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The Impact of Telecommunications Privatization in Peru on the Welfare of Urban Consumers

The Peruvian government privatized Compañía Peruana de Teléfonos (CPT) and Empresa Nacional de Telecomunicaciones (ENTEL) in 1994. Both enterprises were purchased by Telefónica de España. The record of the telecommunications sector under state management was very poor. By 1993 Peru had strikingly low telephone coverage, with lines concentrated in the capital of Lima and in wealthy households. In comparison with international coverage and based on its level of per capita gross domestic product (GDP), Peru should have had eleven lines for every 100 inhabitants. However, Peru's telephone density was a mere 2.6 lines in 1992, one of the lowest of the region. The waiting time for a new line in 1993 was 118 months, whereas customers in Colombia were waiting seventeen months and those in Mexico, eleven months.

Service quality was below international standards. In 1992, only 40 percent of all phone calls were actually completed, partly as a result of the small size and obsolete technology of the network, which easily became congested. Inadequate maintenance also affected communications quality. Telephone cables have a useful life of fifteen years, but in 1993 some of the cables in use were over sixty years old. Only 33 percent of the network was digital.

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CPT and ENTEL both had an excessive number of employees, which resulted in low productivity and a distorted structure of operating costs. Another distinctive feature of the Peruvian telecommunications sector during this time was a skewed tariff structure. Installation charges were quite high by international standards (close to U.S.$1,000 per residential telephone line in 1993), while the flat monthly charge was relatively low. In contrast, tariffs for long-distance and local calls were quite high. This tariff structure was based on the idea that only rich consumers with inelastic demand used the international long-distance service, which led to a cross subsidy between that service and local telephone calls. Because this distorted tariff structure failed to finance universal service, only rich households enjoyed telephone service in Peru in the early 1990s.

Privatization was designed to increase coverage, boost efficiency, and encourage a competitive market in the medium term. The privatization contract set specific investment goals to relax the existing supply constraint. To foster competition, the contract also established a five-year "rebalancing" period, so that tariffs would reflect their long-term marginal costs. Adjusting tariffs immediately was considered too harsh for consumer welfare.

The resulting improvements in telecommunications were impressive. Between 1993 and 1998, the number of lines installed increased by 167 percent. Thus, Telefónica amply met the concession contract's coverage goals. By 1998, the entire market for basic telephone service was covered and the waiting list was eliminated. Service quality also improved substantially. Fully 90 percent of the network was digital, and 99 percent of local and international long-distance calls were completed. Tariff balance was achieved and the sector was open to free competition several months ahead of schedule.

Table 1 presents two tests comparing pre- and postprivatization firm performance indicators. The first test is a first-difference analysis using firm and year fixed effects to analyze the difference between the pre- and postprivatization information. The second is a difference-in-differences test. The difference-in-differences statistic not only tests for a change in the firm's performance relative to the preprivatization period, but it also takes into account performance relative to a control group that didn't go through the privatization process. The control group used is the main Peruvian water and sanitation firm (SEDAPAL), which was not privatized

TABLE 1. Performance Changes in the Telecommunications Sector after Privatization[a]

Sectoral performance measure (P_i)	*Mean*		*First difference*		*Difference-in-differences*		
	Preprivatization	*Postprivatization*	*T test*[b]	*Hotelling*[c]	*Hotelling*[c] *SEDAPAL*	*S-Francia*[d] *Prob > z*	*Kolmogorov-Smirnov*[e]
Profitability							
Return on sales (ROS)	−0.010 (0.029)	0.408 (0.028)	−10.26***	105.35***	49.611***	0.197	0.001***
Return on assets (ROA)	0.002 (0.014)	0.171 (0.021)	−6.99***	48.91***	24.454***	0.328	0.001***
Return on equity (ROE)	0.004 (0.032)	0.313 (0.014)	−7.90***	62.40***	33.451***	0.208	0.007***
Operating efficiency							
Sales efficiency (SALEFF), in thousands of real 1994 soles	143.919 (23.373)	455.316 (47.931)	−6.33***	40.09***	42.511***	0.038	0.007***
Net income efficiency (NIEFF), in thousands of real 1994 soles	−0.979 (3.662)	93.758 (12.355)	−8.32***	69.27***	47.274***	0.030	0.008***
Employment							
Total employment (EMPL)	14,125.630 (575.074)	5,992.167 (543.713)	9.97***	99.37***	38.481***	0.109	0.001***

(*continued*)

TABLE 1. Performance Changes in the Telecommunications Sector after Privatization[a] (*continued*)

Sectoral performance measure (P_i)	*Mean*		*First difference*		*Difference-in-differences*		
	Preprivatization	*Postprivatization*	*T test*[b]	*Hotelling*[c]	*Hotelling*[c] *SEDAPAL*	*S-Francia*[d] *Prob > z*	*Kolmogorov-Smirnov*[e]
Leverage							
Debt to assets (LEV)	0.500 (0.055)	0.458 (0.049)	0.54	0.30	1.915	0.872	0.921
Debt to equity (LEV2)	1.243 (0.339)	0.923 (0.170)	0.76	0.58	1.607	0.003	0.921
Coverage							
Lines per worker (LINES)	39.604 (9.763)	261.005 (78.008)	−8.05***	64.86***		0.005	0.001***

*** Statistically significant at the 1 percent level.

a. The table reports the first difference of the means and difference-in-differences tests. The year of privatization was 1994. Standard errors are in parentheses.

b. The *t* test is for the null hypothesis about the difference between means; the figures for *N* are unequal.

c. The Hotelling test for equality is

$$T^2 = (\bar{\mathbf{x}}_1 - \bar{\mathbf{x}}_2) S^{-1} (\bar{\mathbf{x}}_1 - \bar{\mathbf{x}}_2)',$$

where $\mathbf{x}$ is a $1 \times k$ matrix of the means and S is the estimated covariance matrix.

d. Shapiro-Francia test for normality. The null hypothesis is that the variable is normally distributed.

e. The Kolmogorov-Smirnov test is a nonparametric test to see if the difference in the distribution of the performance indicators is significant.

but which went through a reform process similar to that of the telecommunications firm in the preprivatization period. The specific sectoral per capita gross national product (GNP) is also included to control for the size of the two different sectors.

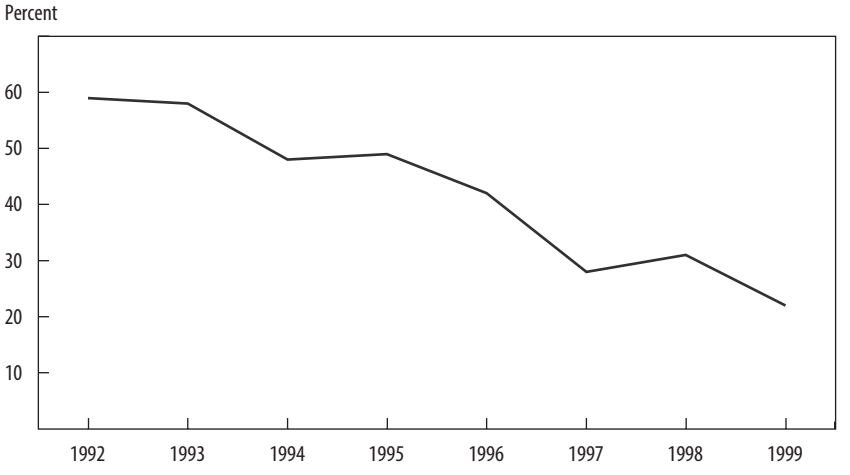
As shown in the table, all the performance indicators with the exception of leverage improved significantly. This holds when a control group is included and the second difference is calculated. The profitability ratios moved from being negative, on average, to positive in magnitudes from 17 percent to 40 percent. Accordingly, net profits over earnings jumped from 5 percent in 1993 to almost 25 percent in 1997. While total profits amounted to U.S.$35.5 million in 1993, in 1997 they were U.S. $400 million.

Sales efficiency saw a fourfold increase after privatization, and net income efficiency rose by more than ten times. Employee productivity, as measured by lines in service per employee, increased from eighty-seven in 1994 to 275 in 1998. The waiting period for a new line fell from 118 months in 1993 to 1.5 months in 1998. One major explanation for such a remarkable increase in operating efficiency is that employment was reduced by more than half after the privatization process, which clearly affected labor productivity. The significant improvement of all the other performance indicators shows that total factor productivity also increased after the privatization process.

Despite these results, public opinion regarding the privatization process, of which the telecommunications sector was the flagship, became increasingly negative over time, as shown in figure 1. In 1992 almost 60 percent of the population was in favor of privatization, but this percentage dropped to just over 20 percent by December 1999. Consumer satisfaction was sharply divided along socioeconomic lines: more than three-quarters of those from the highest socioeconomic group supported privatization, compared with only 21 percent approval from the lowest socioeconomic group. Interestingly, of all the public services, telecommunications was seen as the one that least satisfied the needs of its consumers (see figure 2).

Specifically, this paper analyzes how, in addition to the improvement in the performance of the firm and the quality of service, the privatization of the telecommunications industry in Peru led to price changes that had an impact on consumer welfare and that may be correlated with the negative public opinion of the privatization process.

FIGURE 1. Approval Rate of the Privatization Process



Source: Commission for the Promotion of Private Investment (COPRI).

Measuring Consumer Welfare

It is not our intention to obtain an indicator of aggregate welfare by adding up the welfare of each group affected by privatization. Although we follow many ideas suggested by Galal and others and by Martin and Parker, we use a different model to value consumer welfare.[1] Basically, our purpose is more specific and aims at measuring the net effects on consumers before and after privatization. We first model the market for each product in the pre- and postprivatization scenarios, then identify changes in access to and use of each service, and finally measure consumer surplus changes in both stages.

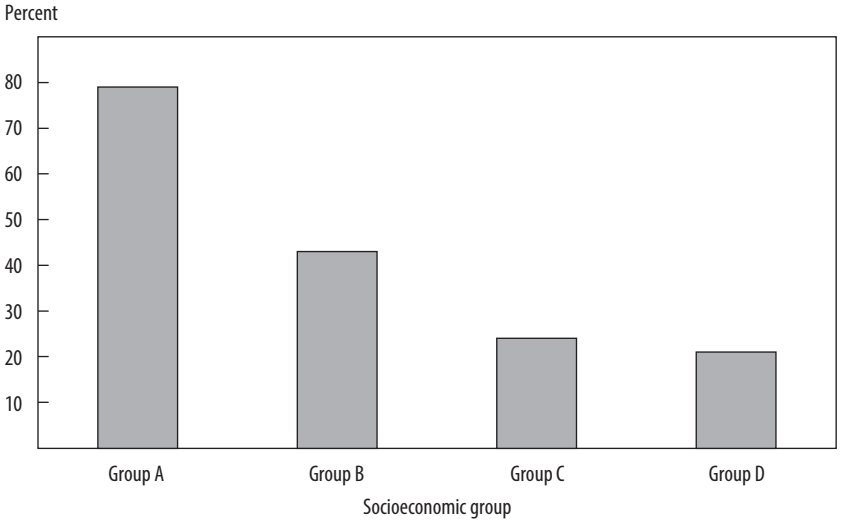
Households' preferences are represented by a utility function,

$$u = u(x_{\text{Local}}, x_{\text{NLD}}, x_{\text{ILD}}, z), \tag{1}$$

in which x is consumption of each service available to a residential customer (namely, local calls, national long-distance calls, and international long-distance calls) and z is a consumption index of other goods. Solving

1. Galal and others (1994) and Martin and Parker (1997).

FIGURE 2. Approval Rate of Privatization by Socioeconomic Group, May 1999



the optimization problem, we derive the indirect utility function, $V(\mathbf{p}, y)$, in which y is the income of each household and $\mathbf{p}$ is a vector with prices of the three basic services and a general price index for the remaining goods.

To access a service, a household compares the value of using the service, $V(\mathbf{p}, y)$, with the cost of access. Having a phone line allows customers to make three types of calls (that is, local, national long-distance, and international long-distance). On the panel, among the households for which we were able to obtain a telephone bill, some households make only local calls while others make local and long-distance calls. We can thus order households according to their consumption decisions.

Econometrically, we model the demand for a specific telecommunications service as a two-stage decision rule. First, we model the decision to access the network using a probit model. From this equation, we obtain the inverse Mills ratio to correct for the access problem. This ratio is included in demand estimations to obtain price elasticities and consumer surpluses for the three services under study, correcting for the bias for lack of access.

Because we use a household panel that evidences variations in prices, income, and demographic characteristics, we can directly calibrate the position of each curve at different points of time without additional assumptions

in unobserved variables. Furthermore, it is not necessary to assume linearity for the demand curves, and we chose the functional form of the demand curves to obtain the best fit rather than for algebraic simplicity.[2] Because of data restrictions, however, our demand estimations do not capture changes in quality of the different telephone services.

The functional form that yields the best fit is

$$q_{it}^{n} = \exp\left(x_{it}\beta^{n} + \mathbf{p}_{it}\alpha^{n} + \varepsilon_{it}\right). \tag{2}$$

The superscript indicates the socioeconomic level; i identifies the household; and t represents time. The relevant prices are $\mathbf{p}_{it}$, so the elasticities are recovered from the parameter, α, for each socioeconomic level. Lastly, q_{it} is the measured traffic for each of the three services considered in this study.

After calibrating the demand functions, we measure consumer welfare five years before and five years after privatization. The combined effect of increasing the number of telephone line installations and reducing access charges boosted consumer welfare from its preprivatization levels.

Our welfare measure is the difference between the consumer surplus of making a certain number of calls and the fixed amount paid for accessing the line (the value of the flat installation charge converted to an annuity). For a given socioeconomic level, j, we define

$$S_{it}^{j}(\mathbf{p}_{it},.) = \int_{\mathbf{p}_t}^{\mathbf{P}_{\max}} q_{it}^{j}(\mathbf{p},.)d\mathbf{p}, \quad \forall j \in \{\text{Local, NLD, ILD}\} \tag{3}$$

as the consumer surplus for using the line for any of the three services, r_{it} as the annual installment made on the flat installation charge, and $\mathbf{P}_{\max}$ as the maximum price the consumers will observe for each of the services, which is instrumentalized by the maximum price over the period under analysis. Thus the equation,

$$S_{it}^{j}(\mathbf{p}_{it}, r_{it}) = \sum_{j} S_{it}^{j}(\mathbf{p}_{t}) \pm r_{it}, \tag{4}$$

measures the total net surplus of all services. Replacing the functional form given in equation 2 and solving the equation, we obtain the surplus as

$$S_{it}^{j}(\mathbf{p}_{it}, r_{it}) = \pm\frac{1}{\alpha^{j}}\exp\left(x_{it}\beta^{j} + \mathbf{p}_{it}\alpha^{j} + \varepsilon_{it}\right)\Big|_{\mathbf{p}_{it}}^{\mathbf{p}_{\max}} \pm r_{it} \text{ and, therefore,}$$

2. See Pasco-Font, Gallardo, and Fry (1999).

$$S_{it}^{j}(\mathbf{p}_{it}, r_{it}) = \pm\frac{1}{\alpha^{j}}\exp\left(x_{it}\beta^{j} + \mathbf{p}'\alpha^{j} + \varepsilon_{it}\right) \pm r_{it}, \tag{5}$$

in which α^j is the elasticity of the price itself for the socioeconomic level j.

Empirical Estimations

We use data from a 1997 household panel specially surveyed for this study regarding access and monthly consumption of telecommunications services over the previous year. We applied the survey to households in Metropolitan Lima, categorized into the high, middle, low, and very low socioeconomic levels. We also included households from the high, middle, low, and very low socioeconomic levels of four other major cities in Peru: Cusco, Arequipa, Chiclayo, and Trujillo. We chose these cities based on the criteria of population and demand for telephone services. The survey sample is representative of approximately 7.6 million inhabitants, which account for 50 percent of Peru's urban population; the degree of representativity is actually greater owing to the similarity of the cities surveyed and the larger cities of the Peruvian coast and the Andes.

The survey questionnaire (applied directly to the most informed person in the household) consists of five sections: the present use and quality of the telecommunications services, the household's potential use of services, characteristics of the household members, characteristics of the household, and a module for transcribing information from the home's telephone bill. The survey encompassed 1,707 urban households, which were selected in the 1996–97 period to represent the residential demand for telephone services in Metropolitan Lima and in Peru's principal provincial cities.[3]

This section reports demand estimates for basic telephone services and computes household welfare changes for socioeconomic levels A through D, where level D is the poorest. We also use previous results for households belonging to socioeconomic levels A and B for provinces outside of Lima.[4] The demand estimation corrects for the selection bias resulting

3. For more details on the survey, see Pasco-Font, Gallardo, and Fry (1999); OSIPTEL (1995); and Torero and Pasco-Font (2000).

4. Torero and Pasco-Font (2000).

from whether consumers have a telephone, as well as for the selection bias caused by households for which telephone bill information could not be obtained.

The prices used are implicit prices, given that we do not have enough information to distinguish between calls made during peak hours (that is, the peak price) and those made during off-peak hours (that is, the off-peak price). The implicit price reproduces the true price for telecommunications services faced by urban households. Because the variable is generated using as inputs the quantity consumed and the total expenses in each service, the implicit price should only reflect a lineal combination of both peak and off-peak prices. We thus do not generate a spurious price, as could be erroneously assumed. The following equation illustrates this idea:

$$\mathbf{p}^{k}_{\text{imp}} = \frac{\text{EXPENDITURE}_k}{q_k} = \frac{q_k^{\text{peak}}}{q_k}\mathbf{p}_k^{\text{peak}} + \frac{q_k^{\text{off-peak}}}{q_k}\mathbf{p}_k^{\text{off-peak}} \tag{6}$$

$$= \left[\mathbf{p}_k^{\text{peak}}\alpha + \mathbf{p}_k^{\text{off-peak}}\beta\right] \qquad \text{for } k = \text{Local, NLD, ILD,}$$

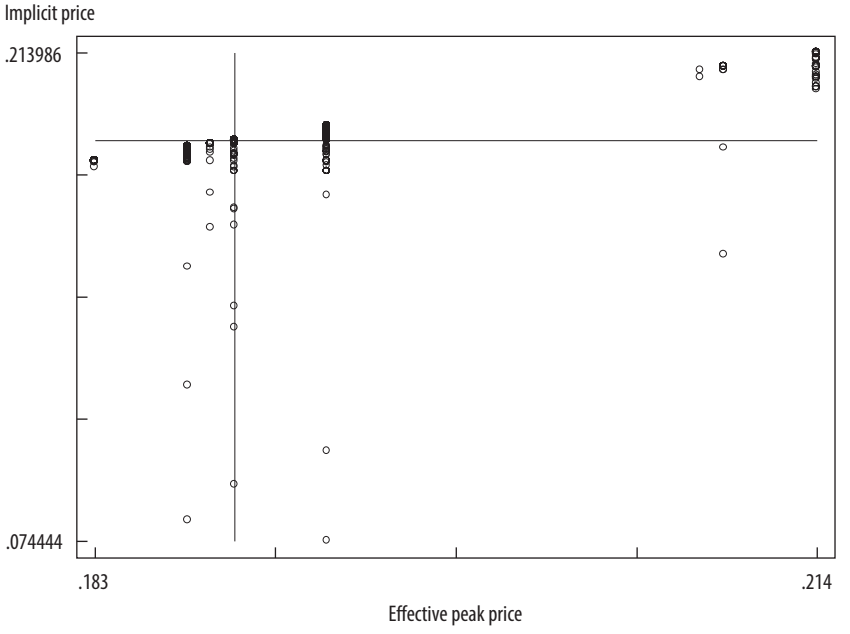
where $\alpha + \beta = 1$.

Figure 3 also provides evidence that the effective price faced by the households is a lineal combination of both peak and off-peak prices. For instance, the figure shows that any deviation from the intersection point between the implicit price and the effective peak price reflects, precisely, the idea of a lineal combination of prices.

We also included a dummy variable identifying whether the households possess cellular phones. Access to cellular phones is a crucial factor, especially since 1997 when the intensity of cellular phones increased substantially. Cellular phone density jumped from 0.2 in 1993 to 3 in 1998. Cellular phones are a complement of fixed phones, however, not a substitute.

The econometric estimations exhibit the expected signs and coefficients (see the appendix for details on the regressions). Furthermore, the price of international long-distance service is significant (and has a positive sign) in explaining the use of local and national long-distance services, indicating some degree of substitution between the two products. Household education and income are also significant and have the expected signs. The fixed district effects that we included were significant as a whole according

FIGURE 3. Lineal Combination: Implicit Price and Peak Price[a]



a. The effective peak prices during the period of study were 0.183, 0.187, 0.188, 0.189, 0.193, 0.209, 0.210, 0.214, and 0.213, while the off-peak prices were 0.091, 0.093, 0.093, 0.094, 0.096, 0.103, 0.105, 0.053, and 0.106. We take 0.193 as our analysis point.

to the *F* statistical test.[5] Given the functional form of our directly estimated demand functions, when the percentage of change in the tariffs is the same, the percentage of change in household welfare is also the same. In other words, household welfare does not depend on total consumption, but rather on the parameters of the demand function. However, the measure of the change in the consumer surplus varies from home to home because the flat monthly service charge represents a different proportion of each home's spending on telephone service. This variance is naturally less within each socioeconomic level given that each level comprises households with similar spending patterns on basic telephone services.

Demand for use of local and national long-distance services is inelastic in all cases. The price elasticities were –0.49, –0.478, and –1.095 for local calls, national long-distance calls, and international long-distance calls,

5. See Torero and Pasco-Font (2000) for details on other controls and econometric estimations used.

TABLE 2. Total Consumer Surplus
Millions of U.S. dollars

Type of service	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*
Local	5.8	8.7	11.1	14.1	17.5	17.9
National long-distance	0.9	1.0	1.3	1.8	2.2	3.2
International long-distance	0.7	0.9	1.1	1.4	1.8	2.2
Total	5.3	10.5	13.5	17.4	21.5	23.2
Total-fixed rent	6.2	7.7	9.7	11.2	12.9	12.7
Growth rate (percent)	—	24	26	15	15	–2

respectively.[6] This result is consistent with many other studies.[7] Moreover, Torero and Pasco-Font calculate these elasticities for all urban Peru using the World Bank's Living Standards Measurement Study (LSMS) surveys for 1994 and 1997; they find that the size of the elasticity remains the same over time, which validates our use of a single elasticity to calculate the consumer surplus for the period under study.[8]

Using the demand elasticities thus obtained, we measure the welfare effects of tariff readjustments for all three services and for increases in the flat monthly charge (see equations 3 through 5). The welfare gains of households that obtained a connection to the fixed network after privatization are also incorporated to capture the total change in consumer surplus. To do this, we used census information on total penetration ratios and the total number of households to quantify the number of new households that obtained a telephone line in the following period ($t + 1$). We assumed that households that had just obtained a line would not place as much value on the service as households that had spent a long time on the waiting list, so we assigned them the minimum welfare for the households in their socioeconomic level and pertinent year. We performed a number of simulations assigning different surplus values to these households that had recently acquired telephone lines, but the results were not substantially affected.

Tables 2 and 3 and figures 4 and 5 summarize our main results. Since privatization in 1994, there has been an absolute gain in total consumer

6. The price elasticities for provinces outside of Lima were –0.69, –0.55, and –1.59 for local, national long-distance, and international long-distance calls, respectively.

7. For example, Pasco-Font, Gallardo, and Fry (1999); Doherty (1984); Zona and Jacob (1990); Gatto, Kelejian, and Stephan (1988); Gatto and others (1988); Duncan and Perry (1994); and Levy (1996).

8. Torero and Pasco-Font (2000).

TABLE 3. Per Household Consumer Surplus by Socioeconomic Level

Socioeconomic level	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*
High (level A)	44.5	54.7	58.5	63.4	67.4	62.7
Medium (level B)	18.6	19.8	23.8	23.5	26.6	23.8
Low (level C)	7.6	6.8	6.6	9.0	8.2	8.2
Very low (level D)	6.0	4.5	0.5	1.3	0.9	1.3

surplus by service and by socioeconomic level, with only a small reduction in the growth rate of consumer surplus after 1997. The story is not uniform across different socioeconomic levels, however, when we analyze the per household consumer surplus. As shown in table 3, the high and medium socioeconomic levels (A and B) experienced a clear gain in welfare, but the welfare gains decreased after 1996 for the low and very low socioeconomic consumer levels (C and D). Welfare levels are lower than preprivatization levels for very low income consumers (socioeconomic level D), and the low socioeconomic level (socioeconomic level C) per household

FIGURE 4. Change in Consumer Surplus by Socioeconomic Level

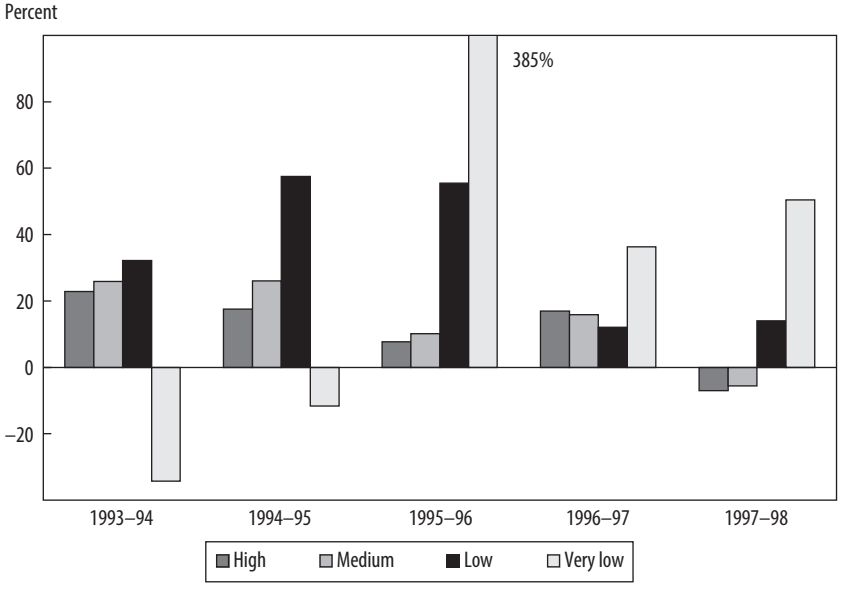
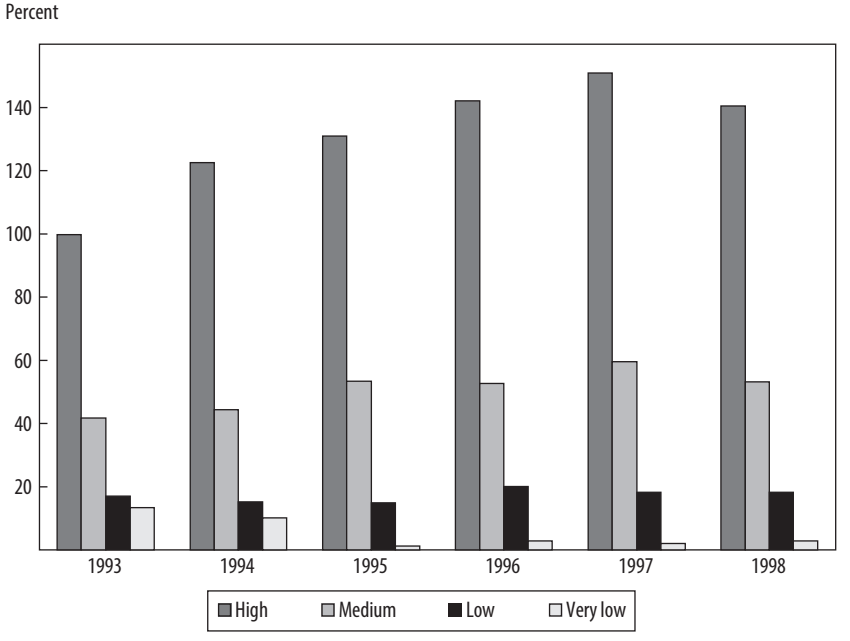


FIGURE 5. Change in per Capita Consumer Surplus by Socioeconomic Level



received increasing gains only after 1996. Even more, relatively the per household consumer surplus has a regressive distribution. Given that the majority of the people surveyed in public opinion polls are from the low socioeconomic level, it is understandable that public opinion regarding privatization and, specifically, telecommunications privatization has worsened over time.

The main explanation for the fall in consumer surplus is fundamentally the permanent increase in the fixed monthly payment, as shown in figure 6. This given percentage price increase had a greater impact on lower socioeconomic levels, because these households use the service less (that is, they make fewer calls). As a result, a greater proportion of their spending goes to pay the flat monthly charge. There is also a cross-price impact with local calls, since the proportionately larger reduction of long-distance tariffs led to a substitution of local calls for long-distance calls.

FIGURE 6. Evolution of Telecommunications Tariffs

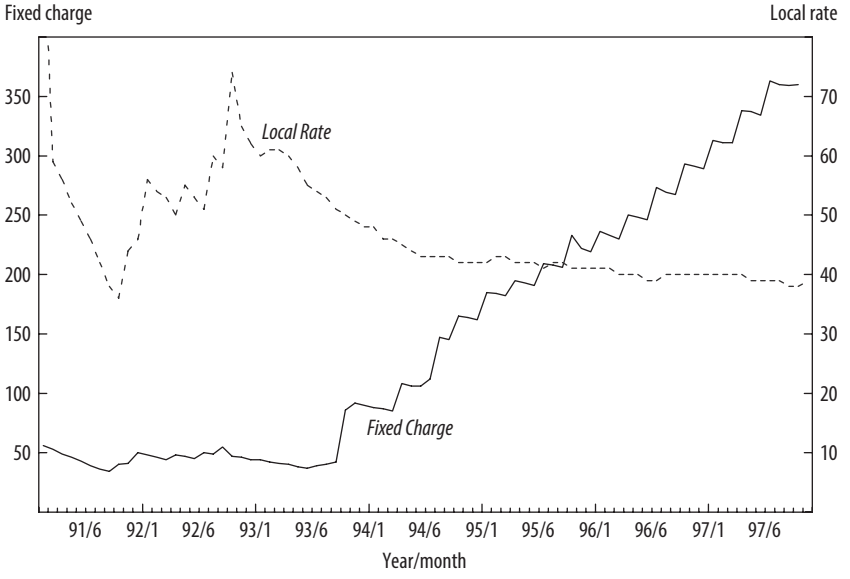
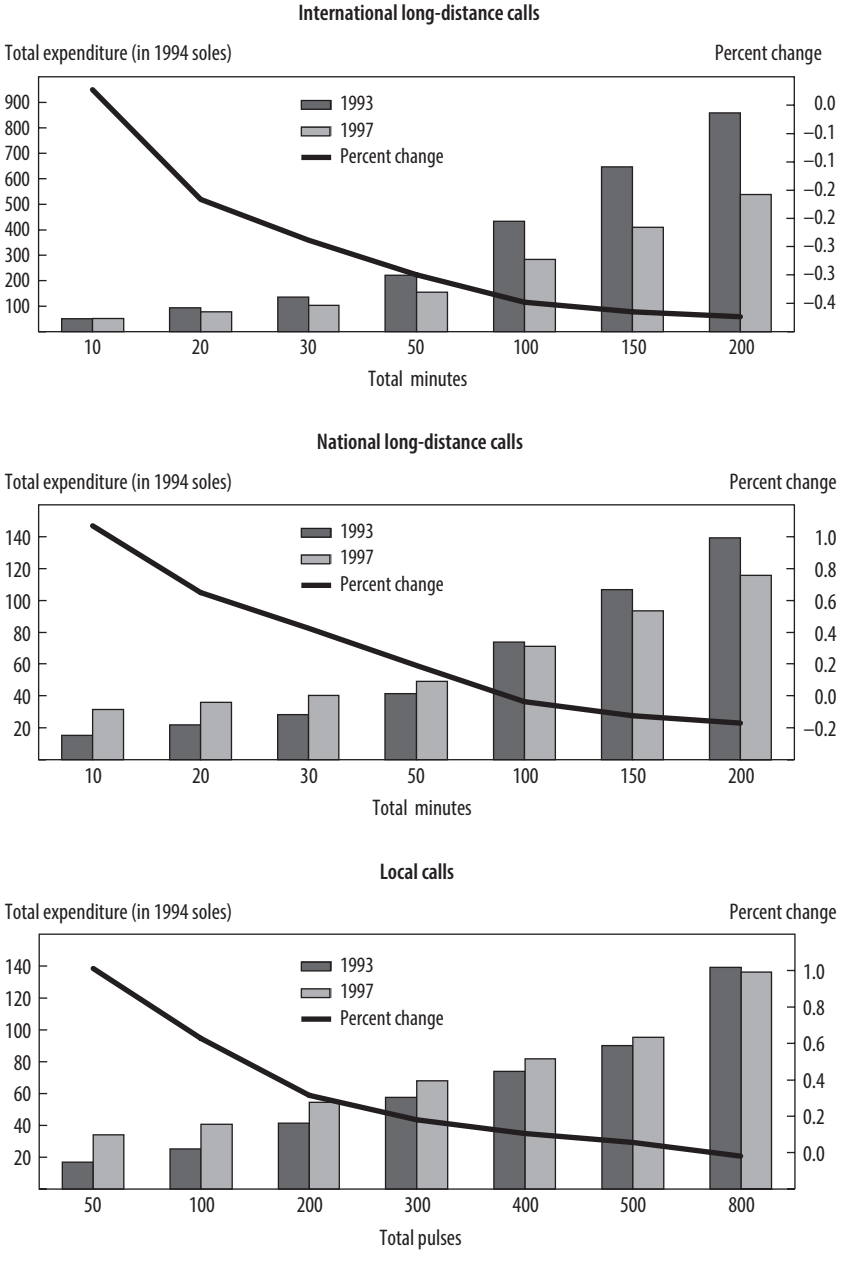


Figure 7 compares how much a consumer spends in each service for a given amount of minutes using prices before and after privatization. As can be seen for local calls, a consumer would only experience a benefit with respect to the preprivatization prices if she consumes around 700 pulses (2,100 minutes) a month, something that only happens in the high socioeconomic levels. The benefits of privatization are substantial in long-distance services, especially in international long-distance, which again is mainly used by high socioeconomic sectors.

To make things worse, in 1997 the agency that regulates telecommunications changed the unit of measure of local calls from three-minute blocks to one-minute units and also expanded the definition of the geographic area. These measures translated into an increase in the price of a local call. This explains the reduction of growth in the total consumer surplus since 1997. When we compare the price of local calls and fixed monthly fees in Peru with prices in Argentina and Chile—two countries that have also been through a privatization process—it is clear that there is still room for tariff reduction in Peru.

FIGURE 7. Evaluation of the Impact of Changes in Tariffs



Conclusions and Final Comments

As a result of poor state management, the Peruvian telecommunications sector was characterized in the early 1990s by low coverage, a long wait for phone installation, outdated technology, poor service, and distorted prices. Privatization reversed the situation, bringing dramatic improvements in coverage, quality, and technology. By 1998 Telefónica del Peru had amply met the goals set in the concession contract and covered practically the entire market for basic telephony. In addition, the telecommunications sector posted greater improvement than any other utilities sector after its privatization. Despite these results, however, the population is quite unhappy with the privatization process and specifically with the telecommunications privatization.

This paper explored one of the possible elements that could explain this paradox by analyzing the welfare implications of telecommunications privatization through the estimation of consumer surplus for different socioeconomic levels. The main conclusion of the paper is that on aggregate, privatization improved total consumer welfare, mainly by increasing consumer access to the service. However, the tariff adjustment required to reflect long-term marginal costs had a relatively negative impact on some consumers. In particular, increases in the fixed monthly payment and the price of local calls negatively affected low and, especially, very low income households, as shown by a detailed per household analysis of consumer surplus.

The growth of total consumer surplus began falling in 1996, after three periods of constant growth. Moreover, our analysis of per household consumer surplus indicates that clients with low usage that had a phone before privatization experienced welfare reductions. Regulatory changes exacerbated this welfare reduction: the reduction in the unit of measure for local calls from three minutes to one minute and the expansion in the geographic definition of local area further increased local tariffs.

This problem could have been avoided if consumer plans had been introduced that took into account the differences among consumer groups. Households from the lowest socioeconomic level mostly use their phone for receiving calls; their major cost is thus the fixed monthly rent. A calling plan featuring a low monthly fixed tariff and higher charges for local calls would improve the welfare of low-income households. The opposite is true in the case of rich households, whose major gain in welfare is through the

intensive use of the phone. The welfare of these households would increase if local and long-distance tariffs were reduced while the fixed monthly tariff was increased. In either case, the central objective of not breaking the equilibrium in the tariffs must be maintained to avoid the entrance of inefficient competitors.

Finally, there is not enough competition in the sector. The price of long-distance calls in Peru was still higher than in other South American countries for the period under analysis. Our decomposition of the consumer surplus also showed this result. Consumer gain from the use of national and international long-distance calls has not increased substantially, as was expected to happen. The situation is worse in the market for local calls. Lack of adequate interconnection fees prevented other companies from using the incumbent infrastructure to compete in the local market.

Appendix: Demand Estimations for Use of Telephones

TABLE A1. Estimate of Local Use Demand in Lima[a]

Explanatory variable	*(1)*	*(2)*	*(3)*
Local rate	–2.50104**	–2.43711**	–2.69987**
	(1.0798)	(1.0654)	(1.1453)
International long-distance rate	0.46661***	0.47299***	0.56981**
	(0.1454)	(0.1450)	(0.2289)
Domestic long-distance rate	–0.03021	–0.03204	–0.06991
	(0.0258)	(0.0258)	(0.0688)
Income	0.00020***	0.00027***	0.00021***
	(0.0001)	(0.0001)	(0.0001)
Income^2	–0.00000**	–0.00000**	–0.00000**
	(0.0000)	(0.0000)	(0.0000)
Rate of penetration in Lima (network externality)	1.54653***	1.50362**	1.68295***
	(0.4810)	(0.4788)	(0.4783)
Percentage of young people in household (13–24 years)	0.41540***	0.40969***	0.42657***
	(0.1718)	(0.1721)	(0.1716)
Percentage of female young people in household (13–24 years)	–0.19354	–0.20360	–0.17186
	(0.2733)	(0.2736)	(0.2735)
Number of persons in the household	0.05551***	0.04490***	0.05667***
	(0.0116)	(0.0118)	(0.0115)
Educational level of household head: elementary school (dummy)	0.67744***	0.75280***	0.72627***
	(0.1646)	(0.1711)	(0.1641)
Educational level of household head: high school (dummy)	0.00890	0.05570	0.03071
	(0.1048)	(0.1056)	(0.1053)
Educational level of household head: technical (dummy)	0.00665	0.03089	0.02754
	(0.0622)	(0.0626)	(0.0628)
Educational level of household head: university (dummy)	0.26024***	0.27576***	0.25576***
	(0.0977)	(0.0980)	(0.0978)
Inverse Mills ratio (reported bill)	–0.35224***		–0.36442***
	(0.0748)		(0.0747)
Inverse Mills ratio (has telephone)		–0.47613***	
		(0.1017)	
Household with cellular phone			0.24504*
			(0.1301)
Constant	4.33102***	4.26831***	4.40877***
	(0.3783)	(0.3703)	(0.4474)
Summary statistic			
No. observations	2,021	2,021	2,021
F	39.18	39.27	37.71
Prob > *F*	0.0000	0.0000	0.0000
R^2	0.4472	0.4471	0.4489

*Statistically significant at 90 percent.
**Statistically significant at 95 percent.
***Statistically significant at 99 percent.
a. The dependent variable is local traffic. The regressions include district fixed effects. The *F* test was significant with $p < 0.001$. Standard errors are in parentheses.

TABLE A2. Estimate of Usage Demand for Domestic Long-Distance in Lima[a]

Explanatory variable	*(1)*	*(2)*	*(3)*
Domestic long-distance rate	–0.76450**	–0.77115**	–0.76220**
	(0.37495)	(0.37482)	(0.3748)
Local rate	–3.61770	–3.45071	–3.61495
	(2.38827)	(2.36629)	(2.3863)
International long-distance rate	0.22918**	0.22044**	0.22976**
	(0.10061)	(0.09992)	(0.1007)
Income	0.00006	0.00008	0.00006
	(0.00011)	(0.00010)	(0.0001)
Income^2	–0.00000	–0.00000	–0.00000
	(0.00000)	(0.00000)	(0.0000)
Percentage of young people in household (13–24 years)	–0.90831***	–0.91983***	–0.91022***
	(0.20355)	(0.20355)	(0.2036)
Number of persons in the household	0.06221***	0.05668***	0.06217***
	(0.02063)	(0.02029)	(0.0206)
Educational level of household head: elementary school (dummy)	0.03781	0.10872	0.03351
	(0.29940)	(0.30238)	(0.2997)
Educational level of household head: high school (dummy)	–0.28387	–0.22875	–0.28673
	(0.18275)	(0.18482)	(0.1832)
Educational level of household head: technical (dummy)	–0.14979	–0.12488	–0.15302
	(0.12789)	(0.12702)	(0.1284)
Educational level of household head: university (dummy)	–0.05385	–0.04131	–0.05584
	(0.18898)	(0.18872)	(0.1889)
Relatives in provinces	0.80352***	0.80008***	0.80190***
	(0.10054)	(0.10075)	(0.1006)
Inverse Mills ratio (reported bill)	–0.16488		–0.16455
	(0.11459)		(0.1147)
Inverse Mills ratio (has telephone)		–0.34240**	
		(0.15569)	
Household with cellular phone			–0.06049
			(0.2034)
Constant	0.32907	0.46022	0.32950
	(0.72941)	(0.71547)	(0.7296)
Summary statistic			
No. observations	1,993	1,993	1,993
F	14.94	14.89	14.47
Prob > *F*	0.000	0.000	0.000
R^2	0.1802	0.1813	0.1802

*Statistically significant at 90 percent.
**Statistically significant at 95 percent.
***Statistically significant at 99 percent.
a. The dependent variable is domestic long-distance traffic. The regressions include district fixed effects. The *F* test was significant with $p < 0.001$. Standard errors are in parentheses.

TABLE A3. Estimate of Usage Demand for International Long-Distance in Lima[a]

Explanatory variable	*(1)*	*(2)*	*(3)*
International long-distance rate	–0.30032**	–0.29966**	–0.30291**
	(0.1327)	(0.1329)	(0.1288)
Local rate	3.27635	3.27247	3.63210*
	(2.0692)	(2.0667)	(2.0169)
Domestic long-distance rate	0.47247**	0.46549**	0.16928
	(0.2575)	(0.2579)	(0.3120)
Income	0.00032***	0.00028***	0.00029***
	(0.0001)	(0.0001)	(0.0001)
Income^2	–0.00000***	–0.00000***	–0.00000***
	(0.0000)	(0.0000)	(0.0000)
Percentage of young people in household (13–24 years)	0.24619	0.24692	0.29232
	(0.16210)	(0.16227)	(0.1629)
Number of persons in the household	–0.03342**	–0.02933*	–0.02871*
	(0.0164)	(0.0165)	(0.0166)
Educational level of household head: elementary school (dummy)	0.03605	0.01072	0.07742
	(0.3390)	(0.3401)	(0.3485)
Educational level of household head: high school (dummy)	0.24340*	0.23572*	0.28810**
	(0.1268)	(0.1301)	(0.1272)
Educational level of household head: technical (dummy)	–0.07673	–0.08159	–0.01962
	(0.0748)	(0.0754)	(0.0745)
Educational level of household head: university (dummy)	–0.07979	–0.08575	–0.05451
	(0.1414)	(0.1413)	(0.1481)
Relatives abroad	0.42043***	0.41573***	0.43631***
	(0.0797)	(0.0795)	(0.0796)
Inverse Mills ratio (reported bill)	0.15635*		0.15052*
	(0.0915)		(0.0912)
Inverse Mills ratio (has telephone)		0.15790	
		(0.1263)	
Household with cellular phone			0.81969***
			(0.2122)
Constant	–0.30561	–0.21470	–0.2472
	(0.6971)	(0.6908)	(0.6871)
Summary statistic			
No. observations	1,940	1,940	1,940
F	8.63	8.61	8.72
Prob > *F*	0.000	0.000	0.000
R^2	0.107	0.106	0.129

*Statistically significant at 90 percent.
**Statistically significant at 95 percent.
***Statistically significant at 99 percent.
a. The dependent variable is international long-distance traffic. The regressions include district fixed effects. The *F* test was significant with $p < 0.001$. Standard errors are in parentheses.

TABLE A4. Estimate of Local Use Demand in Rest of Peru[a]

Explanatory variable	*(1)*	*(2)*	*(3)*
Local rate	–2.51770**	–2.49695**	–2.73689**
	(1.0901)	(1.0859)	(1.0264)
International long-distance rate	0.13041	0.14159	0.08593
	(0.1742)	(0.1748)	(0.1736)
Domestic long-distance rate	–0.16723**	–0.16149**	–0.20133**
	(0.0846)	(0.0829)	(0.0799)
Income	0.00026***	0.00026***	0.00024***
	(0.0001)	(0.0001)	(0.0001)
Income^2	–0.00000***	–0.00000***	–0.00000***
	(0.0000)	(0.0000)	(0.0000)
Percentage of young people in household (13–24 years)	–0.10324	–0.05870	–0.05931
	(0.1607)	(0.1630)	(0.1612)
Percentage of female young people in household (13–24 years)	0.05591	0.03119	0.01638
	(0.2101)	(0.2094)	(0.2102)
Number of persons in the household	0.02486	0.03387**	0.02762*
	(0.0159)	(0.0163)	(0.0159)
Educational level of household head: elementary school (dummy)	0.02254	–0.01363	–0.02756
	(0.1537)	(0.1455)	(0.1536)
Educational level of household head: high school (dummy)	0.34207*	0.25913*	0.26990
	(0.1871)	(0.1553)	(0.1863)
Educational level of household head: technical (dummy)	0.30234	0.21278	0.21799
	(0.2380)	(0.1821)	(0.2369)
Educational level of household head: university (dummy)	0.30172	0.21569	0.22534
	(0.2490)	(0.1817)	(0.2479)
Household in Trujillo (dummy)	0.07068	0.09136	0.03178
	(0.1270)	(0.1020)	(0.1257)
Household in Chiclayo (dummy)	0.40604***	0.20797**	0.39989***
	(0.1201)	(0.0931)	(0.1187)
Household in Arequipa (dummy)	0.65684***	0.72158**	0.62411***
	(0.0808)	(0.0740)	(0.0803)
Inverse Mills ratio (reported bill)	–0.21955*		–0.22679*
	(0.1256)		(0.1251)
Inverse Mills ratio (has telephone)		–0.48061***	
		(0.1531)	
Household with cellular phone			0.48730***
			(0.1049)
Constant	5.03441***	4.98909***	5.32567***
	(0.6049)	(0.5125)	(0.5939)
Summary statistic			
No. observations	1,367	1,367	1,367
F	18.84	19.99	20.70
Prob > *F*	0.000	0.000	0.000
R^2	0.143	0.147	0.154

*Statistically significant at 90 percent.
**Statistically significant at 95 percent.
***Statistically significant at 99 percent.
a. The dependent variable is local traffic. Standard errors are in parentheses.

TABLE A5. Estimate of Usage Demand for Domestic Long-Distance in Rest of Peru[a]

Explanatory variable	*(1)*	*(2)*	*(3)*
Domestic long-distance rate	–0.88501***	–0.87675***	–0.93084***
	(0.2668)	(0.2670)	(0.2660)
Local rate	–4.12475***	–4.12207***	–4.44237***
	(1.6130)	(1.6117)	(1.4689)
International long-distance rate	–0.12508	–0.12430	–0.17276
	(0.1551)	(0.1552)	(0.1619)
Income	0.00034***	0.00038***	0.00033**
	(0.0001)	(0.0001)	(0.0001)
Income^2	–0.00000	–0.00000	–0.00000
	(0.0000)	(0.0000)	(0.0000)
Percentage of young people in household (13–24 years)	–0.17735	–0.18594	–0.14466
	(0.1863)	(0.1873)	(0.1845)
Number of persons in the household	–0.07650***	–0.07736***	–0.07293***
	(0.0257)	(0.0269)	(0.0255)
Educational level of household head: elementary school (dummy)	1.63948***	1.68961***	1.60505**
	(0.5877)	(0.5812)	(0.5908)
Educational level of household head: high school (dummy)	1.70888***	1.80220***	1.65058***
	(0.5980)	(0.5815)	(0.6017)
Educational level of household head: technical (dummy)	1.68089***	1.81349***	1.61857**
	(0.6474)	(0.6123)	(0.6498)
Educational level of household head: university (dummy)	1.75020***	1.89511***	1.68795**
	(0.6558)	(0.6086)	(0.6590)
Relatives in provinces	0.64753***	0.64570***	0.61198**
	(0.2481)	(0.2484)	(0.2459)
Household in Cusco (dummy)	0.33691*	0.28073*	0.38886*
	(0.2006)	(0.1646)	(0.1988)
Household in Chiclayo (dummy)	0.17987	0.04933	0.21719
	(0.2815)	(0.1269)	(0.2814)
Household in Arequipa (dummy)	–0.23580	–0.26647	–0.22870
	(0.1529)	(0.1454)	(0.1514)
Inverse Mills ratio (reported bill)	–0.10615		–0.11262
	(0.1974)		(0.1968)
Inverse Mills ratio (has telephone)		–0.05551	
		(0.2638)	
Household with cellular phone			0.66546***
			(0.1914)
Constant	2.71871***	2.51191**	3.05057***
	(0.9795)	(0.8850)	(0.9870)
Summary statistic			
No. observations	1,348	1,348	1,348
F	9.04	8.89	9.31
Prob > *F*	0.000	0.000	0.000
R^2	0.094	0.094	0.103

*Statistically significant at 90 percent.
**Statistically significant at 95 percent.
***Statistically significant at 99 percent.
a. The dependent variable is domestic long-distance traffic. Standard errors are in parentheses.

TABLE A6. Estimate of Usage Demand for International Long-Distance in Rest of Peru[a]

Explanatory variable	*(1)*	*(2)*	*(3)*
International long-distance rate	–0.43053**	–0.42671**	–0.43494**
	(0.1965)	(0.1954)	(0.1941)
Local rate	–0.01529	–0.01583	–0.07140
	(0.3930)	(0.3949)	(0.4064)
Domestic long-distance rate	0.03703	0.03966	0.02646
	(0.1468)	(0.1453)	(0.1478)
Income	0.00005	0.00001	0.00005
	(0.0001)	(0.0001)	(0.0001)
Income^2	0.00000	0.00000	0.00000
	(0.0000)	(0.0000)	(0.0000)
Percentage of young people in household (13–24 years)	–0.19958**	–0.16790**	–0.19584**
	(0.0868)	(0.0851)	(0.0868)
Number of persons in the household	–0.01994*	–0.01223	–0.01913
	(0.0107)	(0.0114)	(0.0107)
Educational level of household head: elementary school (dummy)	0.33842**	0.26026*	0.32229**
	(0.1548)	(0.1469)	(0.1563)
Educational level of household head: high school (dummy)	0.29067	0.13647	0.27034
	(0.1863)	(0.1569)	(0.1888)
Educational level of household head: technical (dummy)	0.19674	–0.00010	0.17311
	(0.2192)	(0.1618)	(0.2213)
Educational level of household head: university (dummy)	0.21843	0.01178	0.19743
	(0.2256)	(0.1643)	(0.2280)
Relatives abroad	0.22898***	0.22439***	0.22152***
	(0.0323)	(0.0320)	(0.0325)
Household in Cusco (dummy)	0.01044	0.05188	0.01773
	(0.0885)	(0.0632)	(0.0896)
Household in Chiclayo (dummy)	0.08130	0.04759	0.08935
	(0.1423)	(0.0575)	(0.1432)
Household in Arequipa (dummy)	0.05964	0.12444	0.06154
	(0.0782)	(0.0752)	(0.0785)
Inverse Mills ratio (reported bill)	–0.06003		–0.06180
	(0.1012)		(0.1016)
Inverse Mills ratio (has telephone)		–0.30395	
		(0.1187)	
Household with cellular phone			0.12587
			(0.1377)
Constant	1.49021**	1.67851**	1.54550**
	(0.7621)	(0.7375)	(0.7535)
Summary statistic			
No. observations	1,356	1,356	1,356
F	5.56	5.7	5.25
Prob > *F*	0.000	0.000	0.000
R^2	0.094	0.098	0.096

*Statistically significant at 90 percent.
**Statistically significant at 95 percent.
***Statistically significant at 99 percent.
a. The dependent variable is international long-distance traffic. Standard errors are in parentheses.