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Telecommunications privatization and tariff rebalancing: evidence from Latin America

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Abstract

Using panel data on 23 countries, we find a positive and statistically significant relationship between privatization and network expansion and efficiency in the Latin American region. We also find that excess demand for basic service is strongly and negatively related to tariff rebalancing, suggesting that an increase in residential service prices can mitigate unmet demand for basic service in the Latin American region by, in the long run, increasing the supply of main lines. According to our results, a 10 percent increase from the average residential price in Latin America is likely to reduce unmet demand by approximately 4.1 percent. Finally, we find that privatization is negatively related to unmet demand. In particular, privatization reduces unmet demand by approximately 28 percent. This indicates that, even after controlling for tariff rebalancing, there are concrete efficiency gains from privatization.

Keywords: Telecommunications; Privatization; Tariff rebalancing

1. Introduction

Latin America's biggest privatization occurred in July 1998 when TeleBrazil ("Telebras") was sold for approximately US$ 19 billion.[1] The selling of Telebras continues the trend, especially in Latin America, of eliminating the state's equity stake in telecommunications. Since the Telebras privatization, other countries have also considered privatization. In a recent paper, one of us found evidence that telecommunications privatization and competition are positively correlated with technical efficiency and that privatization is positively correlated with network expansion (Ros,

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[1] Telebras was the name of the state-owned phone company in Brazil. In July 1998, the government sold 12 companies: three fixed-line companies, one long distance and international company, and eight cellular holdings.

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1999). Using data from the International Telecommunications Union ("ITU") and various other sources, the paper examined telecommunications reform in developed and developing countries for the period 1986–1995. The same article also found that monthly residential access prices were *positively* correlated with network expansion. That brought into question whether positive network externalities could be captured through lower prices for residential access services.[2]

The purpose of this paper is to build upon previous work and extend the literature in three specific ways. First, we examine a subset of the data used in the previous paper and attempt to replicate the results. For this purpose, we concentrate on the Latin American region alone because of the number of telecommunications privatizations that have occurred over the last 15 or so years in that part of the world. The large numbers of privatizations allow for greater variation in the privatization variable and, by focusing on Latin America, we are able to examine how robust policy implications are for different regions of the world.

Second, we examine qualitatively the way that privatizations have been carried out in Latin American telecommunications markets. This permits us to better understand the privatization process itself and identify what it is about privatization that may explain previous results. While other studies have quantified the impact of privatization (see below), we examine other important factors that often accompany privatization — such as tariff rebalancing — and whether, after controlling for those factors, privatizations by themselves still have a significant impact on key variables.

Finally, and most importantly, we test whether tariff rebalancing has had any effect on network expansion. Many privatizations have been carried out simultaneously with tariff rebalancing. We develop a quantitative variable measuring the degree to which residential access prices are "unbalanced" and develop an excess demand model to investigate how waiting lists are affected by a host of independent variables including the quantitative measure of the degree to which residential prices are "unbalanced". This part of the paper tests the hypothesis that some of the benefits of privatization found in previous studies may be explained, in part, by exogenous factors such as tariff rebalancing that occurred just prior to privatization.

Policymakers undertake telecommunications reform in order to improve the efficiency of the sector and to provide service to as many consumers as possible. As many of these countries seek to "liberalize" their telecommunications sector — which were hitherto mostly government-run monopolies — they have to shape public policy with respect to competition, privatization, tariff rebalancing, elimination of cross-subsidies, licensing, and regulation or settlement of disputes. In order to determine the proper sequence for introducing such reforms, it is vital to learn about the relative impacts on market development of each individual reform. Our paper is intended to contribute a piece to this understanding by measuring the likely impact of privatization and tariff rebalancing.

[2] The main explanation for this result is that low penetration rates in many developing countries arise not from a lack of effective demand but rather from supply-side constraints. Because residential access prices are likely to be below their economic costs and, therefore, below equilibrium levels, holding other factors constant, the decrease in quantity demanded that results from higher residential prices is more than offset by the greater supply that results from increased prices.

2. Effects of privatization

A comprehensive review of the literature regarding the effects of telecommunications privatization and competition appears in a previous study (Ros, 1999). For purposes of this paper, we summarize the most important findings of the relevant literature in this section. We begin with information on why countries have chosen to privatize their telecommunications assets.

2.1. Reasons to privatize

Between 1986 and 1995 (the period studied empirically in this paper), the main provider of basic telecommunications services in 17 countries was at least 50 percent owned by the private sector.[3] Ten of those countries (listed in Table 1) are in Latin America. Since 1995, the most notable addition has been Brazil where, in the summer of 1998, the government sold the Telebras network to outside investors. As mentioned above, Brazil raised $19 billion from the sale, with the average bid exceeding by 64 percent the combined asking price of $11.8 billion.[4]

There are many reasons why governments privatize their telecommunications assets. First, in developing countries, privatization emerged as a policy issue amidst the debt crisis and worsening financial performance of the early 1980s (Adam, Cavendish & Mistry, 1992; see also Ramamurti, 1991). Second, there is also the belief in developing countries that privatization per se leads to the development or "crowding-in" of a nascent private sector and ameliorates any downward trend in aggregate private sector investment (such as that occurred during the 1980s). Finally, countries expect substantial improvements in the efficiency of the telecommunications sector. For example, some of the major telecommunications problems in developing countries are: long wait times for obtaining service, poor service quality, low productivity, and an inability to meet the increasing and sophisticated telecommunication demands of the private sector which, in turn, encourages bypass of the system (Wellenius & Stern, 1994). Given the links between telecommunications and economic growth, it is hoped that improvements in the performance of the telecommunications sector will lead to discernible increases in economic growth and the establishment or growth of an information-age economy. (See Saunders for an extensive review of the effects of telecommunications on economic development. Also see Cronin, Parker, Colleran & Gold, 1993A; Cronin, Colleran, Herbert & Lewitzky, 1993B; Dholakia & Harlam, 1994).

2.2. Predicted effects of privatization

As the state decreases its equity stake in telecommunications, what do economists predict will happen to technical efficiency and network expansion? The new institutional economics (NIE)

[3] For purposes of this paper, privatization is defined as the sale of at least 50 percent of the assets to the private sector. Privatization can take other forms as well, e.g. (1) partial privatization (less than 50 percent sale of assets by the state), (2) transfer of assets to the private sector under leasing arrangements, and (3) introduction of management contracting arrangements.

[4] Mercosur Telecommunications Update, July 29, 1998.

Table 1
Countries in which the main provider of basic services is owned by the private sector (at least 50 percent of assets/shares) 1986–1995[a]

Hong Kong	(1986 or earlier)	Mexico	(1990)
Philippines	(1986 or earlier)	New Zealand	(1990)
Spain	(1986 or earlier)	Argentina	(1991)
United Kingdom	(1986 or earlier)	Bolivia	(1995)
Barbados	(1986 or earlier)	Chile	(1987)
Belize	(1986 or earlier)	Guyana	(1991)
Canada	(1986 or earlier)	Peru	(1994)
United States	(1986 or earlier)	Venezuela	(1991)
Jamaica	(1989)		

[a] *Sources*: Wellenius and Stern (1994) and Molano (1997).

provides important insights into the incentive effects of differing types of ownership structure.[5] According to the NIE literature, the type of ownership has a significant effect on technical efficiency because, at the margin, changes in property rights alter incentive structures faced by decision makers. Predicted efficiency improvements associated with privatization are primarily due to changes in the principal–agent relationship and the concomitant change in transaction costs associated with supervision.

The effect on network expansion is not as clear for a variety of reasons. Applying a principal–agent framework provides important insights into the question of whether there is likely to be, on average, a significant change in network expansion as a result of privatization. Some researchers reject the notion that differences between public and private enterprises are intrinsic. Instead, differences are grounded in the disparity between the objective function of public and private sector owners. Institutional factors in many countries — especially the strong political element of telecommunications policy — increase the likelihood that an important component in the objective function of state-owned telecommunications firms is the provision of basic services to as many individuals as possible — especially residential consumers — at prices that may be below the incremental costs incurred. The inefficient prices that support that objective can only artificially inflate the quantity of basic telecommunications service demanded. Thus, holding other factors constant, a change from public to private ownership during a regime of inefficiently low prices may lead to a very different objective function on the part of the new owners and may negatively affect network expansion. In a private company, shareholders may be reluctant to increase the number of lines in operation unless doing so is profitable or is mandated by concessions.[6]

This brings us to an assertion that had been tested in previous work (Ros, 1999) and remains the basis for this paper. If a government's objective is to provide service to as many individuals as

[5] The new institutional economics is a way of reasoning and approaching political economic problems. Its objective is to broaden and modify the microeconomic foundation of economic theory by taking into account the important effects that institutions have on the performance of economies over time (North, 1990; Levy & Spiller, 1996).

[6] For this reason, some of the privatizations that were carried out contained explicit network expansion goals in the concessions. This was the case in Mexico regarding network expansion in rural areas.

possible at prices below incremental costs, why is it the case that many developing countries — where telecommunications is in state hands — have extremely low penetration rates?[7] One possibility is that in many developing countries, low penetration rates are the result of supply rather than demand-side constraints. For example, Brazil has had a high level of *unmet* demand for basic services as reflected by the willingness of the public to make substantial lump-sum payments simply to queue for telecommunications services. A thriving resale market exists with daily valuations of rates reported in many local newspapers and individuals willing to pay substantially above the official rates required just to queue for service (Ros, 1997). Penetration is low not due to insufficient demand at current prices but rather due to insufficient supply. Prices for residential basic (access) service are below equilibrium levels and lead to excess demand. As a result, we should expect higher prices to be associated with greater supply and less unmet demand, in light of the typically low-price elasticity of demand for access to basic service. We test this hypothesis in Section 4 below.

2.3. Empirical review

To date, there have been surprisingly few empirical studies focused solely on analyzing the effects of ownership or competition on the telecommunications industry. A previous study used newly released data from the ITU to examine the effects of privatization and competition on network expansion and technical efficiency (Ros, 1999). In that study, the sample data pertained to over 100 countries for the period 1986–1995. The study used a fixed-effects panel data model and controlled for the possible endogeneity of privatization and competition by employing a discrete choice instrumental variable approach.[8] The dependent variables were various measures of network expansion and technical efficiency, while the independent variables were dummy variables for privatization and competition and additional control variables such as prices, investment per line, and per capita income. Table 2 summarizes the most important results of that study. ML100 and ML100G are, respectively, main lines per 100 inhabitants and growth in main lines per 100 inhabitants, while MLEmp and MLEmpG are, respectively, main lines per employee and growth in main lines per employee.

As these results show, while privatization appeared to have a statistically significant impact on all measures of network expansion and technical efficiency considered, competition appeared to have a relatively less important role with a statistically significant effect only on main lines per employee.

The other important finding from this study pertained to the effect of residential service prices on network expansion. Specifically, it was found that initial residential connection charges and monthly residential subscription charges are *positively* and significantly correlated with main lines per 100 inhabitants. In addition, for countries with real 1990 GDP per capita less than US$10,000, there was evidence that monthly residential subscription charges are positively and significantly correlated with *growth* in main lines per 100 inhabitants. This finding raises important questions regarding the wisdom of trying to generate positive network externalities through inefficiently low

[7] For a comparison of penetration rates in Latin America see Ros (1997).

[8] The econometric model used is explained in greater detail below.

Table 2
Coefficient estimates from previous study: important independent variables only (percent impact in parentheses)[a]

Independent variable	Dependent variable			
	ML100	ML100G	MLEmp	MLEmpG
Pvtmaj	0.293[b] (34)	0.671[c] (96)	0.685[b] (98)	1.47[d] (330)
Comp	n.s.	n.s.	0.361[b] (43)	n.s.

[a] *Source*: Ros (1999).
[b] Statistically significant at the 1% level.
[c] At the 10% level, n.s. (not significant).
[d] At the 5% level.

residential basic service prices. Since generation of those externalities is frequently the cornerstone of government policy on telecommunications pricing, we examine the matter in some detail below.

Other studies provide additional insights on these relationships. One econometric study of the effects of privatization and competition on total factor productivity (TFP) concluded that competition to AT&T and privatization of British Telecom (BT) have both produced significant gains in productivity: 17 and 25 percent, respectively (Kwoka, 1993). Another study compared BT's performance with those of five telecommunications enterprises elsewhere in Europe using the TFP measure and concluded that BT was less efficient than the control group (Foreman-Peck & Manning, 1988). A study of telecommunication privatizations in Mexico, Argentina, Jamaica and Venezuela concluded: "the most striking and consistent short-run result in the telecommunications sector was the rapid expansion of the network after privatization". (Ramamurti, 1996).[9] Finally, a study of telecommunications in 10 OECD countries found that private ownership increases productivity but that any relationship between the presence of facilities-based long distance competition and productivity growth is statistically insignificant (Staranczak, Sepulveda, Dilworth & Shaikh, 1994).

3. Telecommunication privatizations in Latin America

3.1. Characteristics

As described in Table 1 above, 10 countries in Latin America had privatized their telecommunications network by 1995. Two of those countries, Belize and Barbados, had been privately owned

[9] Specifically, the study found that 3–4 years after privatization, the network grew annually at 13 percent in both Mexico and Argentina, more than 15 percent in Venezuela, and 18 percent in Jamaica. According to Ramamurti, these figures are double or triple historic growth rates and exceed the targets set by governments. In addition, he found that labor productivity (as measured by number of lines in service per employee) grew annually by double digits in Venezuela, 13 percent in Mexico, and 19 percent in Argentina.

Table 3
Tariff rebalancing and network expansion requirements in some privatizations[a]

Country	Year privatized	Tariff rebalancing prior to privatization	Network expansion requirements
Chile	1987	Price set by long-run incremental cost model	Yes
Jamaica	1989	No	No
Mexico	1990	Yes	Yes
Argentina	1991	Yes	Yes
Venezuela	1991	Yes	Yes
Guyana	1991	No	Yes
Peru	1994	Yes	Yes

[a]*Source*: Adam et al. (1992), Saunders (1994), Staranczak et al. (1994) and Galal (1996).

prior to 1986, the first year of our data. We summarize the salient features of some of the remaining eight countries. We examine only those countries where tariff rebalancing occurred just prior to privatization and/or whether there was a network expansion commitment in the concession contract.[10] This information will be used in Section 4 of this paper to develop an independent variable measuring the degree to which prices in some countries are "unbalanced" and deviate significantly from their underlying costs. Table 3 summarizes the qualitative findings.

Chile was among the first Latin American countries to privatize telecommunications networks. Since privatization in 1987, prices in Chile have been based on a theoretical model that estimates long-run incremental costs (Melo, 1994). Beginning in 1988, the model was used to phase out cross-subsidies over a five-year period (Galal, 1996). Apparently, there were also network expansion provisions in the concession contract that accompanied the privatization, although it is not clear what they were (Ramamurti, 1996).

Mexico privatized its telecommunications network in 1990. Network expansion was an important element in the concession contract set up for that privatization (Gonzalez, Gupta & Deshpande, 1998). The concession contract called for annual average growth of 12 percent for the first four years after privatization. Within three months of the announcement (in 1989) that the Salinas administration was going to privatize TELMEX, the publicly owned company was permitted to raise rates substantially. It is noteworthy that just prior to the transfer of ownership, prices of most services were as high as, or substantially higher than, prices of equivalent services in the United States (Foreman-Peck & Manning, 1988).

Argentina rebalanced tariffs just prior to its privatization in 1991 and also included a network expansion provision in its concession contract (Foreman-Peck & Manning, 1988). The price increases that followed were confined primarily to local and long-distance usage charges, although

[10] To the extent that we unintentionally exclude information on some countries that have rebalanced their tariffs, our econometric model should control for this. As discussed below in greater detail, we create a variable measuring the degree to which prices in all countries deviate from prices in the countries that *have* rebalanced their tariffs. To the extent some countries have rebalanced their tariffs but are not included in the "base" (or pool of countries from which the average *rebalanced* residential basic access service price is calculated), their deviation from the base is expected to be minimal.

those price increases were significant even in real terms. At the time, Argentina was experiencing peak hyperinflation. The concession contract called for an initial annual growth rate of 6.5 percent that dropped to 2.8 percent between 1995 and 1996.

The telecommunications sector in Venezuela was privatized in 1991. Network expansion was a formal commitment and a condition of privatization. Venezuela established annual goals for various regions within the country and policymakers expected demand to be met fully by the year 2000 (Foreman-Peck & Manning, 1988). As was the case with Argentina and Mexico, Venezuela raised its tariffs significantly at the time of privatization. The connection charge for residential customers increased from 3500 bolivars in 1990 to 6700 bolivars in 1992, an increase of 91 percent in nominal terms.

Finally, privatization in Jamaica was not accompanied by significant tariff rebalancing or network expansion contracts (Foreman-Peck & Manning, 1988). In contrast, privatization was accompanied by concession contracts in Guyana (Adam et al., 1992) while, in Peru, tariff rebalancing in the early 1990s preceded privatization in 1994 and network expansion requirements were placed in the concession contract.[11]

3.2. Does privatization affect network expansion and efficiency?

To answer this question, we employ the same econometric model that was used in previous work (Ros, 1999). In the present exercise, however, we apply the data only from Latin American countries.[12] The large number of privatizations in Latin America allows for greater variation in the privatization variable and, by focusing on Latin America, we are able to examine how robust policy implications are for different regions of the world. Subsequently, in Section 4, we expand the analysis to explore the effects of tariff rebalancing as well.

3.2.1. Data and variables

Table 1 above lists the countries that privatized telecommunications between 1986 and 1995.[13] From this list, we select the 10 countries in the Latin American region (i.e., South America, Central America, and the Caribbean). To these 10 countries that had privatized at some point between 1986 and 1995, we add 14 other Latin American countries that had not privatized by 1995 (although Brazil privatized in 1998). The 23 countries in the present study are: Argentina, Barbados, Belize, Chile, Guyana, Jamaica, Mexico, Peru, and Venezuela (all privatized) and Bahamas, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Paraguay, Suriname, Trinidad and Tobago, and Uruguay (all not privatized). All requisite data for these countries are taken from an ITU publication.[14] This results in a panel of data with 23 cross-sections (countries) and 10 time periods (yrs).

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[11] See http://www.osiptle.gob.pe.

[12] We also do not examine the effects of competition in the present study because of the lack of data of requisite quality.

[13] As explained earlier, a country is said to have privatized if at least 50 percent of telecommunications assets are in private hands.

[14] International Telecommunications Union, *Yearbook of Statistics: Telecommunication Services* 1986–1995. Geneva, Switzerland, 1997. The ITU is an international organization through which governments and the private sector coordinate global telecommunications networks and services. It is the leading publisher of telecommunication technology, regulatory and standards information, and provides data for approximately 130 countries worldwide.

Table 4
Description of variables

Variable	Description
ML100	Main lines per 100 inhabitants
ML100G	Annual growth in ML100
Wait	Waiting list for main lines, in thousands
MLEmp	Main lines per employee
MLEmpG	Annual growth in MLEmp
Faults	Faults per 100 main lines per year
Prcon	Price paid by residential user for initial connection to the network (1990 US$)
Pbcon	Price paid by business user for initial connection to the network (1990 US$)
Prmsub	Price paid by residential user for monthly network access (1990 US$)
Pbmsub	Price paid by business user for monthly network access (1990 US$)
P3min	Price of a 3 min local call, peak rate (1990 US$)
InvesL	Annual telecommunications investment per main line (thousands of 1990 US$)
GDP	Gross Domestic Product per capita (thousands of 1990 US$)
Pvtmaj	1 if 50% of assets of main provider of basic services privately held, 0 otherwise

We assemble data on the two main dependent variables of interest: (1) main lines per 100 inhabitants and (2) main lines per employee.[15] Apart from these variables, we also assemble annual data on: the wait list for main lines, faults per 100 main lines, investment in telecommunications equipment, and tariff information such as residential and business network access connection prices, residential and business monthly recurring network access prices, and the price of a 3 min local call. We use consumer price index and exchange rate data to adjust and express prices in all countries in equivalent 1990 real US dollars. Finally, we assemble macroeconomic and demographic data such as GDP and population from which we construct other variables like GDP per capita. Apart from the ITU data, we use a dummy variable for privatization (taking the value 1 if a country has privatized, and 0 otherwise). Table 4 below describes some of the variables used in this part of the study.

3.2.2. *Econometric model*

For our econometric analysis, we employ a cross-section/time-series (panel) data model with the following semi-logarithmic functional form:

$$\ln y_{it} = \alpha + \beta' x_{it} + \delta' d_{it} + v_i + \varepsilon_{it}, \tag{1}$$

where $i(= 1, 2, \ldots, M)$ is the subscript for the cross-sectional dimension (country) and $t(= 1, 2, \ldots, T)$ is the subscript for the time-series dimension (yr). In this study, $M = 23$ and

[15] Main lines per employee are used as a proxy for productivity growth. While this is a commonly used measure of the efficiency for the local exchange carriers in the US, it is not a measure of TFP growth which, ideally, should be used. As a result, there may be problems with the use of this measure, particularly because of the strong political appeal of absorbing labor into any state-owned sector.

Table 5
Regression results: effects on network expansion and technical efficiency (t-statistics in parentheses for coefficient estimates)[a,b]

Independent variable	Dependent variable	
	ML100	MLEmp
Pvtmaj	0.20	0.22
	(5.14)	(3.58)
GDPlag	0.25	0.06
	(11.46)	(2.60)
Constant	1.25	4.00
	(15.33)	(41.01)
N (no. of obs.)	215	195
Log likelihood	253.2	161.4
χ^2 statistic	171.5	27.5
Degrees of freedom	(2)	(2)

[a]All estimated coefficients are statistically significant at the 1% level.

[b]In a previous study (Ros, 1999), the privitization variable was found to be jointly endogenous (i.e., correlated with the regression disturbance term). As a result, an instrumental variable technique was used to estimate the coefficient of the privitization variable. Specifically, the decision to privatize was modeled as a discrete choice using a logit model. The predicted probabilities were then interacted with the observed dummy variables and used as instruments in the second-stage estimation process. (See Donald & Sappington, 1997; Duncan, 1985.) In this paper, we tested whether the Latin American data set also displayed the same endogeneity problem. After performing the Hausman test on the two regression equations, however, there was no evidence to indicate that the privitization variable and the individual-specific disturbance terms are correlated.

$T = 10$. In addition, y_{it} is a $T \times 1$ vector representing, alternately, main lines per 100 inhabitants and main lines per employee.[16] This provides two separate regressions based on Eq. (1). α is a 1×1 scalar constant, β is a $K \times 1$ vector of coefficients, x_{it} is a $T \times K$ matrix of observations for each country on K exogenous variables, d_{it} is a dummy variable, δ is the coefficient of that dummy variable, v_i is a $T \times 1$ vector of the effects of omitted individual-specific (here, country-specific) variables, and ε_{it} is a random disturbance variable assumed to be distributed with zero mean and specifiable covariance structure.[17] Treating v_i as fixed parameters leads to the *fixed effects* form of

[16] In the previous paper (Ros, 1999), the *growth* in main lines per 100 inhabitants and in main lines per employee had also been used as dependent variables. Attempts to replicate those regressions with the Latin American data set did not produce the statistically significant relationships that had been observed in the previous paper (employing worldwide data) and are, hence, not reported.

[17] The starting assumption can be that ε_{it} is distributed identically and independently with zero mean and finite, constant variance. This assumption can be relaxed to allow for heteroscedasticity (non-identical distribution) and/or serial correlation (non-independent distribution) following tests on the data.

the panel data model, while treating v_i as a random variable with known distribution leads to the *random effects* form of the panel data model.[18]

3.2.3. Model estimation and interpretation

Table 5 presents the results of estimating the specified panel data model for 23 Latin American countries over 10 years. The results pertain to the random-effects form of the model and are feasible generalized least-squares (FGLS) estimates that correct for heteroscedasticity and first-order serial correlation that varies by country.[19] The exogenous variables used in the two regressions based on Eq. (1) are the privatization dummy and GDP per capita lagged one year.[20] When interpreting the coefficient estimates, it should be remembered that the percentage impact on y of a dummy variable is given by $e^{\delta} - 1$, while β gives the impact on y of a unit change in an exogenous variable x (Halvorsen & Palmquist, 1980).

Comparison of the privatization coefficients in Table 5 with their counterparts in Table 2 confirms that privatization is still a significant factor positively affecting network expansion and technical efficiency. The magnitude of the impact in Latin America compared to the rest of the world, however, is smaller. According to the results, ML100 and MLEmp are, on average, 22 and 25 percent higher, respectively, in the Latin American countries that have privatized. This compares with figures of 34 and 98 percent, respectively, when worldwide data were used.

4. Effect of tariff rebalancing

The third, and most important, objective of this paper is to examine whether tariff rebalancing has had any effect on network expansion and whether, after controlling for tariff rebalancing, privatization remains an important factor. Previous work had established a *positive* correlation between prices for residential basic access service and network expansion (Ros, 1999). In that study, as also in the present one, network expansion was measured by trends in main lines per 100 inhabitants. At first blush, therefore, the finding about the positive correlation would appear to defy the law of demand.

A closer inspection of conditions in most countries — and especially those in our sample of 23 Latin American countries — reveals, however, that a positive correlation is indeed an expected outcome. Main lines per 100 inhabitants is *not* a measure of *total* demand for basic service, but rather only a measure of *met* demand, i.e., the portion of total demand that has actually been

[18] The fixed effects model adds M parameters (the v_i for all M countries) while the random effects model renders the intercept term for each country random. The best-known test for discriminating between these competing models is the Hausman test (Hausman, 1978).

[19] A Bartlett M test confirmed the presence of heteroscedasticity in the two regressions. The computed M statistic (with a χ^2 distribution) had a value of 149.6 and 369.9, respectively, for the two regressions. At 22 degrees of freedom, these χ^2 values were highly statistically significant at conventional levels of significance. This test is proposed for panel data regression by Baltagi (1995) and is described in Judge, Griffiths, Hill, Lukepohl and Lee (1985, p. 448).

[20] In a previous study (Ros, 1999), investment and price variables were included as exogenous variables. Those variables are excluded here because their estimated coefficients are statistically insignificant and their omission improves the log-likelihood values.

satisfied at a given point in time. Viewed differently, met demand is the level of demand that can be served under current conditions of supply. If supply constraints prevent the provision of service to all individuals or households that have requested it, then really a met demand variable like main lines per 100 inhabitants is a measure of actual current supply at prevailing prices. Under these circumstances, total demand exceeds met demand — i.e., actual supply — and the supply constraint is binding because the prevailing service price is too *low*, not because it is too *high*. Therefore, low penetration for basic service in these countries is not a problem of unaffordable high prices, but rather of prices that are too low to induce service providers to meet the level of demand that is being expressed in the market.

If this conjecture is true, then a testable hypothesis and a policy implication should flow from it. First, we should be able to test that the supply constraint is relieved (and the level of unmet demand relative to the level of met demand is reduced) as the price of basic service rises. Second, if that hypothesis is confirmed, then the conventional wisdom of pricing basic service — at least to residential consumers — below cost in order to harness positive network externalities and encourage progress toward universal service would be called into question. From a public policy standpoint, it would then be important to give more credence to price-induced supply constraints as a possible cause of low penetration for basic service than to other demand-side considerations.[21]

4.1. Previous work on shortages and excess demand

The notion that low penetration rates for basic services is primarily the result of supply, rather than demand, constraints is not new and our work is a contribution to the existing literature. Previous work by the World Bank indicates that with proper pricing policies — tariff rebalancing that more closely aligns prices with underlying costs — telecommunications investments may be expected to yield rates of return between 13 and 25 percent (Saunders, 1994). The World Bank has called into the question the policy of stimulating residential consumption through lower prices in developing countries where demand typically exceeds supply (see Saunders, 1994, p. 277). Another body of work relevant to the present paper pertains to shortages and excess demand in socialist and state-dominated economies.[22] This literature explains why shortages were a persistent feature of socialist economies and sheds light on the effects of subsidies on micro-level performance (Kornai, 1992).[23]

4.2. Excess demand model

As in previous works cited, we hypothesize here that low actual penetration and significant and persistent levels of unmet demand for basic service are the direct result of monthly recurring prices

[21] As we noted earlier, even casual empiricism seems to confirm this possibility in a country like Brazil where individuals make large lump sum payments simply to queue for telecommunications services and a thriving resale (black) market for those services exists.

[22] For a review of this literature, see van Brabant (1990).

[23] Kornai develops the concept of the soft budget constraint whereby a firm's expectation that losses will be made up from other sources in the economy or that "profits" will be diverted to other firms negatively affects its efficiency and contributes to systematic shortages in an economy.

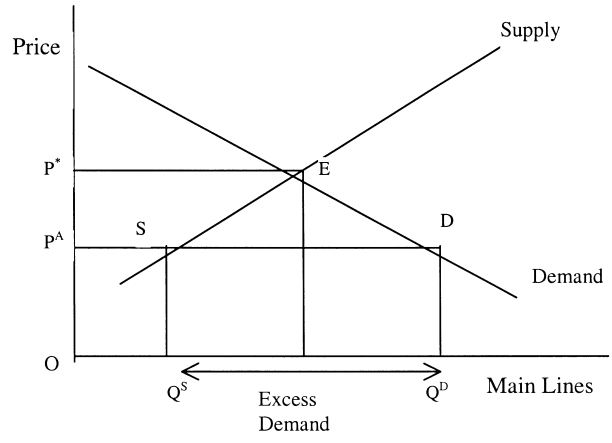

Fig. 1. Graphical view of excess demand.

for access to basic service that are too low, perhaps even below incremental cost. In the absence of cost data, it is impossible to verify directly whether basic service prices — particularly to residential consumers — are indeed below cost. However, we conjecture that indirect evidence may be available by testing the relationship between those prices and the level of *excess* or unmet demand over time. Stated differently, countries that have rebalanced their tariffs and allowed residential basic service prices to increase gradually should have succeeded relatively more at relieving their supply constraints — i.e., undertaking network expansion — and reducing excess demand than countries that have not raised those prices.[24]

For purposes of this study, total expressed demand is the sum of met demand — i.e., the level of service actually supplied at prevailing prices — and unmet demand represented by the number of lines that have been demanded but are still waiting to be served at prevailing prices. This can be understood by reference to Fig. 1. In Fig. 1, the intersection of the supply and demand curves for main lines (at E) depicts the point of equilibrium: supply equals demand at a price of P^*. However, if for whatever reason, actual price were set at P^A, actual expressed demand (Q^D) would exceed demand actual supply (Q^S) by the distance SD (or the span of the double-arrowed line under the horizontal axis). Met demand would be the distance OQ^S. As Fig. 1 shows, raising the price from P^A in the direction of P^* would both expand supply and reduce total demand and, thus, shrink

[24] Even though we refer to the raising of residential basic service prices by the convenient shorthand "tariff rebalancing," it should be understood that rebalancing entails moving *all* service prices closer to underlying incremental costs. That is, under comprehensive rebalancing both below-cost prices should rise and above-cost prices should fall. In this study, we focus exclusively on the more sensitive issue of how *residential* basic service prices have moved. We assume that *business* basic service prices have always been compensatory (i.e., at or above cost) and have not contributed to the problem of excess demand to anywhere near the same degree that low residential service prices may have. It should be noted that the count of main lines includes *both* business and residential lines in service. We assume, however, that the count of excess demand — wait list for service — comprises mainly, if not only, residential lines.

excess demand — causing unmet demand as a percentage of total demand to fall. In this supply-constrained situation, the price is not too *high* to discourage demand; suppression of demand cannot happen until the actual price exceeds the equilibrium price under current market conditions. Of course, as income growth and a greater taste for telecommunications shifts the demand curve itself to the right and more efficient technologies and delivery systems also move the supply curve to the right, the equilibrium level of service may itself rise. However, without more precise knowledge of how much supply and demand would both shift, it is difficult to predict from Fig. 1 alone what would happen to the level of the equilibrium price and the relative levels of met demand and unmet demand — if any.

Given that excess demand is the gap between total demand and supply, any attempt to model excess demand in a reduced form specification would necessarily imply that excess demand is a function of all variables that are expected to influence both total demand and supply. Economic theory suggests that demand is a function of own-price, prices of substitutes and complements, income, and other sometimes unobservable characteristics like taste, consumer knowledge, and demographics. Similarly, supply is a function of the offer price, level and type of supply technology, and supply conditions like government and institutional constraints — e.g., and constraints on competition, privatization, and pricing based on public policy goals. Therefore, excess demand should be, in theory, a function of some — if not all — of all these drivers of supply and demand.

4.3. Key variables

To test our hypothesis, we measure the excess demand variable by the wait list for basic service as a percent of total demand — i.e., main lines in service *plus* the wait list. By construction, this variable lies in the range from zero to one. The disappearance of excess demand would be signified in this formulation by the percentage measure going to zero.

Our tariff rebalancing variable measures how close the monthly price of basic service to residential consumers is to the average residential price for those countries that have rebalanced tariffs and moved their residential prices to more closely approximate equilibrium or compensatory prices. To construct the tariff rebalancing variable, our point of departure is the observation that in many, though not all, of the 23 Latin American countries in our sample, the price of basic service to residential consumers has tended to rise through the 1990s and, in some instances, level off. This trend is best displayed for countries that have privatized — though not all at the same time — namely, Mexico, Peru, and Venezuela. Other countries of interest are Argentina and Chile. In Argentina, the inflation and exchange rate-adjusted monthly price for residential basic service has actually *fallen* through the 1990s; however, that price has stabilized of late at the presumed equilibrium level. In Chile, the price of residential basic service has been set to cover long-run incremental cost for several years; its price is, hence, arguably cost-based and at the equilibrium level.

Tariff rebalancing — moving the price of residential basic service toward cost — is not always associated with, and not necessarily a function of, privatization. Other countries (including Costa Rica, Ecuador, and Uruguay) that have not privatized have also displayed a trend toward higher prices. However, to the extent that rate rebalancing may have been a precursor to, or a concomitant element of, a policy of privatization, we believe that the five countries listed above provide the

basis for constructing at least a *baseline* average price for residential basic service by which pricing trends in the other 18 countries may be measured.[25]

Based on this reasoning, we define a tariff-rebalancing variable for our study in two steps. First, we compute an average price for residential basic service for the above-mentioned five countries in 1995, the last year of our sample. We choose the last year because of the observed trend of prices in these countries to stabilize around their 1995 levels. This average or baseline price is calculated as US $10.64 per residential main line. Second, we measure the deviation of the price of residential basic service from this baseline price in *every* country in our sample for *every* year spanned by our sample.

Two alternate, but equivalent, measures are possible: (1) the ratio of that price for any given country in any given year to the baseline price and (2) the percent deviation of that price for any given country in any given year from the baseline price.[26]

4.4. Model specification

To test our hypothesis that the wait list percentage — excess demand — is reduced as residential basic service prices approach the baseline average price, i.e., tariffs are rebalanced — we specify a variant of the econometric model in Eq. (1).

$$z_{it} = \alpha + \beta' x_{it} + \delta' d_{it} + v_i + \varepsilon_{it}. \tag{2}$$

We retain the panel data specification but do not first take the logarithmic transform of the dependent variable z_{it} which, in this case, is a ratio variable that lies in the range from zero to one.[27]

The exogenous variables employed for this regression reflect the mix of price and non-price variables that, as we discussed earlier, are usually considered drivers of demand and supply. Specifically, non-price variables employed here include:

Demand side: GDP per capita (current and lagged).

Supply side: percent of main lines served by digital switches and lagged investment per line (both measures of technology).

Unlike the model used to test for the effects of privatization on network expansion and technical efficiency, in the present model we use only a single price variable, namely, the tariff rebalancing variable as defined above.[28] Because of the manner in which it is constructed, this variable makes it unnecessary to separately specify the average monthly residential basic service price as an exogenous variable. The average monthly business basic service price is not considered because

[25] This exercise is complicated by serious data limitations mostly in the form of the unavailability of price data in the countries of the region for every year in the 10-year period studied. These gaps in the data mean that price trends in only a subset of the 23 countries can be reliably assessed and that the data panels constructed for those countries are necessarily unbalanced.

[26] Where the ratio exceeds (falls below) one, the percent deviation is positive (negative).

[27] Although our dependent variable is bounded by zero and one, it is *not* a binary variable that only takes on discrete values. Instead, that variable is continuous on the interval between zero and one for the entire population.

[28] As noted previously, our tariff rebalancing variable was created by dividing residential monthly prices by US $10.64. Dividing a variable by a constant does not affect the significance of a regression; it merely alters the magnitude of the coefficient for that variable. For our purposes, dividing by US $10.64 permits us to measure in ratio form the *relative difference* between each country's price and prices that are more reflective of underlying costs.

that price is generally considered to be *above* cost and the wait list is believed to include very few (if any) business consumers. The one-time charges for connection to the network are considered unlikely to have any significance for the wait percentage in a *supply*-constrained environment and are, hence, omitted. The peak-hour price of a 3-min call is omitted for the same reason. Finally, as before, we use a dummy variable to account for the effects of privatization.

We hypothesize that the relationship between the dependent variable and each of the exogenous variables — in particular, the tariff rebalancing variable — will be negative signifying that increments to any of the exogenous variables will cause the wait list percentage to be reduced. We also expect privatization to have a negative effect on the wait list percentage. By including privatization we are testing whether, after controlling for tariff rebalancing, there are still concrete efficiency gains from privatization.

4.5. Model results

We estimate the model in Eq. (2) by FGLS with heteroscedasticity and country-specific serial correlation correction.[29] The estimation routine we use takes account of the unbalanced nature of the panel on account of missing data.[30] Table 6 reports the regression results from the best-fit model (from which all exogenous variables with insignificant coefficients are dropped).[31] The new variables in Table 6 are MLDig (the percent of main lines served by digital switches) and tariff rebalancing (the ratio of residential basic service price to the average baseline "efficient" price).

The wait list percentage — our measure of excess demand — appears to respond most strongly to the tariff rebalancing variable (as was hypothesized in this study) and the measure of technology embodied in the percent of main lines served by digital switches. The coefficients of both variables are highly statistically significant. The effect of privatization is somewhat less statistically significant (with a probability value of 0.083) but would pass the significance test at the 10 percent level.

While all of the variables reported in Table 6 have coefficients with the expected signs,[32] their magnitudes of response are harder to judge. The coefficients measure the impact of each variable on the wait list as a percent of total demand (i.e., wait list plus lines in service). For example, our estimates indicate that privatization reduces waits — as a percent of total demand — by 3.7 percentage points. In order to make this figure more meaningful, however, we calculate the reduction due to privatization and tariff rebalancing in the actual *number* of lines waiting to be

[29] The Bartlett M test confirmed the presence of heteroscedasticity in the regression. The computed M statistic (with a χ^2 distribution) had a value of 157.8, which, at 22 degrees of freedom, was highly statistically significant at conventional levels of significance.

[30] Missing data in panels do not cause biased estimates if they are missing at random and the probability of those data being missing is independent of the observed or missing responses (of the dependent variable). See Jones (1993).

[31] Other model estimates were obtained by use of GLS without correction for heteroscedasticity or serial correlation, the basic random effects model, and robust estimation. The reported model remained superior with the smallest standard errors for the coefficient estimates (efficiency) and highest log likelihood values (goodness of fit). Likelihood ratio tests were also used to establish significant improvements in fit from dropping exogenous variables with insignificant coefficients.

[32] Using the estimated coefficients in Table 6, we generated predicted values for the dependent variable and found that none of them was below zero or above one, confirming that the model did not generate predicted values that were outside the range within which all values for the wait list percentage were contained in the population.

Table 6
Regression results: effects on wait list percentage (excess demand), feasible generalized least squares (*t*-statistics in parentheses for coefficient estimates)

Independent variable	Dependent variable: wait list percentage
Pvtmaj	−0.037[b]
	(−1.736)
Rebalancing	−0.068[c]
	(−4.343)
MLDig	−0.001[c]
	(−4.065)
Constant	0.324[c]
	(14.223)
N (no. of obs.)	71
Log likelihood	195.25
χ^2 statistic	67.83[c]
Degrees of freedom	(3)

[a] As noted previously, our excess demand variable (the dependent variable) varies continuously on the interval [0,1]. The sample with which we have estimated the model does *not* contain data that are, in some manner, censored, as would be the case if only values above or below a certain threshold were observed. Therefore, being neither binary nor discrete nor censored, it is unnecessary to use estimation techniques that are suited to limited dependent variables — such as logit, probit or tobit models. However, purely for comparison, we also estimated a tobit model for Eq. (2), with "censoring" assumed at values 0 and 1. Our estimates for the coefficients of privitization, rebalancing, and technology variables (with *t*-statistics in parentheses) were −0.095 (−8.740), −0.017 (−1.874) and −0.001 (−4.989), respectively. While these results appear to place a higher weight on privatization but less so on rebalancing, we believe, for reasons mentioned above, that it is more appropriate to estimate Eq. (2) using FGLS than a tobit model. Predicted values for our dependent variable from the two sets of estimates were relatively similar, with a correlation between them of approximately 0.8.

[b] At 10% level.

[c] Statistically significant at 1% level.

served. For tariff rebalancing, we first measure the impact on the dependent variable of a 10 percent increase in price from the average residential price in Latin America of US $7.28. We then use the change in the dependent variable to calculate just how much the wait list would be reduced by tariff rebalancing.[33] According to our calculations, a 10 percent increase in the average residential price

[33] The change in the dependent variable, i.e., the change in wait list percentage involves four items: the number of lines on the wait list in the *previous* year, the total demand in the *previous* year, the total demand in the *present* year (all of which are known), and the number of lines on the wait list in the *present* year (which has to be solved for). Thus, evaluating this relationship at the average level for all items (e.g., average number of lines on the wait list in Latin America in the previous year is approximately 218,000), we calculate the average number of lines on the wait list in the present year.

leads to a 4.1 percent reduction in the average number of lines on the wait list. Using the same methodology, privatization leads to a 28 percent reduction in the average number of lines on the wait list.

While the magnitudes of the impacts appear reasonable, more and independent confirmation of these results would be helpful. These results provide two important findings: (1) in supply-constrained environments, abandoning the policy of below-cost pricing of residential basic service may actually relieve the supply bottleneck and *increase* the proportion of met demand and the penetration rate for basic services,[34] and (2) controlling for tariff rebalancing, privatization leads to reductions in unmet demand indicating that there are concrete efficiency gains resulting from privatization.

5. Conclusions

Privatization of telecommunications in several countries of Latin America during the 1980s and 1990s altered significantly the prospects for the development of the all-important telecommunications sector in that part of the world. Several events happened concurrently or almost concurrently to further shake up the status quo in telecommunications and improve performance, prominent among them being the rebalancing of tariffs for basic service.

The purpose of this paper has been to sort out the effects of these events on some important measures of telecommunications network participation by the inhabitants of the Latin American region. The number of main lines in service is often used as an indicator of penetration (market demand). Building on previous work that showed a positive correlation between that variable and the level of residential basic service prices, we made the case that such a positive correlation means that the number of main lines in service at any point is not *total* demand but rather only the level of *met* demand in a supply-constrained environment. That is, network expansion in the countries of the region is more likely to be driven by an *increase* in the price of residential basic service — from below cost levels — than by any decrease in it. When prices are below efficient levels — e.g., below incremental cost — demand outstrips supply and creates a condition of excess demand that can only be relieved by raising those prices up to efficient levels. Therefore, the main lines in service in the presence of inefficiently low prices represent only the amount of supply forthcoming, which is typically insufficient to meet all of the demand at those prices. That is, the main lines in service is a measure of met demand or, equivalently, actual supply in an environment in which supply is constrained by inefficiently low prices.

This paper extended previous work in three directions. First, it tested the robustness of results obtained earlier from a worldwide sample of data regarding the impact of privatization on network expansion and technical efficiency. Using a sample of 23 countries in Latin America for the 10-year period between 1986 and 1995, we successfully replicated the finding from previous work that privatization has a significant positive impact on both network expansion and technical efficiency.

[34] This, of course, assumes that governments do not institute formal or informal mechanisms for providing subsidies that support the pricing of residential basic service below cost.

Second, we explored qualitatively some of the factors that may have prompted so many Latin American countries — a disproportionate share of countries worldwide — to privatize their telecommunications sectors by transferring at least 50 percent of telecommunications assets into private hands. Those countries may have seen positive efficiency gains from private ownership and a way out of the trap of low penetration. As previous work and follow-up work in this study showed, there is definitely evidence from the region that privatization altered incentives sufficiently to relieve the supply bottlenecks from the days of public ownership and increased the supply of main lines.

Third, we tested the hypothesis that low penetration rates in Latin America arise from service prices that are too low. We tested this hypothesis with an econometric model and concluded that tariff rebalancing, privatization, and network technology upgrades all have the effect of reducing the proportion of unmet demand for residential basic service in a country. Specifically, a 10 percent increase in monthly subscription charges (relative to the average residential price in Latin America) leads to a reduction in unmet demand of approximately 4.1 percent. And, most importantly, even after controlling for tariff rebalancing, privatization appears to reduce unmet demand by approximately 28 percent.

The public policy implications of this study are twofold. First, privatization generates concrete efficiency gains that are over and beyond those generated by tariff rebalancing. Second, instead of relying on artificially low prices to trigger greater use of the telecommunications network — on the theory that low prices enable consumers to harness network externalities and increase penetration rates — it is more pragmatic to allow telecommunications operators, especially in countries that have privatized, to recover their costs by charging compensatory prices. A country may be able to generate "high" levels of demand by a deliberate policy of maintaining prices below cost or at low levels, but — as long as it does not provide subsidy support for such prices — it is only by increasing actual supply that the country can actually expect to see service delivered to consumers. Therefore, while privatization clearly favours supply-led growth and network expansion, the all-important role of tariff rebalancing and compensatory pricing cannot be overlooked in sustaining that expansion and reducing unmet demand.

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