589	42%	56%	381627	58%	19%	657215
Total	490415	20%	100%	1987840	80%	100%	2478254

Source: Living Standards Measurement Survey (LSMS) 1991.

Table A3: Access to a Telephone by Quintiles - 1994

	Telephone			No telephone			Total Number of Households
	Number of Households	Row %	Column %	Number of Households	Row %	Column %	
<b>Nation wide</b>							
1	6229	1%	1%	669605	99%	18%	675833
2	15188	2%	2%	750798	98%	20%	765986
3	32570	4%	5%	815827	96%	21%	848397
4	123585	13%	20%	823253	87%	22%	946838
5	444620	37%	71%	747693	63%	20%	1192313
Total	622192	14%	100%	3807176	86%	100%	4429367
<b>Rural</b>							
1	0	0%	0%	200479	100%	15%	200479
2	0	0%	0%	220455	100%	17%	220455
3	0	0%	0%	254218	100%	20%	254218
4	0	0%	0%	270894	100%	21%	270894
5	2391	1%	100%	350862	99%	27%	353253
Total	2391	0%	100%	1296908	100%	100%	1299299
<b>Urban</b>							
1	9235	2%	1%	471179	98%	19%	480415
2	20189	4%	3%	514981	96%	21%	535171
3	53571	9%	9%	542775	91%	22%	596347
4	142846	21%	23%	542108	79%	22%	684954
5	393958	47%	64%	439223	53%	17%	833181
Total	619799	20%	100%	2510266	80%	100%	3130068

Source: Living Standards Measurement Survey (LSMS) 1994.

## The Access and Welfare Impacts of Telecommunications Technology in Peru

Table A4: Access to a Telephone by Quintiles - 1997

	Telephone			No telephone			Total Number of Households
	Number of Households	Row %	Column %	Number of Households	Row %	Column %	
<b>Nation wide</b>							
1	6606	1%	1%	759225	99%	20%	765831
2	18732	2%	2%	787660	98%	21%	806392
3	107893	12%	10%	789380	88%	21%	897273
4	242362	23%	22%	813582	77%	22%	1055944
5	717368	56%	66%	560717	44%	15%	1278086
Total	1092961	23%	100%	3710564	77%	100%	4803526
<b>Rural</b>							
1	0	0%	0%	213672	100%	15%	213672
2	1737	1%	36%	245272	99%	17%	247008
3	0	0%	0%	264030	100%	19%	264030
4	0	0%	0%	295697	100%	21%	295697
5	3066	1%	64%	396130	99%	28%	399196
Total	4803	0%	100%	1414801	100%	100%	1419603
<b>Urban</b>							
1	13818	3%	1%	484783	97%	21%	498601
2	60937	11%	6%	502327	89%	22%	563264
3	155852	24%	14%	505057	76%	22%	660908
4	264162	36%	24%	473377	64%	21%	737539
5	593389	64%	55%	330221	36%	14%	923610
Total	1088158	32%	100%	2295765	68%	100%	3383922

Source: Living Standards Measurement Survey (LSMS) 1997.



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