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Working Paper

The social impact of privatization and the regulation of utilities in Peru

WIDER Discussion Paper, No. 2001/17

Provided in Cooperation with:

United Nations University (UNU), World Institute for Development Economics Research (WIDER)

Suggested Citation: Torero, Máximo; Pascó-Font, Alberto (2001) : The social impact of privatization and the regulation of utilities in Peru, WIDER Discussion Paper, No. 2001/17, The United Nations University World Institute for Development Economics Research (UNU-WIDER), Helsinki

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Discussion Paper No. 2001/17

The Social Impact of Privatization and the Regulation of Utilities in Peru

Máximo Torero and Alberto Pascó-Font *

June 2001

Abstract

Almost five years after privatization took place in electricity and telecommunications, and major reforms had been carried out in the administration of water, the results is not clear *a priori*. In order to elucidate the panorama, this research tries to assess the consumption and welfare impacts of privatization on Peruvian urban households. The objective is, therefore, to asses the income distribution effects of the transformation and to determine which type of households bear a greater portion of the burden or enjoy most of the benefits of price changes brought about by privatization.

To accomplish this objective, three complementary methodologies are followed. The first consists of calculating concentration curves to show how services are distributed among the population. The second methodology, based on the proposal by Waddams Price and Hancock (1998), measures changes in household expenditures associated with changes in structure and prices levels. Finally, demand equations are estimated for the different utilities under study, by applying a two-stage Heckman methodology to correct for the probability of having access to the service. Using the elasticities estimated with this two-stage procedure, we calculate the welfare changes associated with the consumption of the utilities. .../.

Keywords: privatization, welfare impacts, regulation, and utilities

JEL classification: L970, L960, L950, L500, L430, D600

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This study has been prepared within the UNU/WIDER project on The Social Impact of Privatization and Regulation of Utilities in Latin America, which is co-directed by Dr Cecilia Ugaz, UNU/WIDER (Helsinki) and Professor Catherine Waddams Price, University of East Anglia (Norwich).

UNU/WIDER gratefully acknowledges the financial contribution to the project by the Ministry for Foreign Affairs of Finland.

The depth of the reforms, however, particularly the extent of privatization, is uneven across sectors. Despite of this variation in reform, the results in terms of improvement on the supply side are positive and very significant, albeit there are still major problems which could explain why welfare impacts are not significant and may even be negative in the case of electricity and water. Furthermore, even though water coverage has increased considerably, the quality is poor and the service erratic. The electricity sector, on the other hand, has shown major improvements, but the positive effects of privatization are yet to reach the important urban regions of Peru. This factor could explain why consumers, on average, are not experiencing an increase in their welfare. In contrast, telephony is the sector with substantial advancement since the transfer to private ownership. Both in terms of supply and demand, the outcome shows positive results, including technological development. However, a significant reduction in household consumer surplus has occurred since 1997.

In summary, we believe that the utilities services in Peru still need significant improvements, particularly in electricity and water, where reforms are still incomplete, or even non-existent. Finally, we believe it necessary for the providers to develop better plans to allow both consumers and producers to reap greater benefits in terms of welfare and revenue.

Acknowledgements

We thank Catherine Waddams Price and Cecilia Ugaz for numerous helpful comments to the different drafts of this work, as well as all the participants of the project. We are also indebted to a remarkably talented team of research assistants: Virgilio Galdo, Gissele Gajate, Eduardo Maruyama, as well as to two students, Carlos Diaz and Daniel Oda, for their invaluable help in the process of collecting and analysing the data used in this study.

1 Introduction

Since August 1990, Peru has embarked in a drastic stabilization and structural reform process comprising a vast programme of privatizing state-owned enterprises, which included the main utilities of electricity, telephone and, to a lesser extent, water.

In the telecommunications sector, the Peruvian government sold both Compañía Peruana de Teléfonos (CPT) and Empresa Nacional de Telecomunicaciones (ENTEL). CPT had provided basic telecommunications services in the Lima area, while ENTEL was the national and long distance carrier as well as the provider of local services for the rest of Peru. After an auction to the highest bidder, divestiture took place in 1994. Using a first price-sealed bid mechanism, approximately 35 per cent of the common shares of CPT and ENTEL (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 telecommunication companies in Latin America.¹ The outcome of the auction was overwhelming: Telefónica paid US\$ 2,002 million, far more than the second highest bid (US\$ 800 million) which was actually closer to the base price set by the government. Soon thereafter, Telefónica de España S. A. merged the two companies to create Telefónica del Perú S. A. (TdP). TdP was granted a national monopoly, initially for a five-year period,² for the provision of lines, local calls, long distance (LDN) and international long distance services (LDI). Simultaneously, the government created the Supervisory Agency for Private Investment in Telecommunications (Osiptel).

In the electric sector, the government approved in 1992 the Law of Electric Concessions (DL 25844), which separated power generation from electricity distribution. Between 1994 and 1997, the government privatized ten state-owned enterprises for a total of US\$ 1,433.1 million, five in distribution and five in electricity generation. The most significant investment commitment of the privatized generation companies was to increase their total capacity to 560 MW. The government also created two regulatory bodies in this sector, the Supervisory Agency for Private Investment in Energy (OSINERG), and the Commission of Energy Tariffs (CTE). The process in this sector has not yet been completed, as one of the major generating enterprises, Central Hidroeléctrica del Mantaro, and all the distribution enterprises in the south are yet to be privatized.

Water and sanitation is the only public utility where there has been no privatization. The only exception was perhaps the concession to the Italian company Impregilo in December 1999 to operate wells and a water treatment plant in the river basin Chillón in order to sell water to Lima's water company. The government, however, attempted to achieve a more efficient organization and management of the system by decentralizing it.

This reform gave municipalities throughout the country control over water services, with the exception of Lima where these services are still provided by the state-owned

¹ Other companies bought by Telefónica include the former Teléfonos de Chile, currently known as CTC, and Argentina's ENTEL.

² According to the contract, the monopoly was initially scheduled to expire in June 1999, but TdP shortened the term to 1 August 1998.

Sedapal (*Empresa de Servicio de Agua Potable y Alcantarillado de Lima*). It was the only water service provider initially included in the government's privatization programme, but to date has not been privatized. The government has tried, nevertheless, to improve Sedapal's services and coverage.

In addition, in 1992 the government created the national office for services of sanitation (*Superintendencia Nacional de Servicios de Saneamiento, Sunass*) as the regulatory body for this sector. Sunass is responsible for quality control of the services provided, the tariff system, and regulation as well as the inter-sectoral coordination, the issuance of norms for investment plans, and respective control over these investments.

By 1998, Sunass had recognized 45 sanitary services enterprises (*Empresas Prestadoras de Servicio de Saneamiento, EPS*) including the state-owned Sedapal. Another 44 EPS are owned by the municipalities and provide services to 112 provinces throughout the country. Most of these companies were in critical financial circumstances and in August 2000, the government enacted a new law for water and sanitation services to resolve the situation. It is likely that in the near future the regional water companies in financial disarray will be granted in concession to private operators.

Thus, almost five years after privatization in the electricity and telecom sectors, and major reforms in water administration, the outcome is not clear a priori. It is important to note that Peruvians were severely restricted in terms of access to utilities. The electrification coefficient in the early 1990s was below 50 per cent and there were only two telephone lines per 100 inhabitants. Although more people (mainly from low socioeconomic levels) can currently access telephones, electricity or water, many are reluctant to do so because they are unable to pay the monthly bills.

Unlike other experiences, the Peruvian case allows us to determine whether the welfare gains accruing from more people having access to these three utilities will be large enough to offset the increase in user rates. It also allows us to estimate, at different socioeconomic levels, the welfare impacts of price fluctuations in utility services before and after privatization, and/or reforms.

The purpose of this research is to estimate the consumption and welfare impacts of the privatization and reform of the utility sectors (telecommunications, electricity, and water and sanitation) on Peruvian urban households. The household-level compensatory variation associated with these price changes is also computed. The main objective is, therefore, to assess the income distribution effects of privatization and to determine which type of household, classified according to their characteristics, bears a greater portion of the burden or enjoys most of the benefits from price changes introduced by the process. It is important to mention that we believe that the results could be the combined impact of different factors operating simultaneously in the respective sectors at the time of reforms. These can be broadly classified as organizational and technological elements. The former include the measures used to adopt reform: privatization, limited competition, regulation, prevalence of state ownership, etc. A technological element is, for instance, the existence of any substitute of the traditional service (fixed versus cell phones). Both elements, which we will not be able to disentangle, trigger changes in prices, access and quality of the services and therefore influence the welfare effects.

2 The methodology

We follow three complementary methodologies in our analysis. The first, following Demery (1997) and Younger (1999), is the calculation of concentration curves to show how services are distributed among the population. We use dominance tests to assess the concentration of benefits for the three services. We also compare the distribution of benefits with respect to two benchmarks: the Lorenz curve for expenditure inequality, and a 45° line. This allows us to assess whether privatization has been more or less unequal compared to the current income distribution in Peru, and to measure the distance from a perfectly egalitarian distribution represented by the 45° line. We perform the exercise with data for different years to compare the distribution of benefits of one service at different points in time.

Secondly, we follow the methodology of Waddams Price and Hancock (1998) to evaluate the impact of the privatization of utilities. According to this methodology, we will assume that the level of consumption of the service under study is fixed. Thus, we attribute the changes in expenditures to changes in the level and structure of tariffs. This procedure enables us to isolate the effect of price fluctuations from changes in consumption patterns. Formally this is given by:

$$\Delta G = q^* (p_1 - p_2)$$

where G = expenditure in the public service

q^* = quantity consumed

p_1 = initial price

p_2 = final price.

In the Waddams Price and Hancock study, q^* is the average consumption of the two reference periods. Assuming a constant q over time could induce some problems, as it implies that the quantity consumed is not affected by changes in prices. In other words, we assume the public service to be inelastic. But, as mentioned by Waddams Price and Hancock, given that the goods under study have low elasticities, this methodology can give important information about the distribution of welfare gains/losses arising from price changes on different households.

A serious limitation of this methodology in the case of Peru is that it does not take into account changes in the level of access. Although this is a reasonable assumption in a country like the UK where most of the population has access, this is misleading for Peru where a significant share of the population had no access to these service, a fact which makes measuring the increase in public service access extremely relevant.³ In Peru, a major change resulting from the reform of the utilities is the greater share of the population gaining access to these services. This definitely has a positive impact on the welfare of households and should be included in our calculations.

³ For example, access to telephone went from 2.9 per 100 inhabitants to 6.7 in 5 years after privatization.

Our third methodology, then, tries to consider the effect of increases in access. We estimate a system of demand equations to measure the impact of price changes on the utility of the households, taking into account the utilities under study (water, electricity or telephone) as well as food, clothing, and other durable and non-durable goods. This is an attempt to measure the substitution effect associated to the changes in the tariff structure of the services under study.

Given that we need to control for changes in access, it is necessary to use the two-stage Heckman estimation procedure. In the first stage, we model the decision whether or not to connect to any of the services. For this, we estimate a probit model:

$$P(sp) = \beta_1 \ln(p_{ins}) + \beta_2 cover + \beta_3 age + \beta_4 age^2 + \beta_5 natong + \beta_6 wom + \beta_7 su + \beta_8 snu + \beta_9 sec + \beta_{11} \ln(inc)$$

where $P(sp)$ = probability of having access to the service

p_{ins} = installation price as a perpetuity (for telephones)

$cover$ = coverage of the service in the district

age = age of the household head

$natong$ = 1 if the mother tongue of the household head is a native language

wom = 1 if the household head is a woman

su = 1 if the household head has higher university education

snu = 1 if the household head has higher non university education

sec = 1 if the household head has secondary education

inc = monthly household income.

From this equation, we obtain the Inverse Mills ratio to be used to correct for the access problem. This ratio is included in the second-stage estimation, i.e. demand estimations, to obtain price elasticities and the consumer surplus for the three services. The equation for each service is:

$$\ln(q_i) = \beta_0 + \beta_1 \ln(p_i) + \beta_2 age + \beta_3 age^2 + \beta_4 hsize + \beta_5 old + \beta_6 natong + \beta_7 wom + \beta_8 su + \beta_9 snu + \beta_{10} sec + \beta_{11} cas + \beta_{12} horas + \beta_{13} horascon + \beta_{14} male215 + \beta_{15} wom215 + \beta_{16} \ln(inc) + \beta_{17} irm$$

where q_i = quantity consumed of service i

p_i = price of service i

age = age of the household head

$hsize$ = number of members in the household

old = number of members over 65 years

$natong$ = 1 if the mother tongue of the household head is a native language

wom = 1 if the household head is a woman

cas = 1 if the household head is married

<i>su</i>	=	1 if the household head has higher university education
<i>snu</i>	=	1 if the household head has higher non university education
<i>sec</i>	=	1 if the household head has secondary education
<i>horas</i>	=	number of hours worked by the household head
<i>horascon</i>	=	number of hours worked by the spouse
<i>male215</i>	=	number of males between 2 and 15 years in the household
<i>wom215</i>	=	number of females between 2 and 15 years of age in the household
<i>inc</i>	=	monthly household income
<i>irm</i>	=	Inverse Mills ratio.

These equations allow us to estimate price elasticities and to approximate the consumer welfare associated to each of the services in each period of time. This is given by:

$$w_i = \frac{\hat{q}_i}{\beta_i}$$

where w_i = welfare associated to the consumption of good i

\hat{q}_i = estimated quantity consumed of the good i

β_i = own price coefficient of the good i .

This procedure allows us to calculate the welfare gains from price changes before and after reforms for different household groups. Finally, to calculate the gains/losses on different household groups, we construct a counterfactual scenario in which no reforms have taken place and the pre-reform pricing policies prevail.

We use two major data sources for this methodology: the Living Standard Measurement Survey (LSMS) and district level data on prices from Peru's National Statistics Institute for the three utilities under study. The LSMS contains diverse information on the use and consumption of telephone, electricity and water for 1991, 1994 and 1997. The three LSMS, which integrate information on income, expenditure and use of public social services, are quite similar in structure and, with the exception of the 1991 survey, are nationally representative household surveys. The 1991 data give insight on the pre-privatization period, while the 1994 and 1997 surveys provide information on the post-privatization effects.

In addition, we review changes in regulation and in other policies affecting the utilities sectors. We rely on information reported by the four regulatory agencies themselves: Osiptel for telecommunications, Sunass for water and OSINERG and CTE for electricity.

3 Description of sectors before and after the reforms

In this section, we review the main changes on the supply side that have resulted from the reforms affecting the state enterprises operating in each sector. The main objective is to try to quantify, through basic indicators, the situation before and after the reforms, as well as introduce the main characteristics of the reforms, given that they were different in each of the three utilities being studied.

3.1 The telecommunications sector

3.1.1 Situation before the privatization

Up to 1994, two state-owned companies—Compañía Peruana de Teléfonos S. A. (CPT) and Empresa Nacional de Telecomunicaciones (ENTEL)—had covered the telecommunications sector. CPT provided local telephony service in Metropolitan Lima, while ENTEL served the rest of the country, also providing national and international long distance services. This structure had prevailed since the 1970s when the government enacted the Telecommunications Law. Believing the telecommunications sector to be strategic, the government blocked participation by domestic and foreign private investors. One of the most noticeable characteristics of the Peruvian telecommunications sector during state ownership was the high level of demand for basic telephone services that was unfulfilled, reflecting the paucity of investment and restrictive policies. Indeed, given Peru's degree of development at the time, the country should have had a 11 per cent penetration ratio, i.e., 11 out of every 100 households should have had telephones, but penetration was only 2 per cent until 1993. Telephone lines were also unequally distributed, concentrating in Lima and in the wealthy households. It was, nevertheless, assumed in the 1990s that privatization would bridge the gap by boosting efficiency, and by encouraging the development of a competitive market.

The other noticeable feature of the sector in the pre-reform period was the severely distorted tariffs. Even though installation rates compared to the international average were quite high,⁴ the flat monthly charge was relatively low, while rates for long distance and additional local calls were quite high. As in other countries, it was assumed that only the rich, inelastic consumers used international long distance services, so a cross-subsidy was provided between long distance and local telephony services. Under this scheme, investments in infrastructure were restricted to the resources of the public sector. But as public resources were meagre, and the public sector's managerial capacity limited, the telecommunications infrastructure experienced little growth. As a result, the major problem caused by the scheme that had governed the sector up to 1994 was the low coverage of the network. Quality of the service was poor and operations suffered from inefficiencies inherent to public administration.

⁴ The installation charge in 1993 was close to US\$ 1,000 per residential telephone line.

3.1.2 The privatization process

The economic reforms implemented in early 1990 by the government of Alberto Fujimori included privatization of the companies in which the state had a considerable share. Consequently, between November 1991 and February 1992, the government put into effect a comprehensive privatization strategy. This was to establish a time-frame for privatization, define the method and designate the priority sectors according to the specific significance of each sector, the potential ease of its privatization, and the severity of the ‘crisis’ faced by each. The government also created special privatization committees (CEPRIs) to promote and facilitate the process.

To proceed with privatization, the Fujimori government created the telecommunications CEPRI to call for international bids and to set a base price. Three responded, and the winning bid, headed by Telefónica de España, offered US\$ 2.002 billion for a 35 per cent share in CPT and ENTEL. This was almost four times the base price of US\$ 546 million. Of the remaining 65 per cent of shares, minority shareholders held 36.4 per cent and the Peruvian state 28.7 per cent (Table 1). The privatization process was not concluded in 1994, and it was not until July 1996 that the state sold off 26.6 per cent of its shares to small, individual shareholders through a process of citizen participation.

The privatization agreements called for a merger of CPT and ENTEL, but the two entities were to keep separate accounting books. The agreements also established a five-year period of limited competition during which new competitors could not provide basic telephony services. During that period, tariffs were to converge to their long-term marginal costs. The remaining telecommunications services, such as value-added services, mobile telephony, data transmission, e-mail and cable television, were open to free competition. Though this natural monopoly, the government was able to obligate the operator (the winning bid) to meet service expansion and quality improvement goals, which ultimately provided for a total of 1,197,600 lines (Table 2).

The privatization process also introduced a re-balancing period in order to gradually reduce existing tariff distortions. The re-balance considerably increased monthly service charges, but reduced costs for the three types of calls (Table 3 on actual rates). The period of limited competition ended in August 1998, one year before the termination date stipulated in the contract.

In July 1993, the government created the Supervisory Agency for Private Investment in Telecommunications (Osiptel, by its Spanish acronym) to replace the Telecommunications Regulatory Commission and to regulate and oversee the development of the telecommunications market. The new telecommunications law granted this agency autonomy in technical, economic, financial, functional and administrative matters.⁵

⁵ See Figure A1 in the Appendix for more details on the reforms within the telecommunications sector.

Table 1
The privatization process
(in millions of US\$)

Consortia	Base price	Bid	Price per line
Telefónica de España, Graña y Montero, Backus, and Banco Wiese	546	2,002	0.00877
Southwestern Bell, Korea Telecommunications, Daewo Telecommunications, Condumex-Carso, and Banco de Credito	546	857	0.00375
GTE, Compañía Portuguesa and Empresa Brasileira de Telecomunicaciones.	546	803	0.00351

Source: Telecommunications CEPRI obtained from Torero *et al.* (2000).

Table 2
Plans for expansion and modernization in the telecommunications sector
(thousands of lines)

	1994	1995	1996	1997	1998
Metropolitan Lima					
Additional lines installed	65	84	105	126	126
Lines replaced	15	20	30	30	30
Public telephones	1.4	1.4	1.4	1.4	1.4
Rest of Peru					
Additional lines installed	39	56	111	133.3	133.3
Lines replaced	5	10	20	20	20
Public telephones	0.7	2.1	3	3.1	3.1

Source: Osipitel, CPT and Entel Perú concession contract, obtained from Torero *et al.* (2000).

Table 3
Maximum re-balancing rates in the telecommunications sector
(in 1994 Peruvian soles)

Services	1994	1995	1996	1997	1998
Basic residential rate	10.97	14.06	18.64	25.29	31.93
Basic commercial rate	21.80	25.99	29.43	30.52	31.93
Local call (3 min.)	0.144	0.140	0.135	0.128	0.120
Domestic long distance (1 min.)	0.575	0.519	0.458	0.416	0.371
International long distance (1 min.)	3.532	3.205	2.834	2.398	2.035
Residential installation charge	924.00	798.00	672.00	546.00	420.00
Commercial installation charge	1848.00	1428.00	1092.00	756.00	420.00

Source: Osipitel, CPT and ENTEL concession contracts, obtained from Torero *et al.* (2000).

3.1.3 After privatization

The main results obtained through privatization can be analysed either on the supply or demand sides. On the supply side, the principal changes can be summarized in terms of four indicators: coverage, service quality, tariffs, and structure of the company's earnings and its economic efficiency and results.

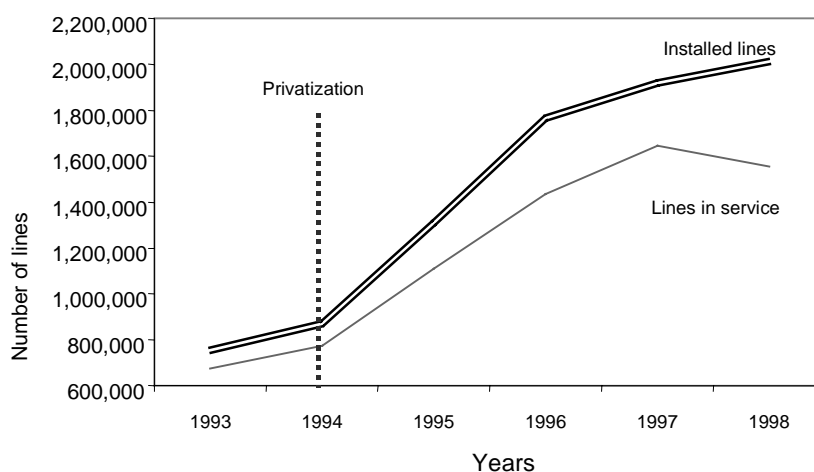
(i) Coverage

One of the main problems in the telecommunications sector was its low level of coverage. By international standards, and based on the country's GDP per capita, Peru should have had a telephone density of 11 lines per 100 inhabitants, but had a mere 2.6 lines in 1992 and 2.9 lines in 1993, which is very low compared to other countries in the region, such as Argentina, Brazil, Mexico, Colombia, Chile, Bolivia and Ecuador. The limited extension of the network was the result of declining fiscal revenues, the debt crisis and the fact that (subsidized) rates did not reflect the cost structure. These factors constrained plans for expanding the network, and the end result was a low level of telephone density. This led to a growing unsatisfied demand that manifested in the waiting time for a telephone: 118 months on average in Peru in 1993 compared to 17 months in Colombia and 11 months in Mexico.

In these circumstances, the first problem to be resolved by the winning bidder was to satisfy demand. In fact, one of the first actions contemplated in Telefónica's contract was the expansion of the telecommunications network. Figure 1 shows the development of the network expansion during 1993-98, and the overall increase of approximately 167 per cent in the number of lines installed. On the other hand, there is a small decline in the number of lines in service after 1997 as a consequence of the high fix charges and an increase in the penetration of cellular phones.

In terms of coverage, Telefónica del Perú was able to comply with the concession goals, and by 1998 had already covered the entire market for basic telephony. This may be the reason why Telefónica decided to advance the date for terminating the period of limited competition. Figure 1 shows a decreasing trend around 1998 in the number of lines in service, which could also be, in addition to the explanations given earlier, an indication of some excess coverage in the sector.

Figure 1
Evolution of the number of lines installed and in service



Source: Torero *et al.* (2000).

(ii) Service quality

The quality of services provided by the state-owned enterprises CPT and ENTEL was below international standards. In 1992, only 35-40 per cent of all phone calls were completed. This low efficiency was partly due to the small size and obsolete technology of the network, which made it prone to congestion. Inadequate cable maintenance was another factor. Telephone cables have a expected lifespan of 15 years, but by 1993 some cables had been in service for over 60 years. In 1993, only 33 per cent of the network was digital. Table 4 shows improvements in the quality indicators under Telefónica’s administration.

Table 4
Service quality indicators in the telecommunications sector

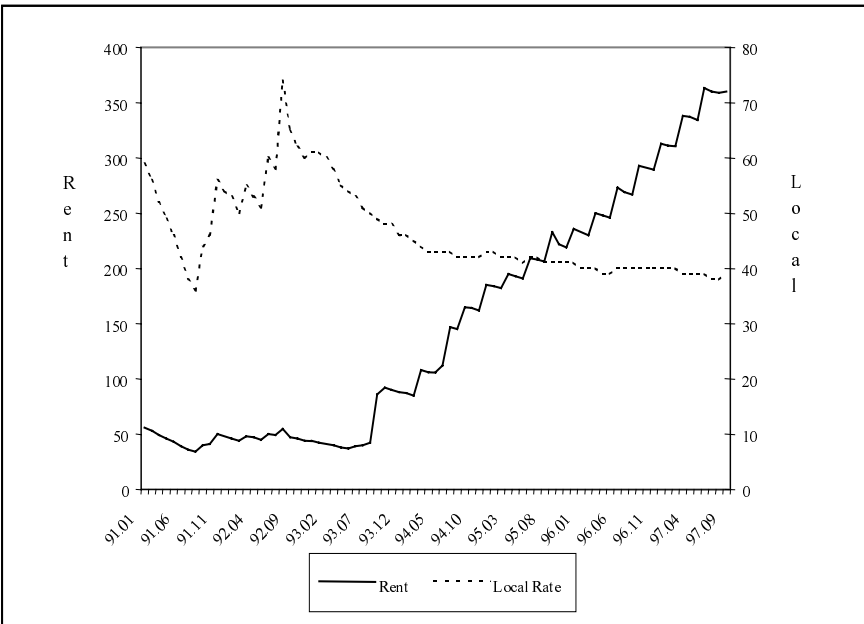
	1994	1995	1996	1997	1998
Local calls completed, %	n/a	96	96	99	99
National long distance calls completed, %	n/a	57	51	53	54
International long distance calls completed, %	n/a	88	90	99	99
Digitization of the network, %	53	77	85	88	90

Source: Osiptel, obtained from Torero *et al.* (2000).

(iii) Tariffs

The low levels of investment by CPT and ENTEL are partially a reflection of the companies’ low earnings, as telephone service charges were below costs. This prevented these state-owned companies from generating the funds needed to expand the network or

Figure 2
The evolution of the index of the basic local rates
(August 1990 = 100)



Source: Obtained from Torero *et al.* (2000).

Table 5
The evolution of telephony rates

Date	IPC	Nominal				Real			
		Rent	Local	LDN	LDI	Rent	Local	LDN	LDI
1993	0.820	5.000	0.170	0.484	4.860	6.099	0.207	0.590	5.928
1994	0.946	11.990	0.180	0.628	3.860	12.676	0.190	0.664	4.081
1995	1.000	14.166	0.185	0.269	3.871	14.166	0.185	0.629	3.871
1996	1.166	25.150	0.207	0.618	3.824	21.568	0.178	0.530	3.279
1997	1.241	36.670	0.213	0.603	3.477	29.538	0.172	0.486	2.801
1998	1.316	43.220	0.234	0.444	3.360	32.841	0.178	0.337	2.553

Note: 1995 average; otherwise end of period.
LDN = national long distance calls; LDI = international long distance calls.

to improve service quality. Political, rather than technical, criteria guided the administration of tariffs, generating a distortion in the tariff structure which failed to cover the costs of telecommunications services. The government subsidized certain services (local telephony services) with high rates for international long distance and other services. Tariffs for telephone services in Peru differed substantially from those in other countries of the region. The cost of installing a telephone line in Peru (US\$ 1,500 in 1993) was above the average for Latin America, and the rate for international long distance service was extremely high. But, on the other hand, Peru had a very low basic monthly rate (US\$ 2.00 in 1993). Furthermore, for those using telephones more frequently than the minimum, the rate for the portion exceeding the minimum was very small.

(iv) Revenue structure, efficiency and economic results

After privatization, there have been important changes in the composition of revenues generated in the sector. While local telephone services have become the most important revenue category, revenues from national and international long distance services have fallen proportionately. These results were foreseen in the tariffs re-balancing scheme. Furthermore, there is a noticeable increase in revenues from mobile telephony, business communications and advertising (see Table 6).

CPT and ENTEL were overstaffed, which led to low productivity and an inadequate structure of operating costs. According to Coopers and Lybrand, wages and salaries in 1992 accounted for 40 per cent of CPT's total costs, while at ENTEL they were 20 per cent of total costs. The result was very high operating costs per telephone line and extremely low profits. Table 7 presents the efficiency and profit results achieved by Telefónica. The gains in efficiency are obvious, and profitability, accordingly, is also very high.

Table 6
Composition of Telefónica del Perú's operating income (in %)

Service	1994	1995	1996	1997	1998
1. Local telephony	35.50	44.19	41.91	37.80	38.00
2. International long distance	30.50	22.71	19.05	16.20	13.20
3. National long distance calls	17.40	12.61	11.83	10.40	9.10
4. Public telephony	5.10	10.45	9.95	9.50	11.30
5. Mobile telephony (cellular phones)	4.00	4.32	10.10	16.70	16.50
6. Cable TV	5.10	0.39	1.12	3.10	4.50
7. Business communications	2.20	3.83	4.32	4.00	4.70
8. Telephone directory	0.20	1.50	1.72	2.30	2.80
Total operating income	100.00	100.00	100.00	100.00	100.00

Source: Annual Reports of Telefónica del Perú.

Table 7
Performance indicators for Telefónica del Perú

	1994	1995	1996	1997	1998
Lines installed per employee	98	155	281	329	355
Lines in service per employee	87	132	228	282	275
Lines in service per 100 inhabitants	3.4	4.7	5.9	6.7	6.3
Waiting time (months)	33	5	2	2	1.5
Net profits (in millions of US\$)	35.5	305.1	348.3	400.5	213
Net profits/earnings, %	5.0	29.4	28.8	24.9	16.9
Net profits/equity, %	2.9	21.1	28.8	24.9	15.7

Source: Annual Reports of Telefónica del Perú.

3.1.4 End of the period of limited competition

The concession contract set the period of limited competition until August 1999. However, Telefónica and Osiptel agreed to end it in August 1998, one year early, when Osiptel decided that Telefónica had achieved the goals outlined in the 1994 concession contract. The two entities reached a new agreement that contemplated some changes, the most important of which include (i) establishing a set of maximum tariffs to be valid until 2001. The earlier contract had regulated the calculation of prices to include a productivity factor, which became effect in 1999; and (ii) reduction in the installation charge from US\$ 270 to US\$ 150.

After termination of the limited competition phase, the government opened the market to new operators for the provision of local, national and international long distance telephony services. New entrants could also use Telefónica's infrastructure by paying an interconnection fee.⁶ This proved to be a controversial issue and required Osiptel's intervention because of lack of agreement among private companies.

⁶ The maximum fee for day-time interconnection was first set at US\$ 0.029 per minute. This fee was much higher than fees charged in Chile (US\$ 0.017) or Mexico (US\$ 0.022).

3.2 The electric sector

3.2.1 The situation before privatization

Before privatization and the enactment of the Electric Concessions Law in 1992, provision of electric services was in government control through ElectroPeru, the state-owned enterprise, and several distribution companies, including ElectroLima. ElectroPeru supervised and coordinated the regional electric companies, while the General Direction of Electricity at the Minister of Energy and Mines was responsible for directing, promoting, controlling and supervising the service. Investments by ElectroPeru increased during 1980-85, but have since fallen (see Table 8).

Due to declining investments, Perú recorded in 1992 an electrification coefficient of barely 48.4 per cent, one of the lowest in Latin America, and an indication that more than half of the country lacked electric service and were thus excluded from modern conveniences. Seventy per cent of the total electric energy in Peru was supplied by the state; the remaining 30 per cent was provided by private self-producing companies using generators.

In 1990, the electric supply deficit in the country reached 26 per cent of potential demand. Terrorist attacks had destroyed a sizeable part of the electric infrastructure, and poor maintenance of the remaining infrastructure resulted in continuous cuts in electricity, and severe rationing. Furthermore, the distribution system's losses increased, reaching an average of 21.8 per cent in 1993.

Electric tariffs, set according to political criteria, were below operation costs and generated huge losses. In 1989, the electric tariff covered only 39 per cent of average operating costs (see Table 9). Companies lacked resources to increase generation capacity, to expand the electric frontier, or to improve the quality of existing services. In 1989, companies in the sector registered losses totalling US\$ 426 million, which is almost three times the earnings generated by the sales of electric energy. During 1990 and 1991, reported losses were US\$ 302 million and US\$ 38 million, respectively, negatively affecting the already minimal investment programme.

Table 8
Investment indicators

	1980-85	1986-90	1990-95
Investment in 1995 in US\$ mm, annual averages by period	656	222.2	89.3
Investment as % of GDP, annual averages by period	1.74	0.57	0.21
Average addition of annual power in MW			
ElectroPeru	88	45	71
Self-producers	8	1	19

Source: ElectroPeru.

Table 9
Average price and average operational cost of electricity
(in US\$/kWh)

Year	Average price	Average cost	Price/cost relation, %
1989	0.0019	0.00483	0.0393
1990	0.00457	0.00619	0.0738
1991	0.00465	0.00508	0.0915

Source: CTE.

3.2.2 *The privatization process*

One of the government's most important measures in the electric sector was the promotion of private investment. In November 1992, a new legal framework was enacted to complement the existing norms promoting competition and to open the sector to both domestic and foreign private investment. This law called for restructuring the national electric sector, and to creating a modern regulatory framework which would cover different activities in the industry. The new regulatory framework contemplated setting up a new tariff system, the establishment of private concessions to operate the services, and the supervision of these operators. In December 1996, the Law of Electric Concessions was revised with regard to its clauses on regulation, while another Law (No. 26734) created the Supervisory Agency for Private Investment in Energy (Osinerg). See Figure A2 in the Appendix for further details concerning the changes in the legislation that affected this sector.

The main elements of the Law of Electric Concessions include:

- Elimination of the state monopoly in the electric sector;
- The de-merger of activities related to the generation, transmission and distribution of electricity. The reform of the state-owned integrated monopolies, ElectroLima and ElectroPeru, followed this pattern;
- Restrictions against the same firm simultaneously providing generation, transmission and distribution of energy, except specific cases stated by law;
- Promotion of competition in electric generation through a tariff structure based on marginal costs;
- Regulation of tariffs in transmission and distribution; and
- Promotion of firms' efficiency by favouring those with lower variable costs.

To attract private investors, the state assumed ElectroPeru's long-term debts. At the same time, three special privatizing committees (CEPRI) were created for the individual sale of the generation, transmission and distribution companies, ElectroPeru, ElectroLima and Etevensa.

The vertically integrated state-owned monopoly, ElectroLima, was divided into five companies, all of which have been transferred to the private sector.⁷ ElectroPeru,

⁷ These include Edelnor, Luz del Sur (both distributors), EDEGEL, EDE Chancay and EDE Cañete (generators).

another vertically integrated state-monopoly, was disassembled, and several of the resulting companies have also been privatized.⁸ Finally, four regional distribution electric companies were similarly privatized⁹ (see Table 10 for details).

Table 10
Indicators for privatized enterprises in the electric sector

Year	Enterprise	Activity	Winning consortium	Participation %	Amount (US\$ m)	Committed (MW)	Reference value ^(a)
1994							
12 July	Edelnor	Distribution	Inversiones Distrillima	60.0	176.49		294.15
12 July	Edelsur	Distribution	Ontario Quinta AW	60.0	212.10		253.50
1995							
25 April	Cahua	Generation	Sindicato Pesquero	60.0	41.80		69.67
17 Oct	Edegel	Generation	Generadores Co.	60.0	524.40	100	874.00
12 Dec	Etevensa ^(b)	Generation	Consortio Generalima	60.0	120.10	280	200.17
15 Dec	EDE-Chancay	Distribution	Inversiones Distrilima	60.0	10.40		17.33
1996							
25 June	Egenor	Generation	Inversiones Dominion	60.0	228.20	100	380.33
27 June	EDE-Cañete	Distribution	Luz del Sur S. A.	100.0	8.60		8.60
2 Oct	Empresa Eléctrica de Piura ^(c)	Generation	Consortio Eléctrica Cabo Blanco	60.0	59.67	80	99.45
1997							
11 Feb	Electro Sur Medio ^(d)	Distribution	Consortio HICA	98.20	51.28	^(d)	52.22
TOTAL					1381.76	560	

Notes: (a) The value of each firm at the time of privatization, determined according to a price paid for 100% sale of the stock of each enterprise.
(b) For capitalization;
(c) 40.33% of the stock for US\$ 40 million by capitalization, and 19.67% for US\$ 19.67 million as payment to the government;
(d) 50% through the 'Programa de Promoción Empresarial' and 50% by investments in electrification.

Source: COPRI.

3.2.3 After the privatization

Privatization results in the electric sector are impressive, even though many important firms and assets are yet to be transferred to the private sector. In terms of earnings for the country, privatization of the sector had generated US\$ 2,074.5 million by 1999, of

⁸ EGENOR, Cahua, ETEVENSA and Electric Company of Piura.

⁹ Electro Sur Medio, Electronorte Medio, Electro Norte, Electro Noroeste and Electrocentro.

which US\$ 1,914.4 million were obtained from stock sales and US\$ 160.1 million through the capitalization of Etevensa and the Electric Company of Piura.

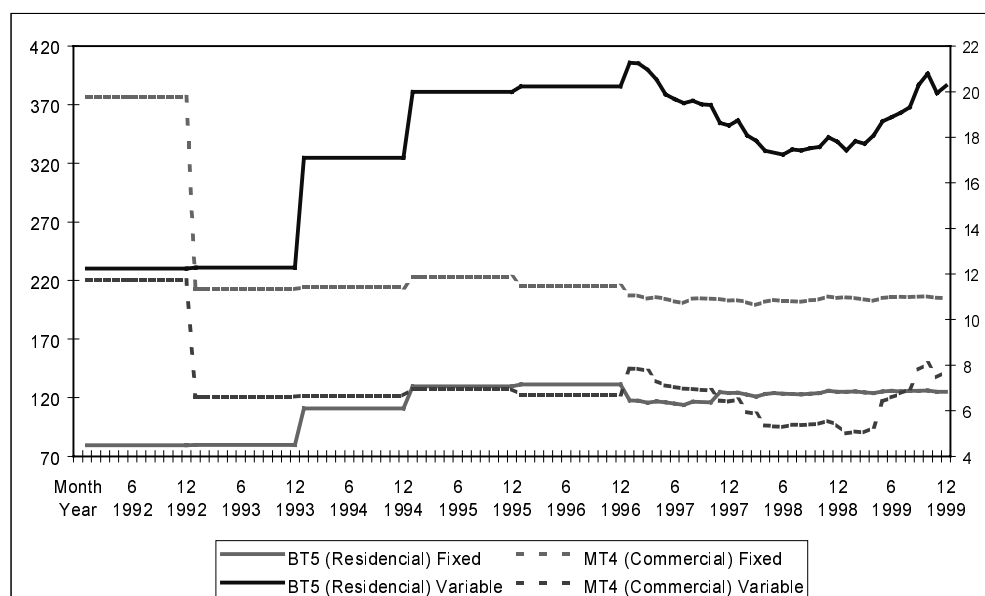
Investments by the privatized companies, totalling US\$ 682 million, have more than doubled the initial investment commitment of US\$ 270 million. Privatization also increased the power generation capacity by more than 25 per cent in five years, tilting the balance from hydro to thermoelectric generation. Peru's heavy reliance on hydroelectric generation makes the country especially vulnerable to climatic circumstances, like floods and droughts. A more balanced generation profile was needed, and thermoelectrical generation has been increased over 136 per cent since 1996 to meet this demand.

Table 11
Efficiency improvements in the electric sector, 1994-99

	1994	1999
Time to respond to queries/complaints, hours	27	1
Time to repair defects, days	7	1
Time to install meter, days	45	2

Source: Edelnor.

Figure 3
The evolution of the index of basic electric rates
(August 1990 = 100)



Note: Fixed monthly rates, particularly for energy and power, depend on the generation costs and on the added value of the distribution. Thus, prices vary according to the location of the final customer. For this reason, rates applicable in the Lima province were used because these represent the greatest share of sales in Peru (67% of the sales of the distribution companies).

Source: CTE Statistical Yearbooks (1992-99).

Privatization has also had an important positive effect on the quality of life of the population through increased access to electricity. For example, currently 100 per cent of Edelnor customers, 83 per cent of whom belong to the poorer segments of Lima's inhabitants, have electricity. Edelnor's investments have added 225,000 customers in

approximately 500 communities to the network. Similarly, customer service has improved. To provide a more comfortable and practical service, distribution companies started call-lines to ease customer doubts. Distribution companies have made huge improvements in efficiency, which can be seen in the reduction of time required to obtain certain services (Table 11).

In the pre-reform period, rates for final users varied according to usage: industrial, commercial, residential, public lightening, and general agricultural, among others. After reform, energy rates were combined with tariff options, and the only tariff differentiation that still exists is the residential rate, option BT5. The commercial rate is currently option MT4.

As Figure 3 shows, the fixed rates for both MT4 and BT5 options remain roughly constant during 1992-99. On the other hand, the variable rate for the BT5 option (residential) shows a drastic increase, while the rate for the MT4 option (commercial) was slightly increased because of the need to ensure sector viability.

As Table 12 summarizes, sectoral growth and the quality of service show positive results. The 109 per cent increase in labour productivity as well as the 40 per cent decrease in energy losses during 1998 are noteworthy.

Table 12
Main indicators of the electric sector, 1994-98

	1994	1998	% Change
Installed power (MW)	4,379.20	5,515.30	25.9
Electrification coefficient, %			
National	58.5	70	19.7
Edelnor	76	100	31.6
Luz del Sur	76	100	31.6
Number of customers (in millions), national	2.31	3.05	32.0
Loss of energy in distribution systems at national level, %	20.6	12.4	-39.8
Per capita energy consumption (kWh)	404.4	566	40.0
Electric energy sales (GWh)	9,335	14,009	50.1
Productivity by employee			
Edelnor	509	1,066	109.4
Luz del Sur	426	1,000	134.7

Source: Electricity Head Office; MEM, Statistical Yearbook 1998; Edelnor; Luz del Sur; CTE and Continental SAP, Evolution and Perspectives of the Peruvian Electric Sector.

3.2.4 International comparison

In addition to the positive indicators given above, Lima currently has the best street lighting index in Latin America; for example, Edelnor has installed some 187,000 new light bulbs since 1994. By the end of 1998, Peru's average electric energy tariff in the residential sector was lower than in Argentina and Chile, albeit higher than in Colombia

and Ecuador, where cross-subsidies prevail.¹⁰ A similar pattern is observed for the average electric energy tariff of the industrial sector in 1998, when average tariff in Peru was lower than in Argentina, Chile and Colombia, although higher than in Ecuador, because of the subsidies applied in that country.

Table 13
Street lighting in Latin America as of July 1999

City	Bulbs per 100 customers
Lima Norte (Edelnor)	31
Río de Janeiro	22
Santiago	20
Bogotá	18
Buenos Aires	14

Source: Edelnor.

Table 14
Average prices of electricity in Latin America as of September 1996
(in US\$/kWh)

Country	Residential	Commercial	Industrial
Uruguay	0.1532	0.1649	0.0873
Chile	0.1376	0.1144	0.0769
Brazil	0.1342	0.1159	0.0557
Cuba	0.1209	0.0766	0.0734
Panama	0.1208	0.1193	0.0998
Argentina	0.1074	0.1592	0.0773
Peru	0.0972	0.1002	0.0564
Bolivia	0.0706	0.1413	0.0789
Paraguay	0.0671	0.0704	0.0557
Colombia	0.0443	0.1065	0.0892
Mexico	0.0403	0.0998	0.0382
Ecuador	0.0245	0.0550	0.0542
Venezuela	0.0121	0.0332	0.0296

Source: CTE.

3.3 The water and sanitation sector

3.3.1 The pre-reform period

In 1981, President Fernando Belaunde created the Water and Sewerage National Service (Senapa), making all domestic potable water and sewerage companies 'subsidiary companies' or 'operative units' of Senapa. These companies were to function with economic, financial and administrative autonomy. A separate water and sanitation company for Lima and Callao (Sedapal) was also set up to operate as a subsidiary of Senapa. Despite Senapa's existence, the provision of water services in some localities

¹⁰ It is important to point out that the electric tariff is exempted from value-added tax (VAT) in Ecuador.

was the direct responsibility of district or/and provincial municipalities. In rural areas, the service was vested with the Health Ministry.

The national structure of water and sewerage services was centralized until the late 1980s. Thus, these services were provided throughout the country by only 15 autonomous subsidiary companies, and 185 operative units. However, a few months before ending his term, President Alan García enacted Legislative Decrees, Nos 574 and 601, which sought to decentralize the existing administrative structure. On the one side, this was an attempt to redress the failures of the prevailing centralized organizational structure, while on the other hand, Garcia's administration tried to retain certain bargaining power in water and sanitation issues. Given the support that Garcia's political party, the APRA, enjoyed in some regions of the country, it could easily exert pressure on the new government in a more decentralized set up.

Through these decrees, responsibility for the potable water and the urban sewerage services which had been subsidiaries of Senapa, was transferred to provincial and district authorities. The only exception was Sedapal (Lima's Potable Water and Sewerage Service Company) which continued to be under central government authority. Also, responsibility for sector services in the rural areas was shifted from the Health Ministry to regional governments. During 1990, Peru had a water and sewerage coverage index of 75.5 per cent and 78.1 per cent, respectively.

In terms of operative efficiency, the water and sewerage sector had a difference of approximately 196.6 million m³ between water volumes produced and invoiced, meaning that about 36.1 per cent of production was not invoiced. Other indicators such as the number of tenured staff (3,481 employees) and the number of workers per 1,000 connections (5.32) were strikingly high. Finally, financial statistics were discouraging, and showed a level of investment of US\$ 14.27 million and net losses after taxes of US\$ 21.3 million. The real average cost per cubic meter of produced water was around 0.043 soles.

3.3.2 *The reforms*

During President Fujimori's term, several laws were introduced to foster private-sector participation in the water and sanitation sector in an effort to finance infrastructure projects which the public sector was unable to afford (Figure A3 in the Appendix shows a time line of legislation changes in the water sector). In 1991, Legislative Decree No. 697— also known as the Private Investment Promotion Law—was enacted in the water and sanitation sector. The law removed all obstacles to private participation, and opened the sector to any company or person, requiring only that the entrant had prior authorization from the municipal government. The private provider was to charge users according to a tariff system fixed by the authorities.

In addition, the government created in 1992 the National Office for Services of Sanitation (Sunass, *Superintendencia Nacional de Servicios de Saneamiento*) as the sector's regulatory body. Sunass oversees quality control of the provided service, the tariff system, and regulation as well as the inter-sectoral coordination, the provision of guidelines for investment plans, and the respective supervision of said investments. But Sunass's operations began to function effectively only in 1994, two years later. Since its creation, the criteria underlying tariff regulation have been economic efficiency, financial viability, social equity, simplicity and transparency. In order to eliminate

distortions generated by previous policies of cross-subsidization, prices are set at levels equivalent to the long-run marginal cost of providing water. In addition, the aim of the tariff system is the recognition and preservation of the country's scarce water resources (Lima, for instance, is in an arid location with almost nil rainfall).

By 1998 Sunass acknowledged the operations of 45 sanitary services enterprises (EPS), including the state-owned Sedapal. Another 44 EPS are owned by the municipalities and provide services to 112 provinces throughout the country. Most of these companies are in critical financial circumstances and the government enacted in August 2000 a new law for water and sanitation services in order to solve the situation.

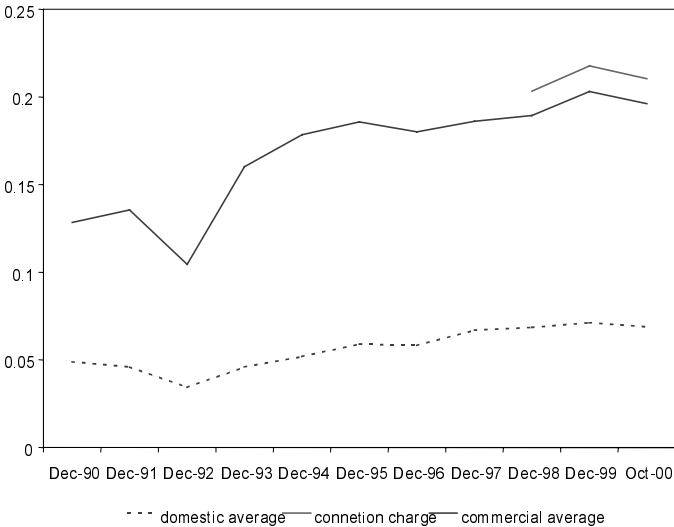
3.3.3 The post-reform period

The reform process in the water and sanitation sector of the early 1990s has produced interesting results. In terms of physical infrastructure, water and sewerage coverage increased by 1999 to 82.8 per cent and 81 per cent, respectively. In addition, the number of installed connections reached 864,791 units the same year, which implies an increment of 32.2 per cent (Table 15). Operative efficiency, however, has dropped.

Non-invoiced water accounted for 43 per cent of the total production in 1999, and the deteriorating economic situation over the last years has increased the number of illegal connections. Service quality, on the other hand, has improved significantly. In 1994, the average time for attending to complaints was around 14 days, it was 4 days by 1999. At the same time, staff on permanent contract was reduced to 1,562 employees, and the number of workers per 1,000 connections to 1.81.

Sedapal's financial circumstances show remarkable improvement. Investment increased during the 1990s to peak at US\$ 101.5 million in 1999. Net profits in the same year after taxes were US\$ 69,099. Finally, the real average cost per m³ dropped to approximately 0.037 soles in 1999. Furthermore, after a period of tariff reduction, there was an important increase in 1992 in the commercial rate, after which average rates for both commercial and residential usage have shown a gradual increase.

Figure 4
The evolution of the index of water and sewerage rates (August 1990=100)



Source: Sedapal Yearbooks (1994-99) and website.

Table 15
Main indicators for the water and sewerage sector

	1990	1994	1998	1999
Physical indicators				
% of population served	72.59	65.57	59.51	58.72
% of water coverage	75.64	74.60	81.56	82.78
% of sewerage coverage	78.10	70.90	79.90	81.00
Area served, hectares	30,722	33,152	38,894	39,762
Water network length, in kilometres	6,527	7,121	8,464	8,652
Drainpipe network length, in kilometres	6,130	6,746	8,033	8,203
Number of connections	654,140	762,929	871,723	864,791
Operative indicators				
Produced volume, '000 m ³	544,730	729,292	705,298	682,509
Invoiced volume, '000 m ³	348,133	427,664	387,917	388,712
Non-invoiced water, %	36.09	41.40	45.00	43.00
Level of measurement, %	56.62	47.30	40.44	
Level of micro-measurement ^(a) , %	29.01	3.50	32.21	51.02
Service indicators				
Average hours of water supply to primary network, per day	n/a	21.3	20.1	23.2
Average time for handling complaints, in days	n/a	14	9	4
Staff				
Regular staff	3,481	1,901	1,555	1,562
Workers per 1,000 connections	5.32	2.49	1.78	1.81
Financial indicators				
Investments, in '000 dollars	14,271	51,021	130,647	101,501
Net profits after taxes, in '000 dollars	(21,300)	68,259	75,989	69,099
Average water tariff (combined) in soles/m ³	0.09	0.67	1.20	1.37
Domestic water tariff (combined) in soles/m ³	0.07	0.51	0.94	
Average cost per m ³ invoiced	0.07	0.57	1.40	1.39
Average cost per m ³ produced	0.04	0.33	0.77	0.79
Average time of collection, in days	116	96	132	111
Real^(b)				
GPI (annual average, 1990-base)	1.00	14.70	20.87	21.59
Average water tariff (combined) in soles/m ³	0.090	0.046	0.058	0.064
Domestic water tariff (combined) in soles/m ³	0.070	0.035	0.045	
Average cost per m ³ invoiced	0.068	0.039	0.067	0.064
Average cost per m ³ produced	0.043	0.023	0.037	0.037

Notes: (a) The level of micro-measure is calculated from the year 1994 when Sunass started operations. Its equivalent in the previous years is a percentage of the number of connections invoiced with effective measurement from total connections.

(b) Calculus with geometric GPI.

Source: Sedapal (statistical yearbooks and the internet).

However, if we review the water service outside Lima, i.e., EPS other than Sedapal, performance is very poor (Appendix Table A1). Similarly, the financial situation of most of these companies shows very large losses (Figure 5).

Finally, in an international comparison (Table 16), Sedapal indicators lag behind those of similar companies in Santiago, Bogotá and Sao Paulo. For example, Santiago’s water company shows an efficiency ratio of 1.1 (workers per 1,000 connections), while the corresponding ratio for Sedapal is 1.8. Non-invoiced water in Santiago accounts for 22 per cent; for Sedapal it is 45 per cent. Santiago also enjoys 100 per cent coverage while coverage in Lima is 84.1 per cent.

Figure 5
Net profits of ESPs in Peru

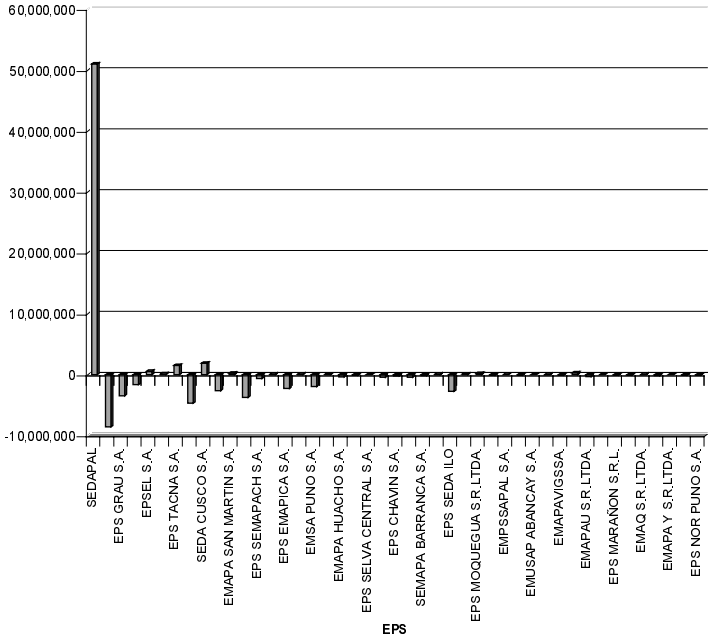


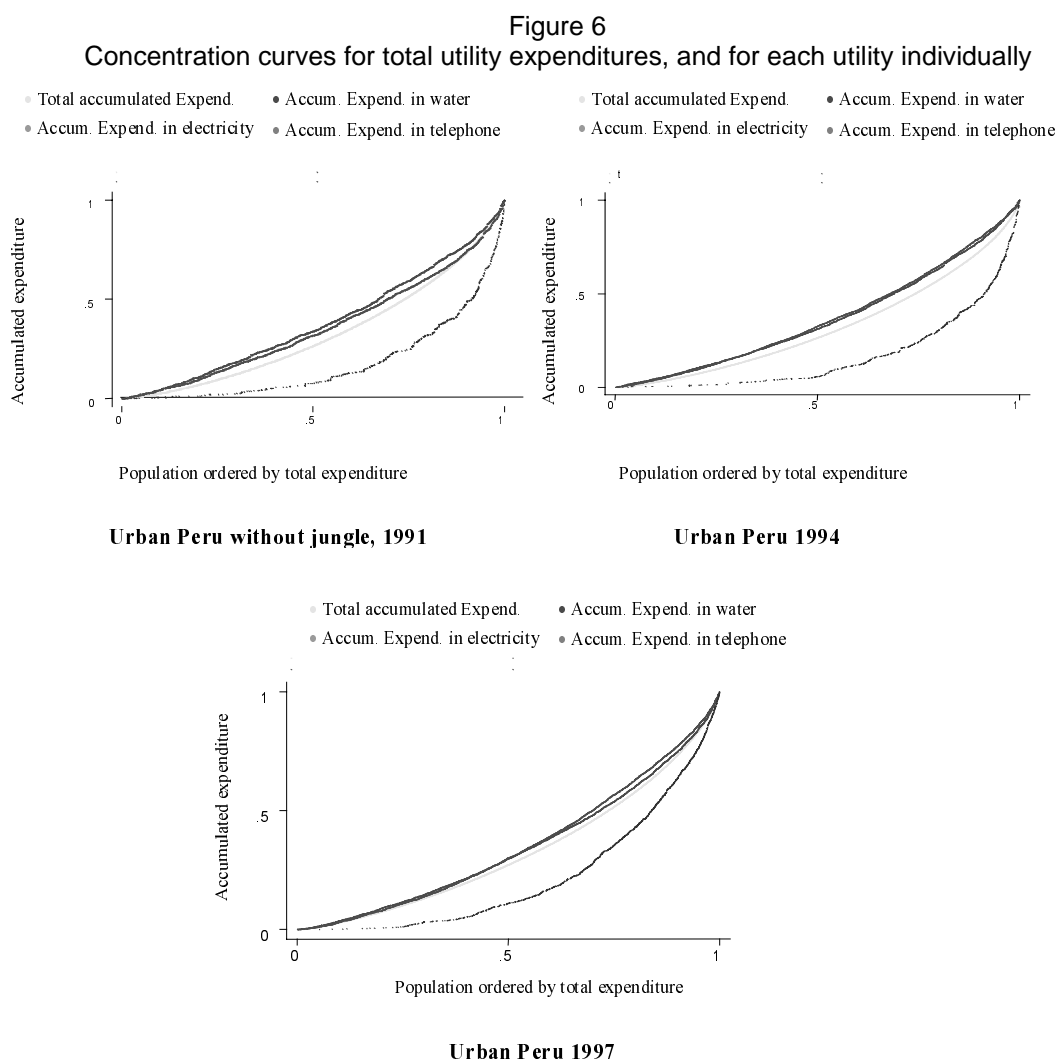
Table 16
Basic indicators of water services in selected countries

Indicators	Peru		Chile	Colombia	Brazil
	1994	1998	Santiago	Bogota	Sao Paulo
Workers per 1,000 connections	2.5	1.8	1.1	1.8	3.1
Average water tariff in US\$/m ³	0.3	0.4	n/a	0.4	0.4
Non-invoiced water, %	41.4	45.0	22.0	n/a	n/a
Level of micro-measurement	3.5	32.3	n/a	n/a	n/a
Coverage, %	74.6	84.1	100.0	94.0	90.0

Note: n/a = not available.
Source: Sedapal; Guillermo and Dianderas, obtained from Bonifaz (2000).

4 Empirical results from household surveys

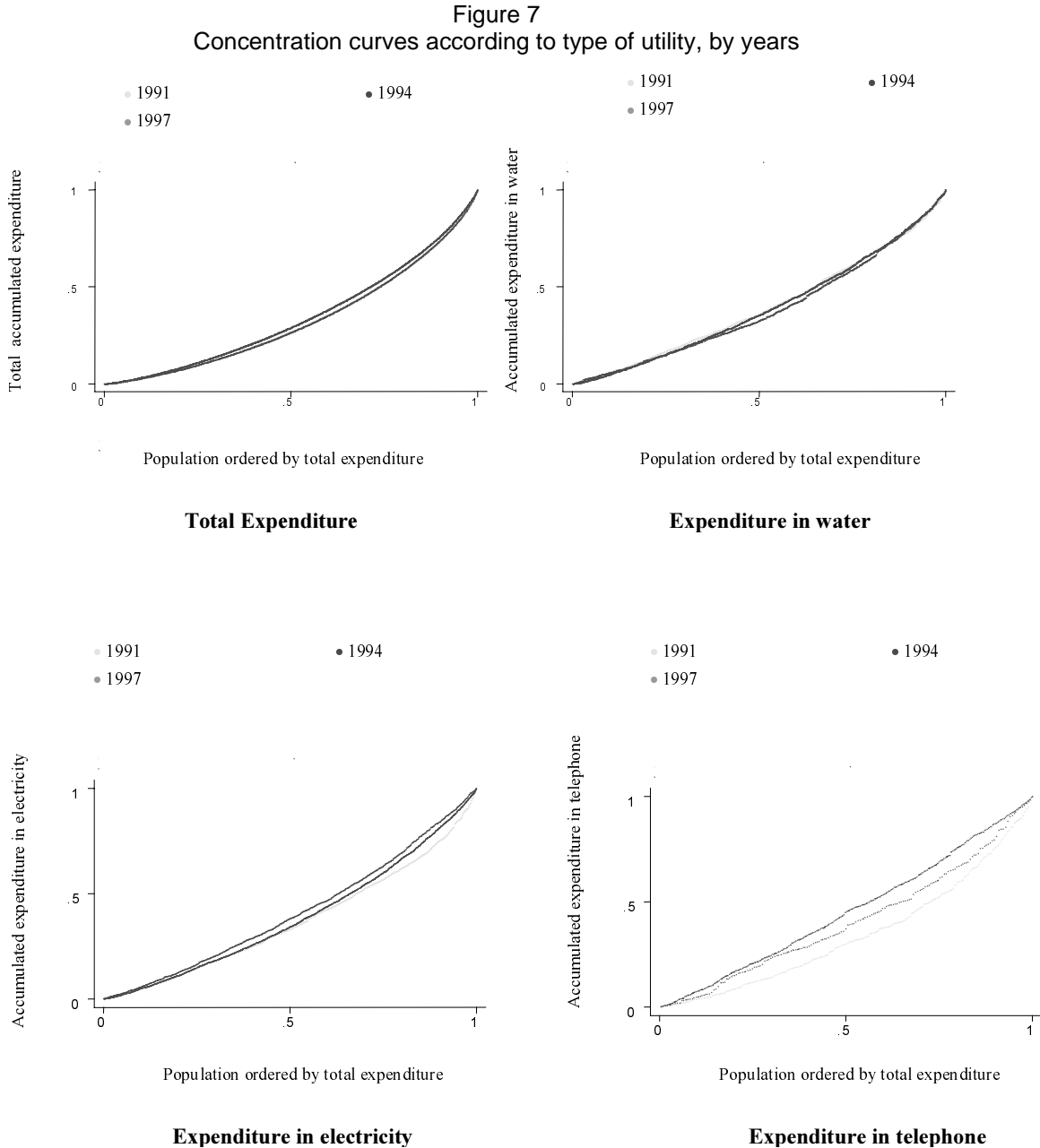
As shown in the previous section, during the last six years Peru's main utilities have undergone important changes that have resulted, in most cases, in significant improvements on the supply side. In this section, we follow the methodology outlined in section 2 to assess the consumption and welfare impacts on the Peruvian urban households. We attempt to verify the effects over different quintiles of the various changes in supply and prices of the three utilities under study.



We follow Younger (1999) to estimate the concentration curves of the expenditure for each service in order to have an initial view of the income-distribution impacts of the changes. Figure 6 presents the expenditure distribution in each public service, with the population classified from the poorest to the richest groups. This allows us to see which services are more regressive (more concave curves) and which more progressive (curves nearer to the imaginary 45° line). It is clearly noticeable that for the three years analysed, initial distribution of telephone expenditures, by families, was the most distorted, and was heavily concentrated in the richer stratum. Despite the initial circumstances, telephone expenditures increased at all income levels. Calculations for the year 1997 show that the telephone curve significantly lost its concavity. Results in

the case of water and electricity, on the other hand, are less evident. It can, nevertheless, be stated that both services tend to be slightly more progressive when compared with the total accumulated expenditure curve.

Figure 7 compares the expenditure in each service during the three years analysed to determine if expenditure distribution has changed significantly between 1991 and 1997. As the figure shows, a significant change has taken place only in the case of telephones, in which the expenditure structure in 1991 was much more regressive than in 1994, and even more so than in 1997.



The Waddams Price and Hancock (1998) methodology requires that the quantity of telephone service consumption be fixed (see the section on methodology). We can take

the value of the expenditure reported for the initial year (1991) or the final year (1997) or calculate the average of both. When the reference consumption has been calculated, the value is assessed by taking the initial and the final price. Given that the quantity of consumption is fixed by definition, changes in consumption are attributed to changes in prices. If there is a fall in prices during the two reference years, the resulting changes in consumption would be positive.

In practice, the estimation is not easy particularly in the case of telephone services because these are made up of three different categories: local, national long distance and international long distance calls. In addition, there exists a fix charge, the so-called ‘basic rent’, which is applied monthly regardless of whether the consumer uses the service or not. Complications are caused by the fact that LSMS’s data on total telephone expenditures for the home are not divided into the different categories. Thus, to decompose the total telephone expenditure, demand equations for each of the three telephone services were estimated. This was possible due to the availability of an additional source of information from the Metropolitan Lima Telephone Service Survey 1996-97 (Cuánto S. A.). The equation has the following form:

$$\ln q = \beta_0 + \beta_1 p_{LOC} + \beta_2 p_{LDN} + \beta_3 p_{LDI} + \beta_4 Y + \beta_5 Y^2 + \beta_6 fam + \beta_7 youn + \beta_8 wom + \gamma X + \mu$$

where q = quantity of pulses (3-minute blocks) consumed in certain type of service

p_{LOC} = local call tariff by pulse

p_{LDN} = national long distance call (LDN) tariff by pulse

p_{LDI} = international long distance call (LDI) tariff by pulse

Y = home income

fam = home members number

$youn$ = percentage of young people (men and women), in the home, between 13 and 24 years of age

wom = percentage of women in the home between 13 and 24 years of age

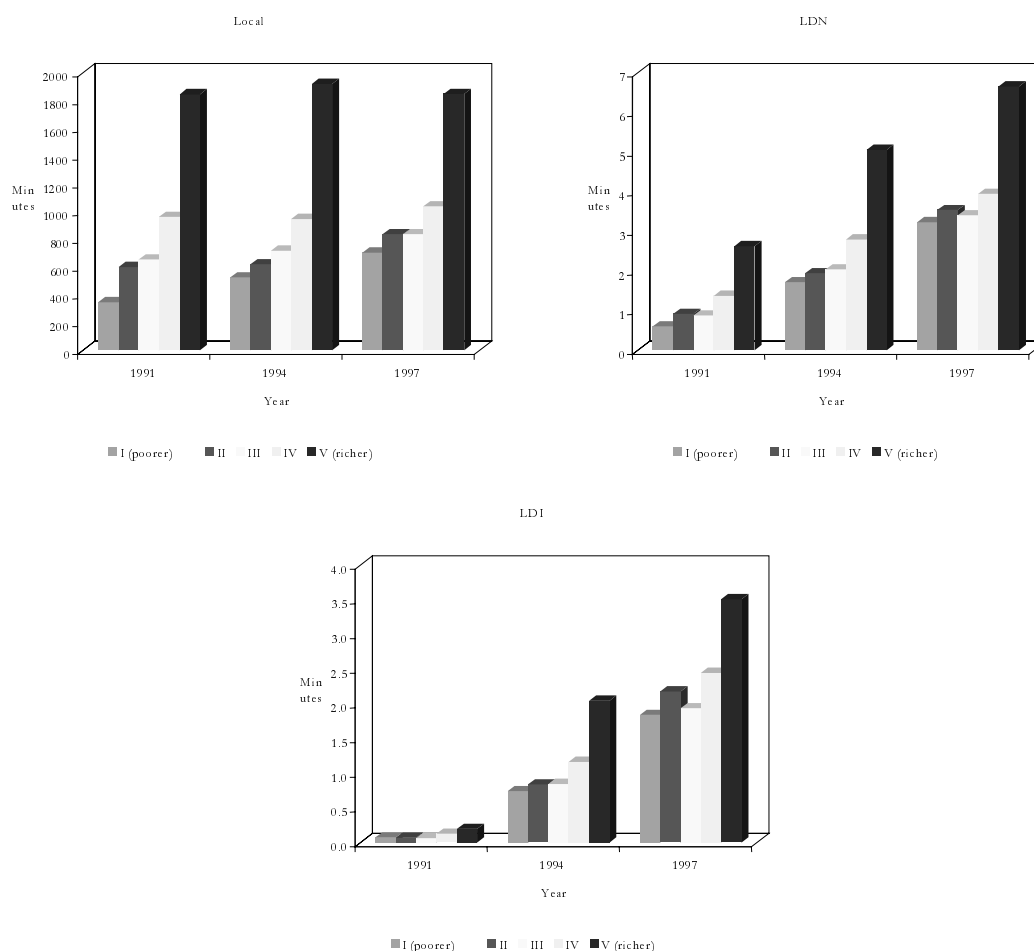
X = other independent variables vector as the level of education of the household head, the telephone penetration index (for local calls demand), the existence of relatives in another province (for national long distance calls demand) and the existence of relatives abroad (for international long distance calls demand).

Using the LSMS household characteristics and the coefficients of the previous regression, it was feasible to calculate an estimated quantity of the consumption for each type of telephone service. These quantities were then multiplied by the respective prices to obtain estimates of the expenditure in telephone services. Thus, it was possible to determine each type of service in the total expenditure. The estimated expenditure structure was applied to the total expenditure provided by the LSMS. After this, it was possible to calculate the monetary gains (or losses) caused by price changes.

Figure 8 shows telephone service consumption in minutes for 1991, 1994 and 1997 for households according to each income quintile. As was expected, the richest quintiles record more minutes in each type of service. An upward trend in consumption can be

noted for long distance calls, both at the national and international levels. This pattern is not apparent in local calls.

Figure 8
Usage of telephone services in urban Peru according to income quintiles,
1991, 1994 and 1997



Note: The LSMS 1991 survey does not include information on communities in the jungle.
Source: LSMS (1991, 1994 and 1997).

Table 17 shows expenditure changes for each type of telephone service based on a fixed level of consumption and prices fluctuations between the two periods (Waddams Price-Hancock methodology). Given the reduction in real tariffs for all three types of calls, the change in expenditure, in a majority of the cases, is positive between 1991-97, and between 1994-97. This is confirmed especially when q^* is assumed to be one of 1997 (see column 1 of Table 17), and it becomes clear that there is an increase in the expenditure for all income quintiles. Furthermore, the positive impact is even stronger in the richer quintiles because they generally consume more units of telephone services, thus making the impact of the increase in the basic rent relatively smaller.

Table 17
Changes in telephone expenditures according to expenditure quintiles, 1991, 1994 and 1997
(in Peruvian soles at June 1994 prices)

	ENNIVs 1991-97		ENNIVs 1994-97		Panel 1994-97		
	Q ₉₇ P ₉₁ -P ₉₇	Q ₉₁ P ₉₁ -P ₉₇	Q ₉₇ P ₉₄ -P ₉₇	Q ₉₄ P ₉₄ -P ₉₇	Q ₉₇ P ₉₄ -P ₉₇	Q ₉₄ P ₉₁ -P ₉₇	Q _{PROM} P ₉₁ -P ₉₇
Quintile I (poorer)							
Δ spending in fixed rent	-23.05	-24.71	-17.54	-18.53	-17.08	-18.20	-18.57
Δ spending in local calls	20.80	6.52	3.54	2.59	3.54	2.82	3.09
Δ spending in LDN calls	0.21	-0.04	0.53	0.28	0.50	0.21	0.41
Δ spending in LDI calls	7.84	0.24	2.47	1.02	2.41	0.74	1.82
Total	5.80	-17.99	-11.01	-14.63	-10.64	-14.43	-13.25
Quintile II							
Δ spending in fixed rent	-23.12	-24.96	-17.55	-18.46	-17.85	-18.04	-18.68
Δ spending in local calls	25.11	9.58	4.31	2.90	3.82	3.31	3.12
Δ spending in LDN calls	0.23	-0.05	0.58	0.31	0.50	0.34	0.31
Δ spending in LDI calls	9.37	0.28	2.95	1.13	2.79	1.19	1.42
Total	11.60	-15.15	-9.71	-14.11	-10.74	-13.20	-13.84
Quintile III							
Δ spending in fixed rent	-22.34	-25.52	-16.88	-18.68	-16.67	-18.89	-17.80
Δ spending in local calls	24.70	11.12	4.37	3.45	4.22	3.97	3.70
Δ spending in LDN calls	0.22	-0.04	0.56	0.33	0.47	0.31	0.41
Δ spending in LDI calls	8.22	0.28	2.58	1.14	2.37	0.95	1.93
Total	10.80	-14.16	-9.38	-13.76	-9.61	-13.65	-11.77
Quintile IV							
Δ spending in fixed rent	-22.07	-25.12	-16.68	-18.54	-16.75	-18.33	-18.47
Δ spending in local calls	30.73	16.72	5.35	4.50	5.82	3.63	4.18
Δ spending in LDN calls	0.26	-0.06	0.64	0.45	0.65	0.33	0.40
Δ spending in LDI calls	10.43	0.50	3.27	1.56	3.47	1.13	1.95
Total	19.35	-7.96	-7.41	-12.03	-6.82	-13.24	-11.93
Quintile V							
Δ spending in fixed rent	-21.33	-24.45	-16.04	-17.92	-18.41	-17.57	-17.68
Δ spending in local calls	53.20	29.49	9.79	8.91	7.70	6.68	8.08
Δ spending in LDN calls	0.44	-0.11	1.06	0.80	0.81	0.59	0.86
Δ spending in LDI calls	14.50	0.83	4.56	2.71	3.93	2.03	3.67
Total	46.81	5.76	-0.62	-5.50	-5.97	-8.27	-5.08
Total							
Δ spending in fixed rent	-22.38	-24.95	-16.94	-18.42	-17.35	-18.21	-18.24
Δ spending in local calls	30.80	14.74	5.45	4.55	5.01	4.07	4.41
Δ spending in LDN calls	0.27	-0.06	0.67	0.44	0.59	0.36	0.48
Δ spending in LDI calls	10.05	0.43	3.16	1.53	2.99	1.20	2.15
Total	18.74	-9.84	-7.66	-11.89	-8.76	-12.57	-11.20

Note: The LSMS 1991 survey does not include information on communities in the jungle.

Source: LSMS (1991, 1994, and 1997).

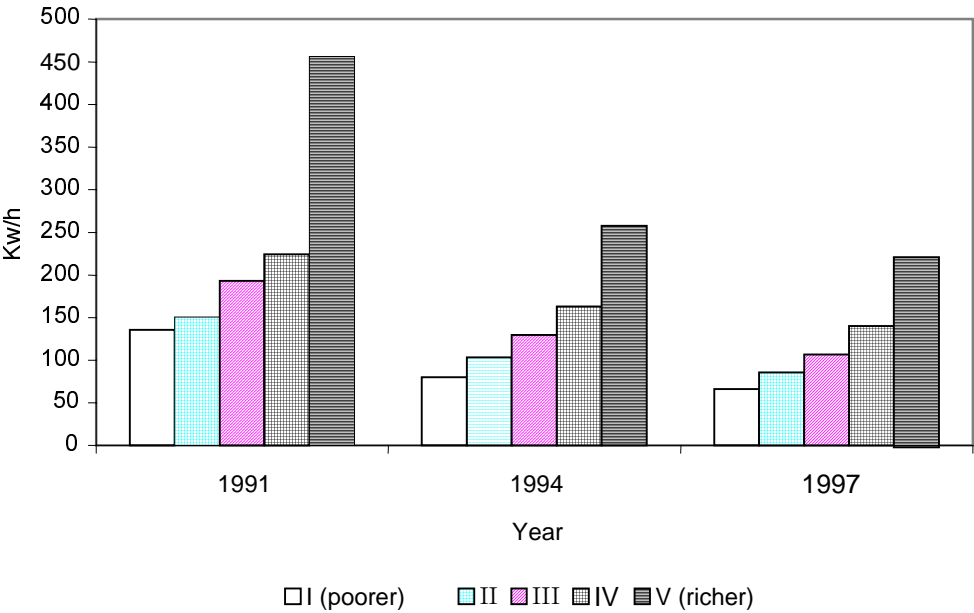
If panel observations that correspond only to 1994-97 are used in the calculations, the impact of new access is overlooked, because we examine households which have had telephones in both periods. Thus, according to panel calculations, the change in total expenditure of telephone services is negative in almost all income quintiles, because of the increase in fixed rent, offsets the effect of the unit tariff reduction. The total effect is positive only in cases where a high rate of telephone service usage exists. This is typically in the richest quintile.

On the other hand, it is important to mention that the effect of providing better access to telephone services, especially for the lower quintiles, is not taken into account in Table 17, given that access improved primarily between 1997 and 1999. Therefore, the results underestimate the welfare gains by excluding households that acquired access during this period. Torero, Schroth and Pascó-Font (2000) show that if this effect is controlled, the lower quintiles also have a positive gain in consumer surplus, reflecting improved access from around 5,000 households with telephones in 1993 to 150,000 by 1999.

Electricity contrasts the trend of telephone services, as electricity consumption has gone down in urban Peru. Figure 9 summarizes the development in kilowatts per hour for each income quintile for 1991, 1994 and 1997. Apart from the expected positive relation between total home income (proxied by total expenditure) and electricity consumption, a drastic drop is observed for all quintiles.

Table 18 also shows that, fixing the levels of consumption of any year, the increase in the price for electric services has caused a decrease in the expenditure on electricity between 1991-97 and 1994-97.

Figure 9
Electricity consumption in urban Peru by expenditure quintiles, 1991, 1994 and 1997
(in kW/h)



Note: The LSMS 1991 survey does not include information on communities in the jungle.
Source: LSMS (1991, 1994, and 1997).

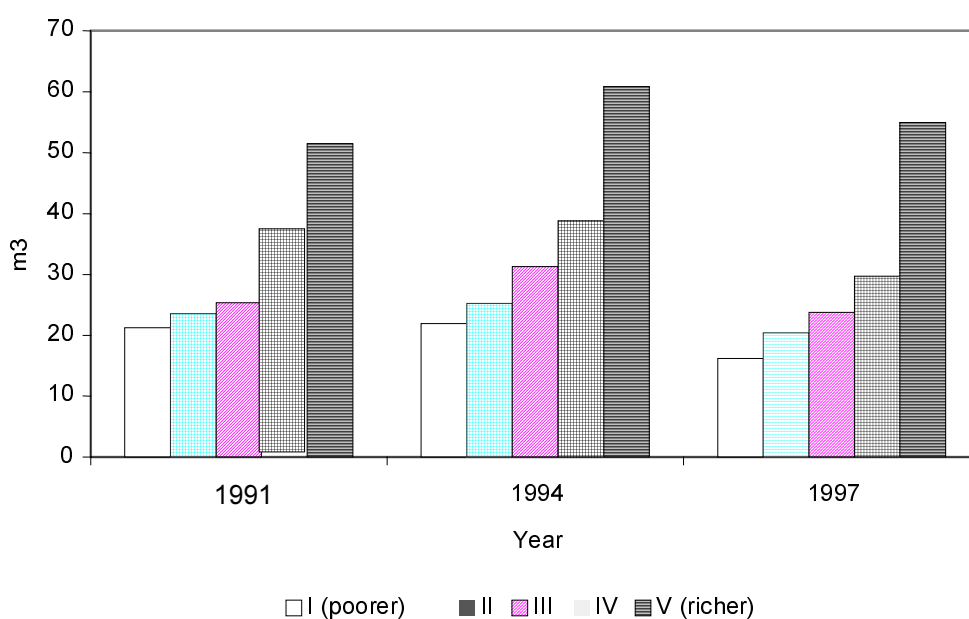
Table 18
Changes in electricity costs by expenditure quintiles for urban settlements,
1991, 1994 and 1997 (in Peruvian soles at June 1994 prices)

	ENNIVs 1991-97		ENNIVs 1994-97		Panel 1994-97		
	Q ₉₇ P ₉₁ -P ₉₇	Q ₉₁ P ₉₁ -P ₉₇	Q ₉₇ P ₉₄ -P ₉₇	Q ₉₄ P ₉₄ -P ₉₇	Q ₉₇ P ₉₄ -P ₉₇	Q ₉₄ P ₉₁ -P ₉₇	Q _{PROM} P ₉₁ -P ₉₇
Quintile I (poorer)	-12.07	-25.28	-6.56	-4.74	-3.92	-4.64	-4.63
Quintile II	-15.77	-28.98	-8.12	-6.88	-6.58	-6.01	-6.84
Quintile III	-20.32	-37.07	-9.18	-8.96	-8.24	-8.28	-8.47
Quintile IV	-26.72	-42.40	-9.40	-11.54	-11.20	-10.98	-11.66
Quintile V (richer)	-41.87	-84.42	-10.07	-17.94	-12.48	-15.54	-12.89
Total	-23.64	-43.23	-8.58	-10.17	-8.56	-9.11	-8.89

Note: The LSMS 1991 survey does not include information on communities in the jungle.

Source: LSMS (1991, 1994, and 1997).

Figure 10
Potable water consumption in urban settlements by expenditure quintile, 1991, 1994 and 1997



Note: The LSMS 1991 survey does not include information on communities in the jungle.

Source: LSMS (1991, 1994, and 1997).

Similar to the telecommunications sector which has been corrected for new subscribers, the greater access of the disadvantaged to electric services changes the total impact to positive. This implies that the welfare increase of new beneficiaries is greater than the welfare decline for old subscribers caused by increases in tariffs. For the rest of the quintiles, the impact remains negative.

Finally, with respect to potable water services, Figure 10 shows consumption for 1991, 1994 and 1997 according to income quintiles. As expected, the richest quintiles consume the largest amounts of water, and there is no clear time trend. Table 19 shows the changes in water expenditure based on a fixed consumption level and changes in

prices between the two periods. Given the increase in the price of water throughout the period, all changes in expenditure are negative; in other words, when the consumption level of any period is fixed, expenditure is smaller than in 1997.

In addition, as in the case of telephones, we adjust the panel sample 1994-97 for greater water access. As expected, the impact of the adjustment is relatively low because only a few urban homes were without water in 1994, and these had obtained the service by 1997. Therefore, the negative welfare effect of the increase in prices during the period predominates.

The last methodology uses the Heckman two-step procedure to measure the impact of changes in utility prices on the welfare of households (see section 2 for details), controlling for access. But instead of expenditure equations, the more simple specification was chosen to build a demand equation system. From this estimation, the price elasticities of the three utilities were found, allowing us to estimate the consumer surplus of the households for the three years LSMS surveys were available.

Table 19
Changes in portable water costs by expenditure quintiles for urban settlements, 1991, 1994 and 1997 (in Peruvian soles at June 1994 prices)

	ENNIVs 1991-97		ENNIVs 1994-97		Panel 1994-97		
	$\frac{Q_{97}}{P_{91}-P_{97}}$	$\frac{Q_{91}}{P_{91}-P_{97}}$	$\frac{Q_{97}}{P_{94}-P_{97}}$	$\frac{Q_{94}}{P_{94}-P_{97}}$	$\frac{Q_{97}}{P_{94}-P_{97}}$	$\frac{Q_{94}}{P_{91}-P_{97}}$	$\frac{Q_{PROM}}{P_{91}-P_{97}}$
Quintile I (poorer)	-1.81	-3.01	-1.78	-2.92	-1.87	-3.70	-2.65
Quintile II	-2.36	-3.81	-2.68	-3.58	-3.00	-3.19	-3.94
Quintile III	-2.93	-3.89	-3.08	-4.79	-2.96	-4.22	-3.77
Quintile IV	-3.39	-5.68	-4.02	-5.95	-3.67	-5.03	-4.30
Quintile V (richer)	-5.81	-6.11	-6.92	-9.11	-5.48	-8.58	-6.41
Total	-3.29	-4.47	-3.74	-5.35	-3.42	-4.95	-4.21

Note: The LSMS 1991 survey does not include information on communities in the jungle.

Source: LSMS (1991, 1994 and 1997).

Table 20
Price elasticity of utilities in urban areas, 1991, 1994 and 1997

	Telephone			Water	Electricity
	Local	LDN	LDI		
1991	-0.931	-2.148 ***	-5.009 ***	-0.605 ***	-1.001 ***
1994	-1.357 **	-2.779 ***	-3.090 ***	-0.877 ***	-0.961 ***
1997	-1.129 **	-3.300 ***	-2.853 ***	-0.604	-1.033 ***

Notes: Level of significance: ** 95%; *** 99%:

The LSMS 1991 survey does not include information on communities in the jungle.

Source: LSMS (1991, 1994 and 1997).

Table 20 shows the price elasticities for the services under study.¹¹ Specifically in the case of telephone, the elasticity is bigger to what previous studies have shown for Peru, particularly on the part of local calls (see Pascó-Font *et al.* 1999; Torero *et al.* 2000). The price elasticity in these two studies for local calls fluctuates between -0.28 and -0.47 but this is based mainly on Lima and other Peruvian cities with the highest penetration rates.

In our specific case, the elasticity is estimated for the domain in the survey that covers all urban Peru. The problem with this level of aggregation is that it includes an enormous variance in terms of penetration,¹² which could explain the higher elasticities.¹³

With respect to water and electricity, water services are elastic and electricity services have elasticities close to unity for the three periods under study.

As mentioned in section 2, there are two main advantages to this methodology. First, it allows us to correct for access to any of the services because of infrastructure constraints and, second, it uses a system of equations that allows us to have a better estimate of the consumer surplus for each of the services in question.

Table 21 shows the consumer surplus and relevant changes in the three utilities (water, electricity and telephony) for the three years for which LSMS surveys were available. Consistent with the other two methodologies, telephone service is the one utility with a major gain in consumer surplus. Clearly, greater access and reduction in the rates for the three types of telephone services account for this gain in consumer surplus. On the other hand, the rate of decrease in local call tariffs declined significantly by 1997, while the fixed charge continued to escalate (see section 3.1). This permanent increase in fixed tariffs could account for the reduction in the change of surplus between 1994 and 1997.¹⁴

Similarly, as shown by the other two methodologies, no significant growth in the consumer surplus can be observed, despite the significant increase in quality and access of water services. Consumer surplus has, on average, remained practically the same as in the pre-reform period. This could be a reflection of the fact that the major reforms affected Lima only. Most ESPs in other parts of Peru are in extremely critical circumstances.

¹¹ Details on the first stage estimation can be seen in Appendix Table A2.

¹² The lowest penetration is 0.4 lines per hundred habitants in Huancavelica and in Lima, the province with the highest penetration, it is 13.5 per hundred habitants.

¹³ Similar studies like the one done by Martins-Filho and Mayo (1993) found too high elasticities, between 1.05 and -1.55, and there are other several studies that found elasticities between -0.446 and -1.734 (see Pasco Font *et al.* 1999 for a review of other studies).

¹⁴ It is also important to mention that in 1998 there was also an increase in the real price of local calls, a factor which further reduces household consumer surplus (see Torero *et al.* 2000).

Table 21
Consumer surplus and consumer surplus changes related to utilities in urban areas,
1991, 1994 and 1997 (in Peruvian soles at June 1994 prices)

	Consumer surplus			Surplus change		
	1991	1994	1997	1991-94	1994-97	1991-97
Telephone						
Local	199.53	157.87	242.37	-41.66	84.50	42.84
LDN	0.36	0.64	0.98	0.28	0.33	0.62
LDI	0.01	0.24	0.63	0.23	0.39	0.62
Water	38.21	32.08	37.99	-6.12	5.91	-0.22
Electricity	163.77	125.21	103.33	-38.56	-21.88	-60.44

Note: The 1991 LSMS survey does not include information on communities in the jungle.

Source: LSMS (1991, 1994 and 1997).

Finally, electricity also conforms to earlier findings, but this is still surprising because we expected to find greater improvement as a result of the reforms. There are two possible explanations. First, given the overdue need to increase tariffs in the pre-privatization period, a re-adjustment in rates was inevitable in order to raise electricity generation to acceptable levels. Second, the process of reforms is incomplete and therefore the impact on the whole country cannot be seen yet.

Conclusions

The last six years have been extremely important in restructuring Peru's utilities. However, the depth of the reforms, particularly the extent of privatization, has been uneven across sectors. Telephone services have been completely privatized while water service companies are still state-owned (particularly Sedapal, a major company). Electricity is in the middle of this continuum as it has undergone an incomplete privatization process, which left Mantaro, the major hydroelectric plant, as well as the distribution enterprises in the southern part of Peru in state ownership.

Despite of this reform mix, results in terms of improvement on the supply side are positive and very significant. Telephone density per 100 habitants has improved from 2.9 to 7.8, water coverage from 75 per cent to 84 per cent, and electrification coefficients have grown on average by 27 per cent. But there are still major problems which could explain why welfare impacts for electricity and water are still insignificant, or even negative.

In the case of water, despite its efforts to improve Sedapal's services, the government did not give sufficient importance to the other EPS serving the rest of the country. Furthermore, Sedapal still lags behind similar enterprises in other Latin American countries. Although 88 per cent of urban households have access to water, it is of low quality and available for limited periods of time. Furthermore, only 45 per cent of the potable water in the urban sectors complies with bacteriological quality standard, and in small cities this percentage drops to 21 per cent (Fernández-Baca 1998). Less than 8 per cent of households have permanent access to water, and 45 per cent of water produced

is not invoiced. Consequently, households incur additional costs in efforts to improve quality and to ensure access.

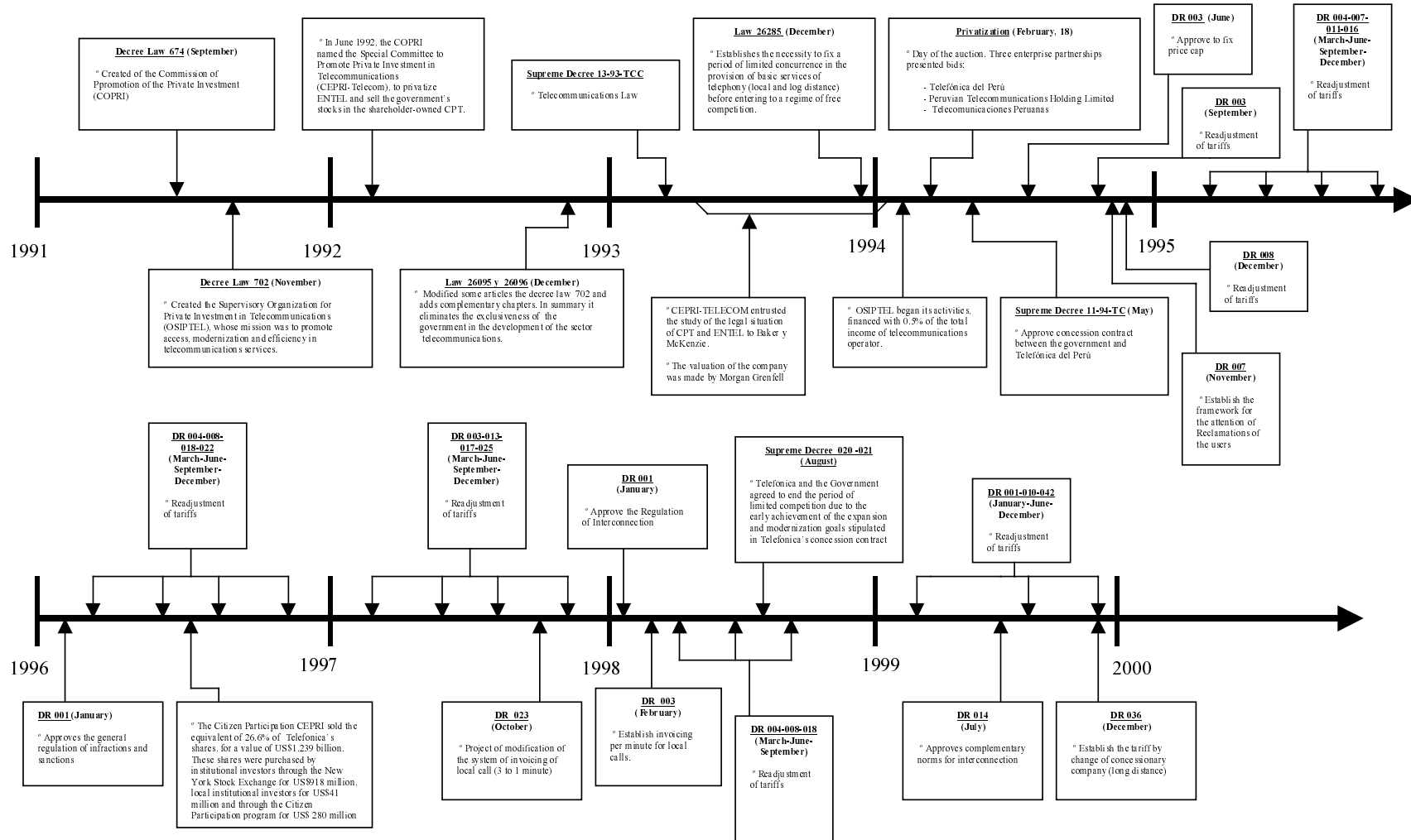
It is difficult to evaluate the impact of the reforms on electricity, because the process in this sector is still incomplete. Important improvements have been made, but these are yet to reach major urban areas of Peru, which explains why consumers, on average, are not experiencing an increase in their welfare.

On the other hand, welfare gains are reduced because of the jump in tariffs necessary for the viability of the sector. By 1993, electric tariffs on average covered just 75 per cent of the costs of electricity, and electric enterprises were consistently losing money. Since the creation of the Commission of Energy Tariffs (CTE), the average residential tariff grew from 6 cents per KW hour to 12 cents by the end of 1996, then dropping to a little over 10 cents between 1997 and 1998. This tariff increase, especially in the period covered by the LSMS utilized here, also explains why we see a consistent reduction in household consumer surplus with regard to electricity.

Finally, telephony is the sector with major improvements since privatization. Both in terms of supply and demand, results show a positive balance. Despite this significant improvement and the increase in progressiveness, it is important to mention that there has been a significant reduction in household consumer surplus since 1997 (Torero *et al.* 2000). This is mainly a reflection of the increase in the price of local calls, and the permanent hike in the fixed rent, plus the sluggish pace of reducing tariffs for long distance calls. But the presence of new firms entering this sector is expected to bring these rates down to international standards. In this respect, the role of the telecommunications regulatory agency (Osiptel) is vital for creating the necessary conditions that allow new firms to enter the market.

In summary, we believe that the utility services in Peru still need considerable improvement, particularly in electricity and water, where major reforms are yet to be concluded or perhaps even to be introduced. Finally, in all these services, we consider it necessary that the providers of the services develop more comprehensive consumption plans to accomplish greater benefits in terms of welfare and revenues for both consumers and producers alike. An optional consumer plan could result from the introduction of new rates and charge options that are more appropriate for each consumer type (see Pascó-Font *et al.* 1999 for the telecom case). The main advantage for this type of pricing scheme is that it takes into account the existing heterogeneity at the family level in different cities.

Appendix Figure A1
Major legislation changes in telecommunications



Appendix Figure A2
Major legislation changes in electricity

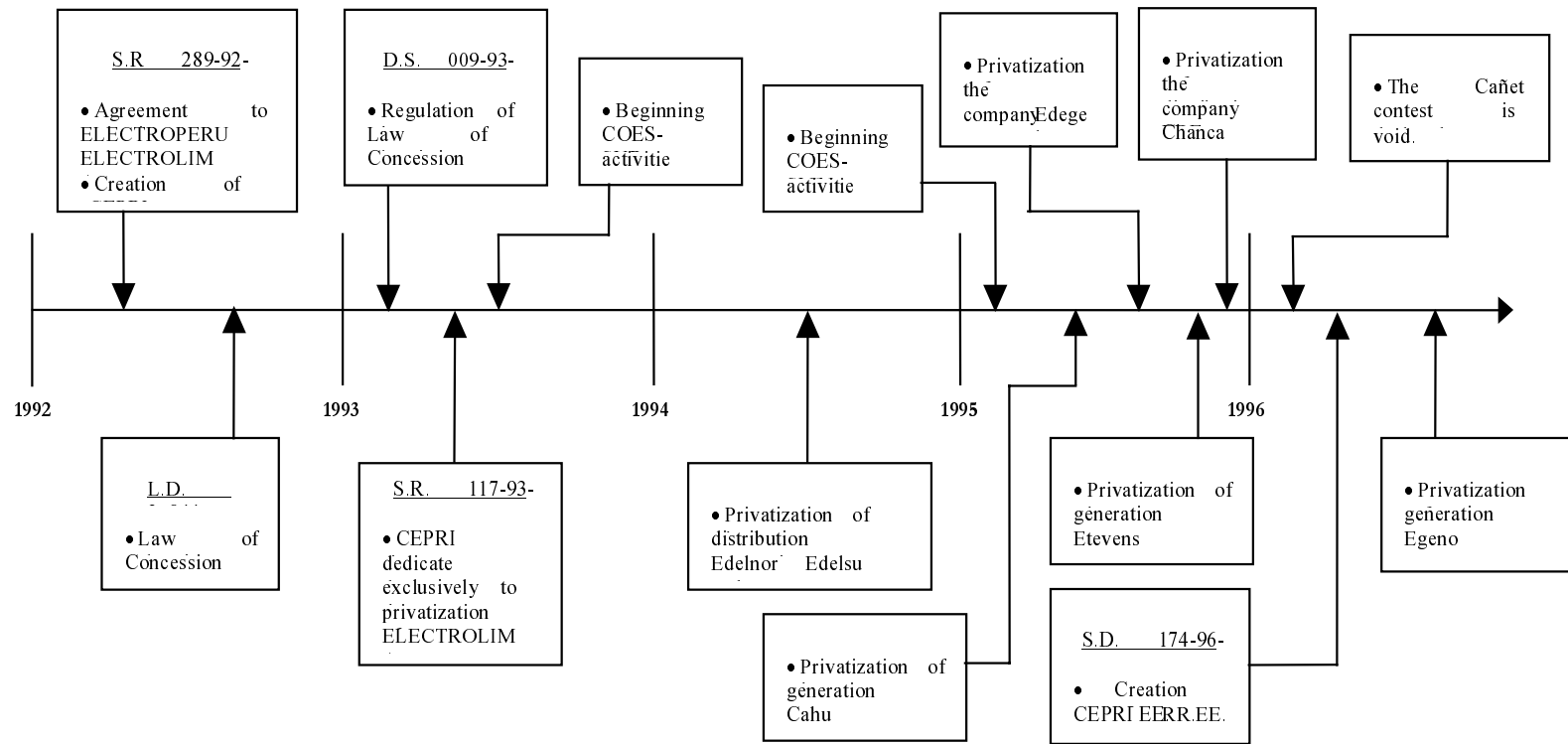
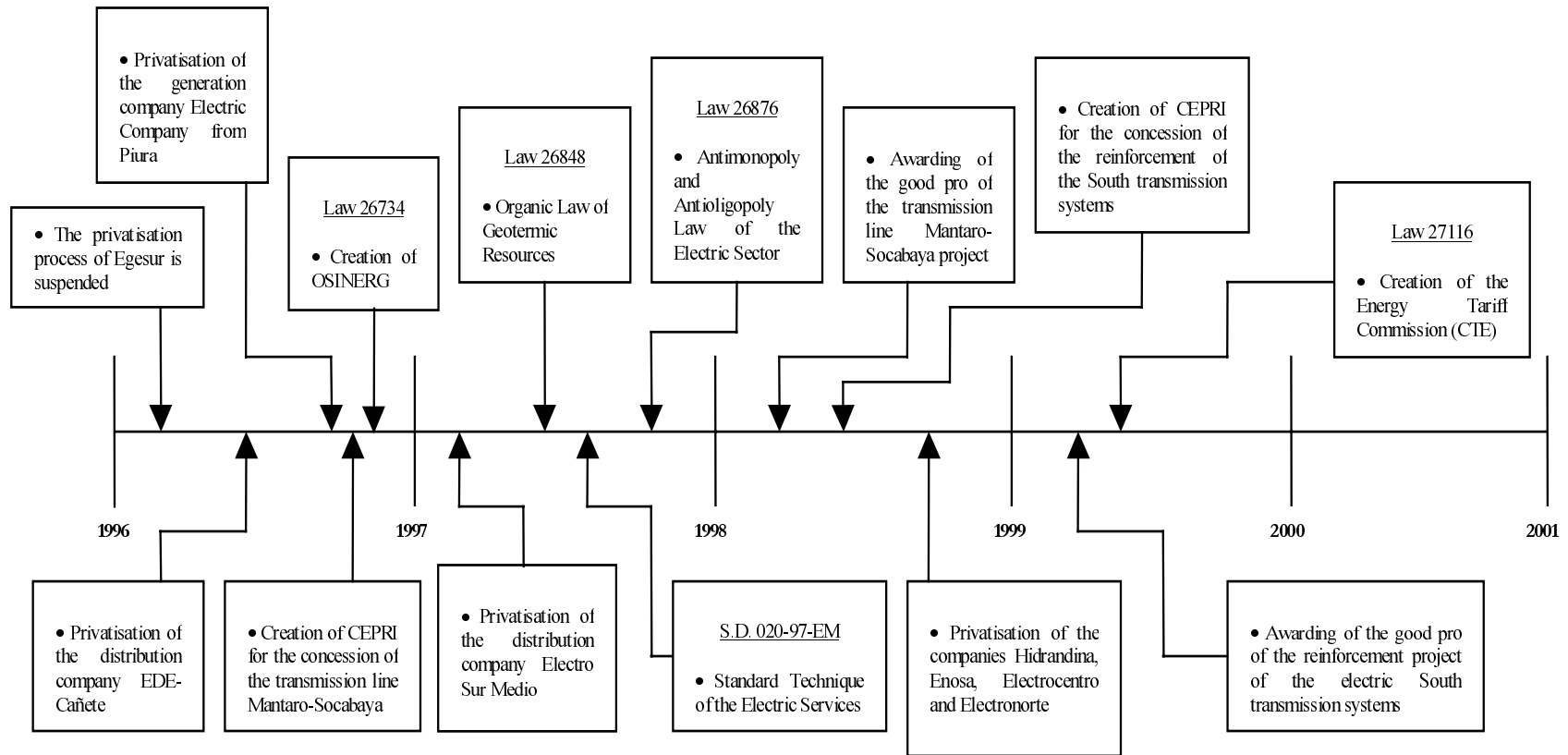
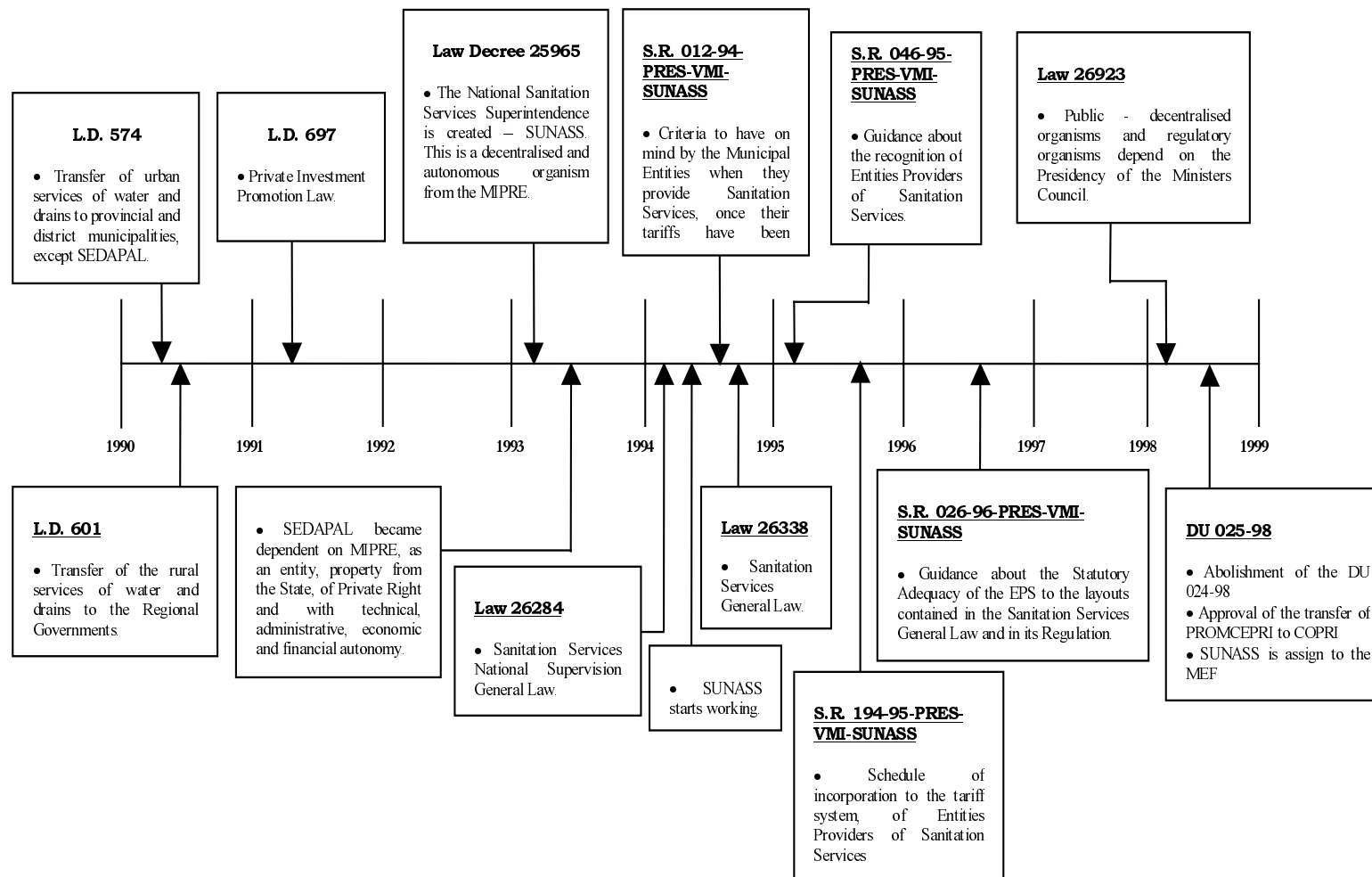


Figure A2 (continues)

Figure A2 (continued)



Appendix Figure A3
Major legislation changes in water



Appendix Table A1
Main indicators of the water and sewerage sector

	Physical						Operative				Financial	
	Water coverage		Sewerage coverage		No. of connections		Produced volume (1000 m ³)		Level of micro measurement *		Real average water tariff (combined) in soles/m ³	
	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998
EPS												
SEDAPAL	98.2%	95.8%	n/a	89.4%	93.4%	86.5%	386	379	7.2%	27.9%	0.056	0.060
SEDAPAR S. A.	n/a	n/a	n/a	83.6%	87.2%	95.4%	221	185	73.3%	74.5%	0.054	0.062
EPS GRAU S. A.	n/a	n/a	n/a	n/a	68.1%	73.9%	411	298	17.5%	17.6%	0.080	0.068
SEDALIB S. A.	n/a	n/a	n/a	n/a	84.0%	84.3%	260	280	41.1%	29.2%	0.056	0.064
EPSEL S. A.	n/a	75.1%	61.4%	67.3%	92.4%	88.9%	218	209	16.9%	18.3%	0.070	0.057
SEDACHIMBOTE S. A.	n/a	n/a	n/a	82.6%	89.4%	76.8%	324	359	6.3%	5.3%	0.049	0.052
EPS TACNA S. A.	n/a	n/a	n/a	n/a	83.7%	82.2%	227	218	34.3%	28.7%	0.054	0.054
EPS LORETO S. A.	n/a	n/a	n/a	n/a	73.8%	69.1%	370	306	6.3%	9.1%	0.055	0.051
SEDACUSCO S. A.	n/a	n/a	n/a	46.4%	94.8%	95.3%	211	187	75.5%	87.7%	0.047	0.067
EMFAPA TUMBES S. A.	n/a	91.1%	n/a	41.7%	76.5%	38.9%	295	541	4.1%	2.1%	0.049	0.071
EMAPA SAN MARTIN S. A.	77.0%	79.5%	60.0%	58.2%	77.2%	75.9%	379	309	34.9%	35.2%	0.054	0.058
SEDAJULIACA S. A.	65.5%	n/a	59.1%	n/a	89.1%	80.1%	114	112	15.4%	25.1%	0.053	0.051
EPS SEMAPACH S. A.	107.2%	n/a	39.8%	41.3%	63.4%	56.6%	364	540	8.9%	14.0%	0.049	0.069
EPS AYACUCHO S. A.	n/a	n/a	n/a	n/a	92.4%	97.2%	366	382	34.4%	33.2%	0.032	0.048
EMAPICA S. A.	n/a	n/a	n/a	n/a	97.4%	93.2%	345	309	0.9%	0.0%	0.028	0.041
SEDACAJ S.A	n/a	n/a	n/a	n/a	83.1%	76.6%	270	249	65.5%	62.6%	0.049	0.055
EMSA PUNO S. A.	n/a	95.0%	n/a	51.3%	87.2%	86.2%	214	190	34.3%	37.1%	0.052	0.065
SEDA HUÁNUCO S. A.	n/a	n/a	n/a	26.0%	84.9%	84.3%	503	460	43.1%	49.4%	0.042	0.046
EMAPA HUACHO S. A.	n/a	n/a	n/a	n/a	81.3%	83.1%	299	273	0.0%	16.8%	0.044	0.048
EMAPA CAÑETE S. A.	n/a	n/a	n/a	n/a	81.3%	80.1%	413	331	50.8%	47.0%	0.039	0.035
EPS SELVA CENTRAL S. A.	n/a	n/a	n/a	n/a	80.3%	88.1%	691	443	23.2%	11.8%	0.041	0.030
EMAPACOP S. A.	n/a	n/a	n/a	n/a	75.1%	70.3%	304	249	0.0%	0.0%	0.044	0.034
EPS CHAVIN S. A.	n/a	n/a	n/a	n/a	95.0%	94.1%	477	592	20.0%	35.0%	0.028	0.030

Table A1 con't.

Table A1 (continued)

EPS	Physical						Operative				Financial	
	Water coverage		Sewerage coverage		No. of connections		Produced volume (1000 m ³)		Level of micro measurement *		Real average water tariff (combined) in soles/m ³	
	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998
EMAPISCO S. A.	n/a	n/a	n/a	n/a	92.4%	88.5%	203	178	1.0%	0.0%	0.029	0.048
SEMAPA BARRANCA S. A.	n/a	n/a	n/a	n/a	72.2%	81.1%	660	355	0.0%	9.5%	0.023	n/a
EMAPA HUARAL S. A.	n/a	64.8%	52.0%	60.3%	82.4%	65.3%	470	478	n/a	10.4%	n/a	0.035
EPS SEDA ILO S. R. Ltda.	n/a	85.5%	61.8%	67.3%	87.6%	84.6%	288	352	69.2%	86.7%	0.062	0.094
EPS MUNICIPAL MANTARO S. A.	n/a	n/a	n/a	n/a	n/a	87.4%	n/a	412	n/a	18.3%	n/a	0.032
EPS MOQUEGUA S. R. Ltda.	n/a	n/a	n/a	n/a	87.8%	86.3%	375	303	37.1%	35.3%	0.039	0.037
EPS MOYOBAMBA S. R. Ltda.	n/a	91.7%	n/a	68.3%	86.9%	82.9%	237	280	35.7%	84.3%	0.047	0.049
EMPSSAPAL S. A.	n/a	n/a	n/a	n/a	96.3%	93.1%	245	212	64.8%	68.6%	n/a	0.028
EMAPA PASCO S. A.	n/a	n/a	n/a	n/a	51.0%	50.5%	n/a	301	0.0%	0.0%	0.018	0.024
EMUSAP ABANCAY S. A.	n/a	54.2%	42.2%	45.2%	95.3%	92.4%	411	344	38.3%	55.0%	0.049	0.045
EPS SIERRA CENTRAL S. A.	n/a	n/a	n/a	n/a	70.4%	78.2%	579	371	4.8%	9.6%	n/a	0.048
EMAPAVIGSSA	n/a	97.9%	n/a	80.7%	66.4%	72.3%	225	227	1.8%	0.5%	0.048	0.044
EMAPAT S. R. Ltda.	n/a	92.3%	31.6%	33.8%	82.0%	84.0%	340	251	75.1%	86.8%	0.110	0.097
EMAPAU S. R. Ltda.	n/a	n/a	n/a	n/a	89.0%	93.4%	416	229	46.4%	58.1%	0.032	0.044
SEMAPAHVCA	2.3%	n/a	0.0%	n/a	91.4%	90.6%	352	293	28.7%	34.5%	0.023	0.023
EPS MARAÑON S. R. L.	n/a	n/a	n/a	n/a	94.1%	88.4%	706	650	8.8%	5.9%	0.030	0.030
EMUSAP S. R. L.	n/a	96.3%	n/a	70.1%	100.0%	93.6%	447	329	73.5%	67.5%	0.048	0.065
EMAQ S. R. Ltda.	n/a	n/a	n/a	n/a	90.3%	93.6%	253	228	20.3%	30.8%	0.020	0.023
EMAPAB S. R. Ltda.	n/a	n/a	n/a	n/a	n/a	87.0%	n/a	279	n/a	0.0%	n/a	0.029
EMAPA-Y. S. R. Ltda.	n/a	85.5%	n/a	44.5%	94.0%	65.4%	113	168	n/a	0.0%	0.019	0.026
EPS EMSAP CHANKA S. A.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.037
EPS NOR PUNO S. A.	n/a	n/a	n/a	n/a	91.2%	91.5%	n/a	136	50.2%	47.1%	0.033	0.029

Note: * The level of micro measurement is calculated from 1994, year in which Sunass started operations. The equivalent for previous years would be a percentage of the number of connections invoiced with effective measurement from the total connections.

Source: SEDAPAL; Internet and statistical yearbooks.

Appendix Table A2
Estimate of access demand for services—Heckman estimation procedure
Dependable variable: network access
(standard errors in parentheses)

Variables	Telephone			Electricity			Water		
	1991	1994	1997	1991	1994	1997	1991	1994	1997
Installation price	1.0435 *** (0.3182)	0.5270 * (0.3129)	-0.2240 (0.2784)						
Coverage in the district	6.2400 ** (2.1510)	5.6539 *** (1.9780)	2.7510 *** (0.5403)	0.3911 ** (0.1601)	0.9236 *** (0.1273)	1.3528 *** (0.1103)	3.1545 *** (0.4514)	3.4862 *** (0.3612)	3.0698 *** (0.3048)
Age of the household head	0.0571 *** (0.0167)	0.0539 *** (0.0152)	0.0369 *** (0.0117)	0.0340 ** (0.0138)	0.0134 (0.0127)	0.0184 * (0.0111)	0.0500 *** (0.0142)	0.0035 (0.0140)	0.0290 *** (0.0087)
Age of the household head ^2	-0.0002 (0.0002)	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)	0.0001 (0.0001)	-0.0001 (0.0001)	-0.0002 * (0.0001)	0.0003 * (0.0002)	-0.0001 ** (0.0001)
Tongue of household head is a native language (=1)	-0.6943 *** (0.1823)	-0.2908 ** (0.1045)	-0.3524 *** (0.0868)	-0.5597 *** (0.1022)	-0.0527 (0.0729)	-0.2043 *** (0.0577)	-0.2562 *** (0.1085)	-0.0716 (0.0601)	-0.2448 *** (0.0634)
Household head is a women (=1)	0.2054 ** (0.0927)	0.2583 ** (0.0829)	0.2384 *** (0.0666)	0.1610 * (0.0893)	0.0988 (0.0696)	0.2212 *** (0.0736)	0.1393 (0.0867)	-0.0177 (0.0661)	0.1399 ** (0.0602)
Household head has higher university education (=1)	1.7000 *** (0.1151)	1.4544 *** (0.1032)	0.9980 *** (0.0808)	0.5055 *** (0.1252)	0.7152 *** (0.1401)	0.7924 *** (0.1546)	0.7434 *** (0.1249)	0.9110 *** (0.1371)	0.3819 *** (0.0878)
Household head has higher non university education (=1)	1.2271 *** (0.1570)	1.3796 *** (0.1213)	0.8138 *** (0.0909)	0.4675 *** (0.1844)	0.4305 *** (0.1600)	0.4980 *** (0.1308)	0.8986 *** (0.1640)	0.6288 *** (0.1426)	0.2704 *** (0.0916)
Household head has secondary education (=1)	0.8087 *** (0.0999)	0.7871 *** (0.0919)	0.4472 *** (0.0678)	0.2535 *** (0.0791)	0.4225 *** (0.0758)	0.3742 *** (0.0687)	0.3598 *** (0.0663)	0.2654 *** (0.0633)	0.2700 *** (0.0534)
Log. monthly household income	0.2842 *** (0.0535)	0.5206 *** (0.0523)	0.8449 *** (0.0448)	0.4079 *** (0.0493)	0.4277 *** (0.0510)	0.5315 *** (0.0415)	0.2529 *** (0.0428)	0.2658 *** (0.0394)	0.3251 *** (0.0352)
Constant	-9.8568 *** (1.2660)	-8.9893 *** (0.8454)	-8.2634 *** (0.6504)	-3.0703 *** (0.4422)	-3.3080 *** (0.4139)	-4.1779 *** (0.3592)	-5.4604 *** (0.5859)	-4.8224 *** (0.4570)	-5.0831 *** (0.4057)
Obs.	1708	2282	2651	1708	2282	2651	1708	2282	2651
Censored Obs.	1389	1876	1864	175	255	374	247	360	552
rho	0.1978 (0.0503)	0.2626 (0.0712)	0.3241 (0.0563)	0.8012 (0.0406)	0.1637 (0.0656)	0.0440 (0.0763)	0.2626 (0.0687)	-0.4270 (0.2088)	-0.7988 (0.0512)
sigma	1.4352 (0.2640)	1.0608 (0.0729)	0.8481 (0.0294)	0.7584 (0.0182)	0.6433 (0.0131)	0.5390 (0.0087)	0.7853 (0.0188)	0.7221 (0.0232)	0.7727 (0.0233)
lambda	0.2839 (0.1024)	0.2786 (0.0860)	0.2749 (0.0498)	0.6076 (0.0391)	0.1053 (0.0427)	0.0237 (0.0411)	0.2062 (0.0546)	-0.3084 (0.1587)	-0.6172 (0.0554)

* Significant at 90% ; ** Significant at 95%; *** Significant at 99%

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UNU World Institute for Development Economics Research (UNU/WIDER)
Katajanokanlaituri 6 B, 00160 Helsinki, Finland

Camera-ready typescript prepared by Liisa Roponen at UNU/WIDER
Printed at UNU/WIDER, Helsinki

The views expressed in this publication are those of the author(s). Publication does not imply endorsement by the Institute or the United Nations University, nor by the programme/project sponsors, of any of the views expressed.

ISSN 1609-5774
ISBN 952-455-158-6 (printed publication)
ISBN 952-455-199-4 (internet publication)

