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Telecommunications Reform, Access Regulation, and Internet Adoption in Latin America

Latin America is betting on the potential "new economy" productivity payoffs from telecommunications reform. It wants fast improvements in the quantity and quality of its information and communications technology. The optimistic ten-year growth target issued by Chile's Telecommunications Subsecretariat in mid-2000 for fixed line, mobile phone services, and Internet products is quite illustrative.[1] By 2010, it expects fixed phone penetration to more than double, reaching 49 percent of the population, mobile penetration to triple to 60 percent, and Internet access to quadruple to about 50 percent.[2] Similar statements made by key policymakers from Argentina to Mexico suggest that this optimism is shared throughout the region. The underlying assumptions are, first, that the liberalization of the sector has progressed enough to allow the countries of the region to make the most of cheaper technologies and the lower costs of access to web-enabled telecommunications technologies and services; second, that most policymakers expect that once supply has increased enough, demand will quickly follow thanks to the diffusion of the new technologies throughout the region, thus requiring very little input from the government beyond ensuring the liberalization of the telecommunications sector; and third, that this process should significantly con-

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1. "Chile's Optimism Greeted with Skepticism," *Latincom*, 6 October 2000, p. 12.
2. In comparison, 41 percent of the United States population currently has a computer.

tribute to closing the gaps between the poorest and the richest citizens across and within countries.[3]

The generalized optimism evident in these assumptions seems somewhat excessive for now. The main purpose of this paper is to show that competition is not yet the effective norm in Latin America's telecommunications sector and that the government still has a strong role in the sector to ensure that the new economy spreads its expected benefits throughout the region. More specifically, we argue that much regulation, in particular in the area of interconnection rules, must still be introduced in the noncompetitive segments of the business if the telecommunications sector is to be competitive enough to achieve the desired goals. Effective competition and regulation are crucial if the telecommunications reforms are to allow the new economy to yield gains for everyone.

The empirical analysis of this paper tests the assumption that the Internet, like any other innovation, will enjoy an autonomous diffusion process, as argued recently by many analysts.[4] Once we account for unobserved country-specific characteristics, we find little evidence to support the view that such an exogenous Internet diffusion process is taking place in Latin America. We argue instead that regulatory actions and policy interventions are needed, especially in terms of access to phone lines (both fixed and mobile) that are still lacking in the region. In that context, we show how the main regulatory determinants of access rules in Latin America drive the odds of network integration and hence the incentives for investment in telecommunications infrastructure necessary to sustain the regional diffusion of the Internet.

The paper is organized as follows. We first review some stylized facts on reform and its effects on the level of telecommunications and Internet penetration in the region. The subsequent section econometrically tests the determinants for the differences in Internet penetration rates around the

3. Some authors have serious doubts that these benefits will be evenly distributed, and they talk about the risks of a digital divide among nations without an explicit government intervention. See Pippa Norris, "The Global Divide: Information Poverty and Internet Access Worldwide" (www.ksg.harvard.edu/people/pnorris/acrobat/IPSA2000.pdf [2000]); Francisco Rodriguez and Ernest Wilson III, "Are Poor Countries Losing the Information Revolution?" *info*Dev working paper, World Bank (www.infodev.org/library/working.htm [2000]).

4. See the background papers to a recent World Institute for Development Economics Research (WIDER) research project, available on the WIDER website (www.wider.unu.edu/).

world and in the region, including tests of the importance of regulation as a determinant of cross-country differences in Latin America. We then summarize some of the main regulatory issues that will have to be addressed by the region's telecommunications regulators. The section also draws the main lessons from existing theory for the outstanding regulatory agenda. In particular, we highlight all the issues regulators must consider when designing interconnection agreements. The final section concludes. Appendix A outlines the basic technical and economic features of a communication network, while appendix B provides a glossary.

What Are the Outcomes of a Decade of Institutional Changes?

The sector has undergone major institutional changes in response to a combination of factors, including the poor historical performance of the public enterprises that traditionally ran the sector, a reduction in government financing of sectoral investment deficits as a result of fiscal crisis, and new opportunities created by technological progress. The 1990s saw the adoption of new laws aimed at liberalizing telecoms; these have been at least partially implemented in all countries in the region except Costa Rica and Uruguay. Moreover, of the twenty countries surveyed in table 1, about 75 percent have fully or partially privatized the historical operator.[5]

One of the goals was to introduce competition, at least gradually. The dissemination of cellular phones, the opportunities for call backs, and other technology changes forced competition into the sector in many countries. Most have some degree of competition, although often with restrictions. This can be seen in the generous exclusivity periods granted to the first entrants in the business after privatization. These first entrants typically were strategic investors who took some risks and wanted some protection for those risks, at least during the early 1990s. In exchange, governments demanded investment commitments to improve coverage and service quality. The main exception is Uruguay, where a 1992 referendum resulted in the rejection of changes in the sector and, in particular, of its liberalization. In some other countries, including Costa Rica, Ecuador, and Honduras, political and economic problems postponed the

5. All the data used and quoted in this document are from the International Telecommunication Union (ITU) database unless otherwise specified.

TABLE 1. Summary of Key Reform Elements in Latin America's Telecommunications Sector

Country	*Key reform law*	*Year of first incumbent privatization action*	*Degree of privatization of incumbent operator*	*Period of exclusivity for initial new incumbent*	*Level of competition (as of early 2000)*[a]			*Effective creation of regulatory agency*	*Is regulator specific to telecommunications?*	*Regulator financing*	*Supervisory organization*
					Local	*Long distance*	*Digital cellular*				
Argentina	1989	1990	Full	1990–2000	P	P	P	1990	Yes	Regulatory fee	Ministry
Bahamas	1992	Delayed			M	M	M	1993	No	Government budget + auction revenue (license/ spectrum) fee	
Bolivia	1995	1995	Partial	1995–2001	M	M	D	1995	Yes	Regulatory fee	Ministry
Brazil	1997	1998	Full	1998	P	P	P	1997	Yes	Government + auction revenue	Ministry
Chile	1982	1987	Full	None	F	F	F	1977	Yes	Government	Ministry
Colombia	1991	Not yet	None	None	D	F	D	1994	Yes	Regulatory fee	Ministry
Costa Rica	1996	Not yet	None	n.a.	M	M	M	1996	No	Regulatory fee + government	Parliament
Dominican Rep.	1998	1999	Full	n.a.	F	F	F	1998	Yes	Auction revenue + government	Public controller
Ecuador	1995	Not yet	None	1995–2000	M	M	P	1995	Yes	Auction revenue	Head of state
El Salvador	1995	1997–98	Partial	None	F	F	F	1997	No	Auction revenue + government	Ministry
Guatemala	1995	1998	Full	None	F	M	F	1996	Yes	Auction fee	Ministry
Honduras	1996	In process	None	1995–2005	F	M	D	1996	Yes	Government	Ministry
Jamaica		1989–91	Full	n.a.	M	M	F	1995	No	Regulatory fee	Ministry

Mexico	1990	1990–91	Full	1990–96	F	F	F	1996	Yes	Government	Ministry
Nicaragua	1995	In process	n.a.	1995–99	M	M	F	1995	Yes	Auction fee	Head of state
Panama	1995	1997	Partial	1997–2002	M	M	P	1996	No	Auction fee + government	Head of state
Peru	1991	1994	Full	1994–99	F	F	F	1994	Yes	Regulatory fee	Ministry
Venezuela	1991	1991	Partial	1991–2000	M	M	F	1991	Yes	Regulatory fee + government	Ministry
Uruguay	1992 referendum rejected liberalization	No	None		M	M	F		Yes	Government	Ministry

Source: Authors' compilation, based on International Telecommunication Union (ITU) database, regulators' websites, and World Bank internal documents.

a. Level of competition: M = monopoly; D = duopoly; P = partial competition; and F = full competition. These definitions are taken from ITU and refer to the number of licencees rather than the actual degree of competition.

actual reforms, but table 1 shows that the major laws have already been introduced.

Another important change has been the creation of independent regulatory agencies. Table 1 reveals that in most countries, these agencies are sector specific and are accountable to a ministry rather than to the head of state or parliament. Consequently, the main threat to the agency's independence from political interference results from its lack of financial autonomy. As long as a minister is expected to sign off on a budget transfer to finance the regulator's expenses, there is a risk of conflict of interest in regulatory decisions.

The final institutional change worth mentioning is one that has not yet happened. While most countries have introduced the appropriate legislation and while most regulators have defined the basic regulatory principles they intend to follow on most issues, the supporting analytical work is still lagging. Take the example of the regulatory regime. Most Latin American countries have decided to rely on a price cap. This implies that the regulator must have some idea of the efficiency gains realized by the operators, since this gain will eventually have to be shared with the users. No country has yet defined the methodology for assessing these gains, which leaves the regulatory decision open to negotiation. Regulatory gaps like this one seem not to have had dramatic impacts in the region, however, probably because of the competitive international environment and continuous technical changes that drive costs and tariffs down.

So far, the general outcome associated with the reforms has been quite impressive. Table 2 summarizes key performance changes that occurred during the 1990s. The improvements were dramatic, as they reflect the joint effects of reform and technology changes, but they are not sufficient. For instance, although the growth in the number of phones per hundred inhabitants increased by close to 40 percent between 1996 and 2000, phone penetration is still only about 25 percent of what it is in high income countries (thirty-one residential main lines per hundred households in 1998 for Latin America and the Caribbean versus 113 for North America). The gap in access to phone services is closing, however, with the acceleration in the penetration of cellular phones—from 100,000 in 1990 to 39 million in 1999. One in every four phone users in Latin America now relies on mobile. In Paraguay and Venezuela, cellular phone users outnumber fixed phone users. Service quality has also improved. For instance, faults are dropping, and waiting times to get new phones continue to

TABLE 2. Evolution of Selected Partial Performance Indicators in the Telecommunications Sector

	Main telephone lines per 100 inhabitants		*Cellular subscribers per 100 inhabitants*		*Faults per 100 main lines per year*		*Residential connection rate (in dollars)*		*Residential monthly subscription fee (in dollars)*	
Country	*1990*	*1999*	*1990*	*1999*	*1991*	*1998 or 1999*	*1996*	*1999*	*1996*	*1999*
Argentina	9.31	20.11	0.04	12.12	42.4	17.3	69	150	11.1	13.2
Bolivia	2.76	6.17	0.00	5.16			168	131	5.5	1.7
Brazil	6.50	14.87	0.00	8.95	4.5	3.2	1,112	28	2.7	6.0
Chile	6.60	20.70	0.11	15.05	97.0	52.0	258	159	15.3	16.3
Colombia	6.91	16.03	0.00	7.53	80.4	56.0	321	181	2.9	3.8
Costa Rica	10.05	20.41	0.00	3.53		42.1	63	58	5.3	3.9
Dominican Rep.	4.76	9.81	0.04	5.02			98	98	6.6	6.6
Ecuador	4.78	9.10	0.00	3.09	197.0	82.0	167	136	1.0	1.7
El Salvador	2.42	7.61	0.00	6.22			297	331		7.1
Guatemala	2.13	5.51	0.00	3.05			258	223	0.7	0.0
Haiti	0.69	0.87	0.00	0.31				48		5.7
Honduras	1.72	4.42	0.00	1.24	61.2	24.0	33	15	2.3	1.5
Jamaica	4.46	19.91		5.64	85.2		16	16	6.6	2.7
Mexico	6.48	11.22	0.08	7.94	9.4	2.2		111		14.5
Nicaragua	1.26	3.04	0.00	0.90			33	192	6.6	2.1
Paraguay	2.66	5.54	0.00	8.13			822	561	3.3	4.8
Peru	2.61	6.69	0.01	4.02	54.0	23.8	504	130	8.9	14.0
Uruguay	13.43	27.07		9.54		5.6	382	89	9.1	8.5
Venezuela	7.63	10.91	0.04	14.34		3.5	39	101	2.5	9.5
United States		>100.00		31.55		13.4		44		19.9

Source: International Telecommunication Union (ITU).

decrease (and have effectively converged to zero as many users can now simply get a mobile phone). Finally, connection fees and subscription charges are falling as well. All of these factors contribute to the overall positive impression generated by the outcomes of the reform.

There are also problems, however. First, most governments in the region do not seem to appreciate that negotiating privatization is the easy part; they underestimate the importance of introducing and enforcing a regulatory regime that results in outcomes mimicking the effects of competition. Indeed, the implementation of the regulatory agenda is still lagging, and competition continues to be restrained in ways that impede the achievement of the full effects of reform in the sector. For instance, Latin America counts many Internet telephony service providers, which capture both terminating and originating long-distance traffic. These could put competitive pressure on traditional licensed operators. Some countries, such as Argentina, initially explicitly prohibited Internet providers from offering the equivalent of phone services, which they viewed as telecommunications services requiring licenses either as traditional circuit-switched long-distance services or as value added services subject to their own set of rules. Others, such as Chile, have quickly legalized these substitutes to phone services; this raises the issue of discrimination, since these companies may not have the same service obligations as traditional operators. The majority, however, has not yet issued opinions on the matter. In the best cases, this has led to a wait-and-see strategy by potential entrants, while in the worst cases, it has generated conflicts. In Colombia, for example, the gradual approach to market liberalization appears to be interfering with the much faster technological progress: when the cellular operator Comcel started selling voice services without a long-distance license, all the existing long-distance carriers that had paid the required $150 million for that license immediately sued, revealing the difficulties of building a dynamic vision of competition in this environment with changing technologies.

Second, high prices continue to be perceived as an issue in the region. To a large extent this is a result of limited competition. For most countries, the exclusivity periods granted to facilitate privatization resulted in lasting high connection and usage tariffs. Table 2 shows that residential connection rates continue to be high when compared to the United States, even if they have gone down significantly. These exclusivity periods are now coming to an end in Argentina and Venezuela, and this should lead to a market-driven reduction in tariffs. However, most countries have not yet defined the rules for ensuring competition in a sector in which the regulatory debate continues to center on how much the owners of the bottleneck facilities charge for access.

Finally, there are concerns that tariffs may not have dropped enough and that demand from the poorest is likely to be rationed, a consequence of the continued problem of income distribution in Latin America. As of mid-1999, for instance, only 10–15 percent of the population had the resources to get online.[6] This is not a random fact. A study conducted in 1999 of the distribution of the gains from utilities privatization in Argentina suggests that unless regulation is effective in redistributing the gains to all users, reform mostly benefits the local co-owners of privatized assets.[7] In terms of access to new technologies, this implies that unless service obligations and ability-to-pay constraints are built into regulatory decisions, there is a reasonable risk that the distribution of the benefits of reforms will reflect the current distribution of wealth.[8]

What Drives Cross-Country Differences in Internet Access?

The Internet has the potential to provide a wide array of benefits, ranging from education to business opportunities. Internet subscriber penetration across Latin America is about 1 percent. As of 1999, about 98 percent of these connections were through analogue modems used in combination with a phone line. This correlation between telephone access and Internet access is illustrated in figure 1 for a sample of twenty Latin American countries. The linear trend line provides quite a good fit.

Table 3 summarizes some of the indicators available for Latin America on the spread of Internet access in the region. For a large majority of the countries of the region, Internet access dates from the second half of the 1990s.[9] The table shows that the number of Internet service providers

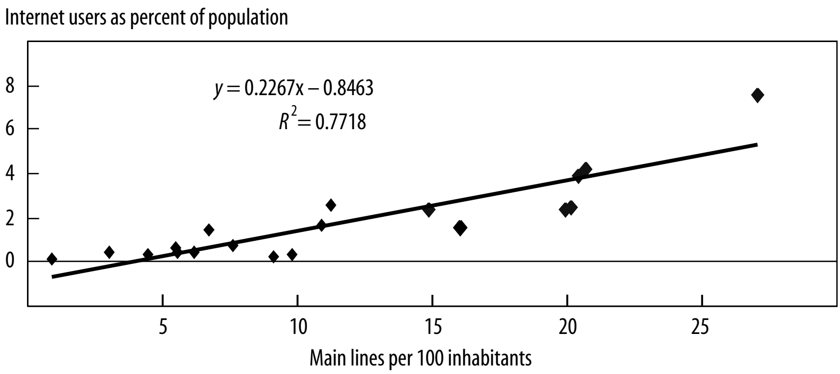
6. "Mass Market Internet Still Some Way Off in Latin America," *Latincom*, 16 June 1999, p. 5.

7. Chisari, Estache, and Romero (1999).

8. See the related WIDER research program. See also Estache, Wodon, and Foster (2002); Estache, Gomez-Lobo, and Leipziger (2001).

9. The 1999 business-to-business transactions in Latin America are estimated at $288 million, with about two-thirds concentrated in Argentina, Brazil, and Mexico. The equiva-

FIGURE 1. A Simple Correlation between Telecommunications Access and Internet Use



is generally high enough in most countries to suggest that competition is not a major issue in this specific activity. Usage charges continue to be quite high, however. In 1999, the average cost of being online, including service provider fees and local call charges, was $52 per month, twice the equivalent cost in the United States.

One of the most obvious explanations for the continued high costs is the existence of strong impediments to effective competition. Anecdotal evidence tends to confirm this line of reasoning. For instance, in Brazil, which represents about 50 percent of all Latin American users, the high delivery costs for Internet service result from the near monopoly position of the incumbent on international gateways. This is a problem for most potential entrants as well as for users, and it forces providers to be creative in finding ways to finance their services. One example is Bradeco Bank, which introduced a free-access Internet service in December 1999 in an attempt to adopt a business model based on advertising fees. The most widely chosen option, however, is revenue sharing with local telephone companies, following the European model. This solution will require some regulatory intervention, since in many countries local telephone companies are also ISPs and are unlikely to work out deals that may hurt that part of their business.[10]

lent figure for the United States is $114 billion. See Morgan Stanley Dean Witter, *Latin America Internet Report,* February 2000.

10. An example is Telefónica, which owns Terra Livre, a free Internet access provider.

TABLE 3. Indicators of Potential Access to the Internet, 1999

Country	*Start date of Internet access*	*ISPs*	*Internet hosts per 10,000 inhabitants (in 2000)*	*Internet users as percent of population*	*Internet charges*[a]	*Personal computers (in thousands)*	*Cable TV subscribers (in thousands)*
Argentina	1989	170	38.48	2.5	27.90	1,800	5,890[b]
Bolivia	1995	9	1.14	0.4	15.07	100	70
Brazil	1994	280	26.22	2.4	12.24	6,100	1,932
Chile	1992	26	26.42	4.2	19.12	1,000	656
Colombia	1994	15	9.59	1.6	n.a.	1,400	613[b]
Costa Rica	1993	2	20.47	3.9	20.00	400	75
Dominican Rep.	1995		7.89	0.3	n.a.	n.a.	n.a.
Ecuador	1993	9	1.52	0.2	25.00	250	200[b]
El Salvador	1996	7	1.54	0.7	11.4	100	277
Guatemala	1995	10	8.30	0.6	22.00	110	
Haiti	1996	n.a.	n.a.	0.1	n.a.	n.a.	n.a.
Honduras	1996	17	7.60	0.3	40.00	60	n.a.
Jamaica	1994	20	39.40	2.4	n.a.	110	251[b]
Mexico	1989	148	40.88	2.6	25.51	4,300	1,984
Nicaragua	1994	7	2.04	0.4	19.48	40	310
Paraguay	1996	22	3.02	0.4		60	95
Peru	1994	54	3.00	1.5	21.99	900	380
Uruguay	1993	12	76.09	7.6	n.a.	330	400
Venezuela	1994	32	5.91	1.7	n.a.	1,000	600[b]

Source: ITU.
a. Monthly cost of 20 hours off peak, in dollars.
b. Figure for 1998.

Table 3 reveals a few additional issues as well. The clearest among them is that personal computer (PC) penetration continues to be quite low. The percentage of the population who owns a PC varies between 5 and 10 percent, depending on the country. The equivalent share is about 50 percent in the United States or around 20 percent in Spain and Portugal, for instance.[11] While cable television offers an alternative to phone connections to the Internet, analysts do not consider this access mode to represent an immediately feasible solution.[12]

A comparison of the various pieces of information provided in table 3 provides some interesting stylized facts on the linkages between reform, income level, and Internet access. First, two of the largest users of the Internet (Uruguay and Costa Rica) are not highly competitive and have not privatized their telecommunications sector, which suggests that sector performance is not necessarily driven by ownership and competition. The fact that both countries are small and lie close to countries that have undertaken major liberalizations, thus providing service alternatives, still hints at the role of an appropriate competitive environment as a key driver. Second, the table gives the impression that the Internet is for the rich. Figure 2 illustrates this idea by showing the cross-sectional correlation between per capita gross domestic product (GDP) and Internet access. The correlation between average income levels and Internet access is indeed quite obvious. This confirms the analysis of Norris, who uses a cross-section of 179 nations to regress the number of people online on variables measuring economic, social, and political development.[13] She finds that only GDP per capita and the share of research and development spending in GDP are statistically significant; economic factors thus outweigh all others in predicting cross-country differences in Internet usage.

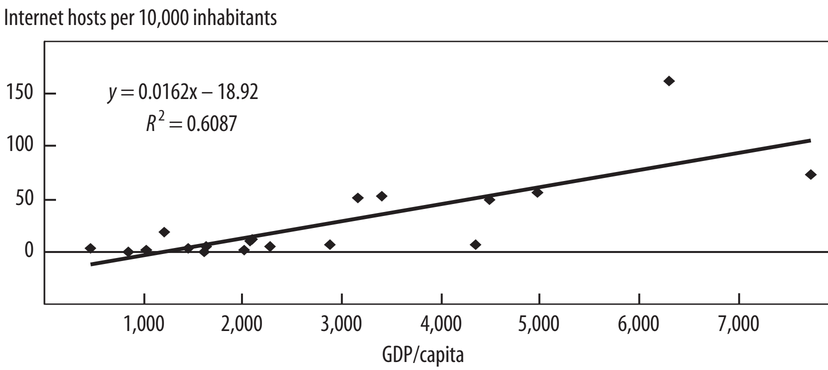
Combining the information in table 3 with the World Institute for Development Economics Research (WIDER) database on income distribution provides further food for thought on the use of the Internet. Chile, Costa Rica, and Uruguay are the top three users. The WIDER database

11. Morgan Stanley Dean Witter, *Latin America Internet Report,* February 2000.

12. *Latincom* quotes forecasts predicting a 20 percent share of potential Internet access using cable TV by the year 2010; see "TV Sector Primed for Growth as Economic Recession Lifts," *Latincom*, 5 June 2000, p. 1. The equivalent figure is currently 40 percent in the United Kingdom and over 20 percent in Spain and the European Nordic countries.

13. Pippa Norris, "The Global Divide: Information Poverty and Internet Access Worldwide" (www.ksg.harvard.edu/people/pnorris/acrobat/IPSA2000.pdf [2000]).

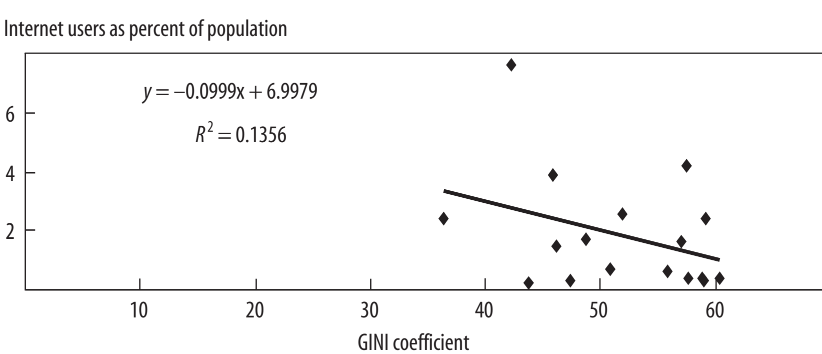
FIGURE 2. A Simple Correlation between Internet Access and GDP per Capita



indicates that Costa Rica and Uruguay are among the most equitable in the region in terms of income distribution, while in Chile poverty has declined significantly in recent years, although income distribution has remained stable. This pattern suggests that income distribution also matters. Figure 3 provides a simple visual representation. While it is not as convincing as figure 2, it hints at a negative correlation between Internet access and an indicator of inequality in income distribution, namely, the Gini coefficient.

These stylized facts are a first attempt to clarify the notion of a digital divide. Income is what matters most. A richer country can be expected to have more Internet users than a poorer one. Perhaps a more subtle result is that for a given level of average income, an additional dollar given to the

FIGURE 3. A Simple Correlation between Internet Use and Income Distribution



poor more than compensates for the resulting diminished Internet use on the part of the rich from whom a dollar is taken away, generating an overall increase in Internet access.

A More Formal Look at the Facts

In the remaining part of this section, we conduct a multivariate analysis to investigate whether these findings still hold after a closer scrutiny, once additional factors are taken into consideration. Another goal is to identify the relevance of policy variables. We estimate a simple regression building on the naïve correlations just discussed, as well as on additional information on Internet access costs and access to complementary equipment (such as computers) as determinants of growth in Internet access and use. While the correlations in the preceding section exploit the cross-country differences in Internet diffusion at one point in time, the rest of the analysis is based on longitudinal data that allow us to control for country (and sometimes continent) fixed effects that are potentially correlated with the dependent variables and might lead to biased estimates of the effect of technology and growth on Internet diffusion. By allowing for country-specific fixed effects, we attempt to purge our estimates of the effects of unobserved differences in Internet diffusion across countries, such as those stemming from permanent differences in educational attainment and institutions.[14]

In this context, the inclusion of access costs is crucial, since one of the main regulatory issues in the telecommunications sector involves the design of interconnection access rules and its implications for access costs. Finally, we also test whether a model of technological diffusion based on epidemic theories of diffusion may explain Internet access in Latin America.

Our tests use two samples of data. The first is for the whole world; it is designed to identify any regional specificity for Latin America. The second focuses on Latin America only, making full use of the additional institutional and technological information available for that region. The number of explanatory variables is drastically restricted by the available data. We feel, however, that the databases are good enough to generate some useful policy insights.

14. For a recent survey of international technology diffusion and its empirical importance, see Keller (2001).

The specific model we use for the whole world is the following:

$$\ln H_{it} = a_0 + a_1 \ln Y_{it} + a_2 \ln P_{it} + a_3 \ln L_{it} + a_4 \ln C_{it} + a_5 \ln H_{it-1}, \quad (1)$$

where for generic country *i* in year *t*, *H* is the per capita number of Internet hosts (or Internet users in the second set of regressions); *Y* is per capita GDP; *P* is the Internet access cost, defined as the sum of thirty three-minute local calls plus monthly phone subscription rates; *L* is the per capita number of digital fixed telephone lines; and *C* is the per capita number of personal computers.

The tests that focus on Latin America extend the model in equation 1 to include additional regressors, namely, whether the incumbent operator is privatized in a given year and whether an independent regulator is present in a given year. Some specifications also control for the degree of income inequality as measured by the Gini coefficient.[15]

To check the robustness of our results, model 1 (and its extension for Latin America) is estimated twice, using two different dependent variables H. In the first estimation, we use Internet hosts, while in the second we employ Internet users (taken from a different source).[16] The estimates are for the period 1990–99. Data are from the International Telecommunication Union/Telecommunication Development Bureau (ITU/BDT) database and the World Bank's Information for Development Program (*info*Dev). All money variables (GDP and costs) are expressed in dollars.

Equation 1 is fairly standard, and only the last term (the lagged dependent variable) deserves further comment. The term comes from a Gompertz model of technology diffusion, which is commonly used for estimating the sales of relatively new products. It derives from the idea that the number of new users who adopt a certain good or service in a given period depends on both the maximum number of potential users (usually a fraction of the total population) and the number of existing users who can "spread" further adoption. These models typically produce life-cycle diffusion curves over time, with an introductory phase characterized by slow growth, a growth phase reflecting the highest rate of

15. Data on Gini coefficients come from the WIDER database. Because data are not available each year, we have interpolated the actual series with a linear trend and used the estimated value as a regressor.

16. A host is a domain name that has an IP address record associated with it. This would be any computer system connected to the Internet (via full- or part-time, direct or dial-up connections).

consumer acceptance, and a maturity phase in which the product reaches its saturation point. The Gompertz and logistic curves are probably the most popular in a wider class of curves.[17]

Epidemic models can be criticized on several grounds, mainly because they posit an exogenous process that does not explicitly model demand and supply factors, but rather relies on primitive treatments of information acquisition. In this case, however, we are simply checking whether the lagged dependent variable resulting from the stock adjustment process reflects a diffusion process for Internet use. If such a process is found in the data, one might be tempted to argue that Latin America currently is not doing well simply because it started the adoption process relatively late. If there are forces driving an exogenous process of diffusion (which may not be well specified, as in the case of imitation), then Internet adoption should converge toward an equilibrium level; this raises the further question of the rate of convergence.

Our exercise is partially motivated by Kiiski and Pohjola, who use a Gompertz model to test Internet diffusion in member countries of the Organization for Economic Cooperation and Development (OECD) and in the whole world.[18] The basic difference between our approach and Kiiski and Pohjola's is that by using the panel structure of the data, we can control for unobserved country-specific characteristics that are potentially correlated with the included regressors, particularly with the lagged dependent variable.

In equation 1, the coefficient a_5 of the lagged dependent variable should give information on the diffusion process. If diffusion is present, it is expected to be positive but smaller than 1. In the absence of diffusion, the coefficient should be 0.[19]

The models are estimated via generalized least squares (GLS), with weights given by country population. Standard errors are robust to arbitrary heteroskedasticity. Because of the bias of the within-group estimator when the lagged dependent variable is included on the right-hand side,

17. See Stoneman (1995) for a comprehensive survey.

18. Kiiski and Pohjola (2001).

19. The Gompertz model is usually written as $\ln H_t - \ln H_{t-1} = a(\ln H^* - \ln H_{t-1})$, where H^* is the steady-state level of users, which should depend on income, prices, and population: $\ln H^* = b_1 \ln Y_{it} + b_2 \ln P_{it} + b_3 \ln L_{it} + b_4 \ln C_{it}$. In this model, the coefficient a is the speed of diffusion. The smaller the value of a, the more hysteresis in the diffusion process. For $a = 1$, there is no diffusion, and countries converge instantaneously to the steady state. This model can be rewritten simply as $\ln H_t = a \ln H^* + (1 - a)\ln H_{t-1}$, which is equation 1.

specifications including the lagged dependent variable and fixed effects are estimated via instrumental variables (IV), using the Anderson-Hsiao IV estimator. In the regression for the world, the test for a region-specific effect for Latin America is an *F* test that the coefficients of the right-hand side variables for the Latin American countries are jointly different from the coefficients for the rest of the world.

The Determinants of Growth in Internet Hosts

Table 4 summarizes the results of two regressions that test the determinants of Internet hosts in the world. The first regression ignores possible diffusion and tests for the relevance of time and country fixed effects. The second tests the diffusion model and thus includes a lagged dependent variable. The models are estimated using additive continent-specific and year-specific dummies (to allow for unobserved differences across continents plus worldwide macroeconomic shocks), their interaction (to allow for continent-specific macroeconomic shocks), and additional country-specific fixed effects (to control for time-invarying country-specific characteristics). When we run the regression for Latin America only (table 5), we allow for additive year and country dummies. *P* values are reported alongside the estimated coefficients.

In table 4, the lagged dependent variable is not significantly different from zero. This suggests that the exogenous diffusion process found by Kiiski and Pohjola tends to disappear once country fixed effects are properly accounted for.[20] On the other hand, the lagged dependent variable would be positive and significant if one allowed only for additive continent or year dummies (results are not reported here). For these reasons, specification 1 is our preferred model.

Specification 1 confirms the impressions given by the stylized facts reviewed earlier. GDP per capita is an important predictor of Internet diffusion. A 10 percent rise in per capita GDP is associated with about a 7 percent rise in the number of hosts per capita, suggesting that the Internet is a normal good. Access to basic infrastructure, such as digital lines and PCs, matters (they enter with the correct signs and are significant). A 10 percent increase in PCs per capita is associated with a rise in hosts per capita of about 9 percent. Similarly, a 10 percent increase in fixed lines is accompanied by an increase in hosts per capita of almost 6 percent.

20. Kiiski and Pohjola (2001).

TABLE 4. Determinants of Internet Hosts in the World

Explanatory variable	*(1)*		*(2)*	
Lagged dependent variable[a]			−0.464	(0.387)
Ln GDP per capita	0.713	(0.033)	0.935	(0.122)
Ln costs	−0.345	(0.109)	−0.505	(0.213)
Ln phone lines per capita	0.573	(0.062)	0.758	(0.068)
Ln PCs per capita	0.878	(0.007)	0.642	(0.179)
Summary statistic				
R^2	0.996		0.993	
F test for Latin America	1.47	0.211	1.01	0.403
No. observations	353		353	

a. The dependent variable is the log of Internet hosts per capita in the world. All specifications control for additive year and continent effects, interactions of the two, and country effects. *P* values are in parentheses.

Finally, Internet costs enter significantly and negatively. A 10 percent drop in costs is associated with an increase in hosts per capita of about 3 percent. This suggests that regulators should devise policies aimed at lowering such costs, both directly via universal service obligations (USOs) in rural areas and indirectly by promoting competition among service providers and devising appropriate interconnection rules, since Internet service providers usually rely on the incumbent's local loop to supply their services to customers.

Table 4 also provides a test of any Latin American specificity (*F* test). The *p* values are well above any standard critical value, such that one cannot dismiss the idea that Latin America is similar to the rest of the world. These results imply that once one adequately controls for unobserved country-specific characteristics that do not covary over time, the different performance of Latin America with respect to the rest of the world is mainly to be ascribed to differences in the evolution of the right-hand variables rather than to differences in the reaction parameters.

Table 5 summarizes the regressions that focus specifically on Latin America. Here we look at the effects of regulation and privatization as well as income inequality. The first two regressions are the same as in table 4, using all the available information for Latin America (sixty observations). Regressions 3, 4, and 5 are based on a restricted sample of thirty-four observations, corresponding to the country-year points for which data on Gini coefficients and institutional variables are available.[21]

21. The countries in the restricted sample are Argentina, Costa Rica, Ecuador, Jamaica, Honduras, Mexico, Nicaragua, Paraguay, Peru, and Venezuela.

TABLE 5. Determinants of Internet Hosts in Latin America

	Whole sample				*Restricted sample*					
Explanatory variable	*(1)*		*(2)*		*(3)*		*(4)*		*(5)*	
Lagged dependent variable[a]			0.257	(0.602)						
Ln GDP per capita	1.822	(0.001)	1.703	(0.001)	1.887	(0.013)	2.219	(0.004)	2.460	(0.002)
Ln costs	−0.410	(0.282)	−0.321	(0.407)	−0.956	(0.004)	−0.759	(0.028)	−1.012	(0.016)
Ln phone lines per capita	1.227	(0.043)	1.021	(0.076)	2.255	(0.067)	2.231	(0.011)	2.094	(0.072)
Ln PCs per capita	−1.062	(0.381)	−1.248	(0.348)	−3.395	(0.037)	−4.836	(0.008)	−6.294	(0.009)
Ln Gini coefficient							−10.149	(0.039)	−13.870	(0.010)
Regulation									1.061	(0.070)
Regulation*privatization									−1.076	(0.093)
Summary statistic										
R^2	.984		.988			.988		.992	.994	
No. observations	60		60			34		34	34	

a. The dependent variable is the log of Internet hosts per capita in Latin America. All specifications control for additive year and country effects. The restricted sample includes Argentina, Costa Rica, Ecuador, Jamaica, Honduras, Mexico, Nicaragua, Paraguay, Peru, and Venezuela. *P* values are in parentheses.

The table confirms the rejection of the diffusion model for Internet hosts. As before, the lagged dependent variable is not significant once country fixed effects are taken into consideration.[22] The log computer variable enters with a negative sign. One possible interpretation for this result is that the low Internet diffusion is primarily explained by the absence of adequate infrastructure (fixed lines). For a given number of fixed lines, an increase in the number of PCs tends to depress Internet diffusion, possibly because of the congestion of the available lines.[23]

The third regression replicates the specification of the first but uses the restricted sample. The results are similar, although the value of the coefficients is somewhat magnified. In the fourth regression, we control for the log of the Gini. Inequality seems to matter substantially: a 10 percent fall in the Gini (approximately one standard deviation increase) leads to a doubling of Internet diffusion (≈ 10.149*.10). This is a remarkable effect. The other coefficients remain essentially unchanged and still significant.

In the fifth regression, we include the institutional variables for whether the sector is regulated and whether it has been privatized, conditional on the sector being regulated.[24] The results suggest that while regulation

22. A word of caution. The Anderson-Hsiao estimator is consistent for *N* (the number of cross-sectional observations) going to infinity. We clearly fall short of fulfilling this condition when we restrict the sample to Latin America.

23. Computers per capita might be endogenous to Internet diffusion, since the more people use the Internet, the higher will be the incentive for others to buy a PC, perhaps due to a demonstration or externality effect. The direction of this bias, however, is likely to lead to an overestimation of the coefficient on log computers. Similarly, access costs might be endogenous to Internet growth. An increase in the number of hosts would lower access costs through higher competition, although if higher access costs attract more providers, the bias would be in the opposite direction. Finally, GDP per capita might itself be endogenous to telecommunications infrastructure since the latter can affect economic growth (Röller and Waverman, 2001). In this case, one would reasonably suspect that our estimate of the effect of GDP is biased upward. Unfortunately, we do not have credible instruments for these variables.

24. Although the privatization was preceded by the establishment of a regulator in all the countries covered by the sample, this gives a somewhat misleading impression of the diversity in strength and independence of regulatory institutions. Argentina's regulator became significantly more competent in the 1990s and is now one of the most capable in the region. Many others, however, have a much more limited capacity to tackle the problems they are expected to address. In addition to regulatory endowment problems, capture is still an issue in the region; Levy and Spiller's concerns (1994, 1995, and 1996) thus continue to be quite relevant even if they are not explicitly addressed here.

boosts Internet diffusion, Internet growth returns to its preregulation level as soon as the sector is privatized.[25]

The Determinants of Growth in Internet Use

We now consider Internet users (taken from *info*Dev) rather than Internet hosts as our left-hand side variable. As before, we look first at the whole world (table 6) and then at Latin America (table 7). The results in table 6 suggest again that diffusion is absent once country fixed effects are taken into account, and specification 1 is again preferred. Coefficients have the right sign, although they are less significant than before. The main engines of growth in Internet users are access to personal computers and availability of phone lines, while GDP and costs seem to matter less once fixed country effects are incorporated. A 10 percent rise in lines per capita tends to increase the number of Internet users by about 8 percent. An important difference in comparison with the focus on hosts is that the *F* test could not reject the hypothesis that Latin American countries are jointly different in terms of the determinants of Internet usage.

The model of Internet use based specifically on Latin America provides interesting additional insights (see table 7). First, GDP and PC access are the dominating variables, in contrast to the determinants of Internet hosts. This explains the rejection of the worldwide model for Latin America; it suggests that the determinants of Internet use (as opposed to the diffusion of Internet hosts) are somehow dominated by different forces in Latin America. A 10 percent rise in GDP per capita increases the number of Internet users by about 13 percent (1.371*10 percent), while a 10 percent increase in lines per capita tends to increase the number of Internet users by about 7 percent (0.735*10 percent).

Second, Internet costs are somewhat more significant as a determinant of use in Latin America than in the world, although not enough to serve as a clear determinant factor. Again, the results are sensitive to the introduction of specific controls. As in table 5, we restrict our sample to those countries with information on inequality and institutional variables, which reduces our sample size from sixty-three to thirty-six observations. A comparison of regressions 3 and 1, however, makes us wary of extending the

25. Care must be taken in interpreting these results, since the full effects of regulation and privatization may not have occurred yet in Latin America.

TABLE 6. Determinants of Internet Users in the World

Explanatory variable	*(1)*		*(2)*	
Lagged dependent variable[a]			–0.452	(0.172)
Ln GDP per capita	0.236	(0.606)	0.363	(0.565)
Ln costs	–0.173	(0.503)	–0.297	(0.383)
Ln phone lines per capita	0.801	(0.299)	2.061	(0.118)
Ln PCs per capita	2.182	(0.000)	2.580	(0.001)
Summary statistic				
R^2	0.986		0.976	
F test for Latin America	2.53	0.041	2.86	0.024
No. observations	383		383	

a. The dependent variable is the log of Internet users per capita in the world. All specifications control for additive year and continent effects, interactions of the two, and country effects. *P* values are in parentheses.

results for the restricted sample to the whole of Latin America: the coefficients change significantly, thereby suggesting that the restricted sample might be nonrandomly selected in terms of users per capita. Inequality enters significantly with a negative sign, such that a 10 percent rise in the Gini coefficient halves Internet diffusion. As before, it is difficult to find any independent effect for privatization and regulation. Lines per capita now enter with a negative sign, but we cannot reject the hypothesis that its coefficient is statistically undistinguishable from zero at the 5 percent significance level.

What Are the Regulatory Policy Implications?

Both the stylized facts and the econometric results suggest three clear issues with policy implications: affordability matters, as revealed by the systematically significant sign of GDP per capita and the overall relevance of Internet access costs; access to basic telecommunications services matters, as indicated by the systematic relevance of the number of fixed digital lines per capita; and access to basic connection infrastructure matters, as indicated by the relevance of the number of PCs per capita. The third issue fits into what some would label industrial policy. PC penetration continues to be low in the region because import barriers and high transport costs reduce the availability of mass market computers (below $1,000). This is a major inhibitor to Internet penetration.

TABLE 7. Determinants of Internet Users in Latin America

	Whole sample				*Restricted sample*					
Explanatory variable	*(1)*		*(2)*		*(3)*		*(4)*		*(5)*	
Lagged dependent variable[a]			–1.120	(0.570)						
Ln GDP per capita	1.371	(0.008)	1.622	(0.053)	0.358	(0.687)	0.478	(0.324)	0.314	(0.573)
Ln costs	–0.337	(0.360)	–0.686	(0.377)	–0.282	(0.477)	0.091	(0.775)	0.202	(0.610)
Ln phone lines per capita	0.735	(0.061)	1.432	(0.291)	0.033	(0.950)	–0.912	(0.033)	–0.728	(0.094)
Ln PCs per capita	0.326	(0.571)	1.785	(0.489)	–0.477	(0.327)	–1.527	(0.047)	–1.442	(0.093)
Ln Gini coefficient							–10.496	(0.014)	–10.204	(0.041)
Regulation									–0.168	(0.582)
Regulation*privatization									0.288	(0.435)
Summary statistic										
R^2	.979		.941			.984		.992		0.992
No. observations	63		63			36		36		36

a. The dependent variable is the log of Internet hosts per capita in Latin America. All specifications control for additive year and country effects. The restricted sample includes Argentina, Costa Rica, Ecuador, Jamaica, Honduras, Mexico, Nicaragua, Paraguay, Peru, and Venezuela. P values are in parentheses.

The decision to increase the number of PCs per capita has implications for many types of policies, and its discussion goes beyond the scope of this paper. The first two issues, however, can be addressed by rather well-defined regulatory policies, and they fit into the unfinished reform agenda mentioned earlier.[26] Access costs in regulated activities are driven by regulatory guidelines, which accentuate the importance of the outstanding regulatory agenda.[27] More specifically, access and affordability must be addressed jointly by the design of regulation to ensure that the expansion of Internet usage in the region follows an expansion of the access to telecommunications services. This requires a higher phone penetration than is currently the norm and strong improvements in the integration of the old fixed networks with the new communications tools. The main concerns that regulators should have in addressing these issues are the focus of the rest of this section. We first review the access problem and then conclude with affordability.

The Access Problem in Theory and in Practice

To send an e-mail, most of us first access the Internet by calling an Internet service provider (ISP) over a telephone line. The sending computer breaks the e-mail message into around twenty pieces, on average. These pieces, or packets, are sent over a standard telephone line to the ISP, using a modem to convert the computer's digital information to the analog waves that telephone lines transmit. Each packet is transmitted to the nearest router, which is a special computer dedicated to receiving and forwarding packets; it is the Internet equivalent of a telephone switch. The router passes each packet on to another router, or to the destination if it is close enough. Once all the packets arrive at their destination, they are reassembled into the original e-mail and read. Of course, the user does not care about which routers have handled the individual packets in an e-mail. What matters is the joint function of all of the components. In the language

26. This paper does not address issues relating to e-commerce, which raise many other regulatory problems.

27. Wallsten (2001) finds that the joint effect of privatization and regulation on fixed network expansion is significant and positive for a heterogeneous sample of African and Latin American countries; Gutierrez and Berg (2000) also find significant positive impacts of the regulatory framework on telephone lines per capita for a sample of nineteen Latin American countries in the period 1985–95.

of economics, the different parts of the network are called complements—items that are worth more as a unit than as individual pieces.

All this translates into very practical issues for regulators. First of all, interconnection should be mandated to ensure complementarity: if the various bits are not interconnected, the service will not work. This raises a technical problem of compatible standards and interfaces, although it is probably not a major problem for Latin America since the underlying technologies are developed abroad. Operators are mainly users rather than suppliers of new technologies. The type of intervention at this level should therefore be minimal.[28] Once technical interconnection is ensured, the externality problem should disappear, at least in principle. If all consumers are interconnected, they benefit from the network effect, independently of their choice of operator. Unfortunately, the picture is not quite so simple, since interconnection is also an economic problem. Once a feasible interface is established, operators have to find ways of compensating other operators for the use of the latter's infrastructure.

The obvious solution is to let the parties negotiate an interconnection agreement, and this is what most regulators take as a first step, as shown in table 8. This may work when there is a double coincidence of wants between the two interconnecting operators, that is, when both operators have subscriber bases of comparable sizes and need each other in order to terminate calls destined for the rival's network. This is unlikely to be the case in Latin America under current conditions. Typically, an incumbent operator is integrated over all the basic components of a network, and it faces entrants that only have parts of the infrastructure and need access to some of the incumbent's elements (generally the local loop). Such entrants depend on the incumbent's facilities, while the reverse is not true. Negotiations are thus doomed to fail. Consequently, the regulator or the competition agency must act as a referee.

The first step for the referee is to identify costing rules to ensure that competition creates an interconnected network combining not only traditional telecommunications networks, but also all the new information and

28. In principle, regulators could ask operators to adopt particular standards or technologies. Standards often emerge on a commercial basis, however, and it is questionable whether the regulator would be able to pick the best standard or technological solution to enforce. Technological neutrality while ensuring interoperability seems the best approach to regulation.

TABLE 8. Basic Interconnection Principles in a Sample of Countries

Country	*Nature of interconnection charges*	*Pricing model*[a]	*Regulatory approval of charges*	*Unbundling of facilities or accounts*
Argentina	Commercial agreement	LRIC	Yes	Yes
Bolivia	Imposed by regulator; commercial agreement	LRIC	No	No
Brazil	Commercial agreement	n.a.	No	n.a.
Chile	Imposed by regulator	LRIC	Yes	No
Colombia	Imposed by regulator	LRIC + FDC	Yes	Yes
Costa Rica	Imposed by regulator	Opportunity cost	Yes	No
El Salvador	Commercial agreement	LRIC	No	Yes
Jamaica	Commercial agreement	None	No	No
Mexico	Commercial agreement	LRIC	No	Yes
Panama	Commercial agreement	LRIC	No	Yes
Peru	Imposed by regulator working as a cap; commercial agreement	LRIC	Yes	Yes

Source: ITU.
a. LRIC: long-run incremental costs; FDC: fully distributed cost.

communications technologies, including mobile, Internet, satellite, and cable television networks. The most common costing rule for assessing the costs that must be covered by interconnection rates is the long-run incremental cost (LRIC). The usual method is to estimate these costs based on international comparisons, and only a few countries in Latin America are developing their capacity to actually estimate them through a formal model. Argentina, Colombia, and Peru are currently following the lead of the United States, whose 1996 Telecommunications Act requires the Federal Communications Commission (FCC) to establish a transparent model for assessing costs.[29] Colombia has put forth an impressive proposal to work along the same lines; the expected effect on costs is dramatic. Initial simulations for Argentina indicate that the regulator could get companies to cut connection costs from 2.35 cents per minute to 1.1 cent per minute.

LRIC has several benefits and some potential limitations. As a measure of the true economic cost of an asset, LRIC sends the right make-or-buy signal to alternative suppliers of infrastructure. It is a long-run measure of costs and does not overestimate the value of assets, as would

29. See Benitez and others (2002).

most likely occur if one adopted historic costs. This is quite important for countries with a long tradition of accounting systems distorted by inflation, which is often the case in Latin America. Capital is included in the measure (depreciation is rightly considered to be an economic cost), and it potentially allows for full recovery. In fact, if a new technology were more efficient than an existing one in a competitive market with free entry, then entry would occur and prices would have to equal LRIC. LRIC should represent the long-run equilibrium level of charges, such that it guarantees the achievement of allocative efficiency. Although the details are quite complicated, the underlying principles for its computation are the following:

—Assets are valued and depreciated on a current cost-accounting basis, giving the current replacement cost of a modern, efficient asset;

—Operating capital costs are grouped together according to the cost type and cost driver;

—Cost-volume relations are estimated, showing how these costs change over the long run with volumes of the relevant cost driver; and

—Increments are defined, and the model determines how much the volume of a cost driver falls if an increment is no longer provided. The cost-volume relations then show the cost saving.[30]

LRIC has three important shortcomings if badly calculated. First, LRIC is at odds with traditional depreciation practices (typically straight-line). In the presence of technological progress, straight-line schedules would underestimate the true annual economic cost. Slow depreciation schedules may be attractive to regulators, who can then obtain lower current prices and hence encourage entry. This does not have any economic justification, however, and it is only sustainable if the regulator simultaneously promises higher future prices, since otherwise investments would never happen. Second, the computation of LRIC is for an activity that is an input to the production of two or more outputs, which is a common feature in telecommunications (think of exchange switches). The definition of increments is therefore crucial, and it is often dictated by objectives other than

30. LRIC can be derived using either bottom-up approaches (based on engineering estimates of the assets and operating resources needed to provide services) or top-down methods (based on existing cost structures reported in the accounts). Bottom-up estimates are more precise in enabling cost causation for capital assets to be identified, since they are based on explicit parameters; they are also easy to review. They encompass many areas for disagreement, however, such as the definition of appropriate equipment. In contrast, top-down approaches can reflect complex networks and do not omit costs. Their downside is that they are more opaque and hence may hide inefficiencies.

efficiency. Third, LRIC computations involve a lot of discretion, particularly in the definition of a sensible cost of capital to be reflected in the minimum rates of return required to motivate investors to make the necessary investments in countries with a high degree of uncertainty.

The theory behind LRICs is respectable, but their calculation is another matter. It requires a strong commitment to establish reasonable asset valuation rules that support the development of the model. Reconciling LRIC and common depreciation practices is quite a challenge. The impressive proposal for the implementation of LRIC in Colombia, which is posted on the regulators' website, ignores this issue. LRIC also assumes that the regulator is able to assign the various joint and common costs in a fair way, while common practice employs arbitrary rules. This is why the case of Argentina is very interesting: the regulator decided to formally discuss the allocation decisions with all the operators before its adoption, providing a quantifiable ground for debate.

The calculation of the LRIC of the bottleneck facility to which all new entrants want to connect is not the end of the story. The next question is how to use the LRIC estimate to set the access price. Access prices often represent over half of the costs for downstream entrants. Imagine the following stylized situation. To provide one unit of the final good, downstream firms need one unit of the upstream input that is produced by the bottleneck owner at a unit LRIC, c_0, in exchange for a unit access charge, a. If all firms in the downstream sector are similar (in terms of technology and thus of costs) and their products are identical, then firms undercut each other until price competition drives all extra profits to zero. The price charged to final users ends up equal to the marginal cost of each firm, which amounts to the sum of the access charge and any other cost incurred in transforming the intermediate good. If we denote the latter by c, the final price would be $p = a + c$. The lower the access charge, the lower the final prices and the higher the total quantity consumed by the end-users.

Without any other source of distortion, the best course is to follow a marginal rule: the price to the final user (the consumer's willingness-to-pay) should be set equal to the total marginal cost of production. The access price should thus be set equal to the marginal cost of production ($a = c_0$), and the consumer price would be $p = c_0 + c$. On the other hand, distortions in the incumbent's retail prices typically exist for various reasons, for instance because the bottleneck also involves some unapportioned fixed costs; hence a marginal rule would not allow them to be recovered. Another type of distortion arises when the incumbent's prices do not reflect its cost structure, because the incumbent is constrained by social obligations to charge identical prices in different geographic regions. Under these circumstances, a marginal rule is not the correct benchmark unless additional instruments are used simultaneously to relieve the access charge from additional tasks. Access charges purely based on LRIC are an appropriate benchmark when retail-level distortions are eliminated (for instance, by tariff rebalancing) or addressed through other instruments. On the other hand, the common practice to apply uniform markups to the LRIC estimates to recover unapportioned costs does not reflect much economic analysis.

Table 9 summarizes the main options for access pricing under different situations.[31] A quick glance suggests that the rather complex theoretical contributions deliver one message: the access charge often performs too many tasks. While it is true that theory is extremely useful for understanding the mediating function of access prices, regulators should, whenever possible, resist the temptation to use access pricing as an instrument for the promotion of too many goals. Different goals and policy objectives lead to alternative ways of calculating optimal charges.

Regulators should be aware that a sequencing of events can reduce the complexity of the access problem. For instance, if the regulator believes there are barriers to entry, the tax/subsidy issue of the entry barrier should be addressed directly and made explicit, rather than buried into the access pricing problem. The latter may indeed be the only option available, but the regulator must first determine that all other options are not feasible. The first question to consider is why entry should be promoted. If it is expected to bring benefits from product variety, for example, a simultaneous effort should be made to remove the barriers to entry and promote product variety. This can be done by mandating equal access, for instance, which is the solution that has been adopted in Peru and Venezuela where either the law (in Peru) or the interconnection regulation (in Venezuela) explicitly states that all interconnection agreements must reflect the principles of neutrality, nondiscrimination, and equal access. A similar argument can be made for universal service obligations, as discussed below. By understanding the links between different

31. For more detail, see the surveys by Armstrong (2002) and Valletti and Estache (1999).

TABLE 9. How to Set an Access Charge: What the Theory Says

Basic case	*Access charge*	*Potential problems*	*Eventual remedies (with best practice examples)*
First best	LRIC	May require lump sums	Tariff rebalancing (Dominican Republic); USO funds (Chile and Peru)
Second best	Ramsey[a]	Informational content; may not be sustainable	Global price cap (under study in Costa Rica, Mexico, and Peru)
Productive efficiency	ECPR[b]	Partial rule	
Extensions:			
Entry promotion for product variety, entry barriers, learning-by-doing	Decrease	Fixed cost may not be recovered	Direct explicit or implicit subsidies (through differentiated treatment of incumbent and new entrants as in Brazil; under study in Ecuador and Honduras); equal access
Bypass, cost duplication only	Increase	Small entrants have a disadvantage	Quantity discounts
Market power	Decrease	Fixed costs may not be recovered	Price regulation; competition policy (Argentina, Brazil, and Mexico are the most typical examples of an effective coordination between the competition agency and the telecommunications regulator)

a. Ramsey prices are inversely related to the elasticity of demand and apply to both final and intermediate services. They are second best in the sense that they are the best that the regulator can do when it cannot repay the incumbent's fixed costs via lump sums; thus the wholesale and retail prices alone should recover the incumbent's costs. Ramsey charges are a good theoretical benchmark based on the principle that markets are related, such that demand and supply cannot be considered in isolation. They can be put in practice via global caps that limit the overall price of a basket of services (both retail and wholesale), while the operator is left with the flexibility to set individual prices within the basket. See Laffont and Tirole (2000) for additional details.

b. The efficient component pricing rule (ECPR) states that the access charge should be set equal to the direct cost of supplying access plus the opportunity cost represented by the forgone profits of the incumbent when it is displaced by an access seeker. This is equal to the difference between the retail price and the cost of the competitive segment. ECPR willingly narrows its considerations on the allocation of production between the bottleneck proprietor and its rivals. With regard to theory, it introduces the powerful concept of opportunity costs. In practice, ECPR is a rather simple rule guaranteeing that only efficient entrants are granted access. It gives valid guidelines if the recovery of fixed costs is not a problem and if static productive efficiency remains the only goal. On the other hand, ECPR allows monopoly rents and anti-competitive conduct if not conjoined with complementary instruments (such as final price regulation or price floors and ceilings).

problems, new instruments become available and allow fine-tuning of the regulatory process.

The consensus approach adopted by Argentina to identify reasonable estimates of the access charges is quite instructive. From the viewpoint of market liberalization, Argentina has made most of the right moves since 1998. Argentina has opened the market, has allowed the resale of services, and now considers all operators to be service providers. The local network has been unbundled. Interconnection has been set at incremental cost. Argentina has also adopted minimum subsidy auctions for the yetunserved areas. Many issues are outstanding, but the model is well on the way to becoming one of the most pro-market models in the region, and it may be a leading indicator of future trends. The regulators now recognize that the implementation of many decisions requires analytical support. In that context, the telecommunications regulator financed a research project to estimate a cost model for telecommunications, with the support of a research grant from the World Bank. The project also received funds from the main incumbent telecommunications companies, which demonstrated concern for access issues as they prepared for the announced liberalization of the market. The research project brought together some of the top foreign academics in the field of regulation and, in particular, access pricing. Most notably, Jean-Jacques Laffont and Bill Sharkey helped identify major issues in conversations with the key operators and the regulator, and the author of a similar model developed for the United States was recruited to train a team of young local researchers.

The process of model development may, in fact, have been one of the most useful aspects of this experience. Argentina now has a cost model that has been used to assess LRIC in the context of universal service obligations. Had it not been for the recent crisis, the country would have made more progress on the access issue as well. In the meantime, Argentina is working with benchmarks like many other countries, but many actors in the sector hope to see policymakers return their attention to these microeconomic issues once the macroeconomic situation is stabilized. Good regulation requires some initial investment, and it is too often one of the first expenses to be frozen when an economic crisis sets in.

How to Address the Access Problem When Investment Is Needed

The second component of the regulatory challenge is the need to encourage investment. There is a trade-off between optimal access regulation in a static framework versus in a dynamic one. If static regulation reduces the use of monopoly power over the infrastructure, then it also reduces the profits that can be earned by the investor or owner of the facility. Access regulation that sets interconnection rates based on simple cost recovery rules, while encouraging efficient use of assets, may risk discouraging investment. The reason is simple. If operators rationally anticipate that the regulator will grant access at cost after the initial investment is made, then everybody will wait for someone else to make the investment. This is a typical free rider problem that may cause big losses in social welfare. At best, investments are reduced; in the limit, production may never be initiated at all if no one invests in infrastructure.[32]

At the same time, however, the regulator should promote the legitimate objective of creating a level playing field downstream. Imagine the typical environment for telecommunications operators in Latin America, in which a network has to be built, the investment cost declines over time as a result of technological progress, and operators are left to bargain first to settle interconnection charges. Incumbent operators must first decide whether and when to invest, knowing that their exclusivity period either has already ended or will do so soon and that their rivals are deciding whether and when to seek access. A major element in the bargaining game between the two parties is the specific design of the access rules defined by the regulator.

One might think that if operators offer sufficiently differentiated products, then the use of the investment is nonrival; infrastructure owners therefore do not fear the dissipation of profits caused by downstream competition and, in fact, have an incentive to optimize the use of the facility. This conjecture is simply not true. Negotiations can only take place over variables that can be altered at the time of negotiation. Because the investment has already taken place, infrastructures themselves are sunk and cannot play a role during negotiations. The provider thus has a weak position. It gains nothing from denying the rival the use of the infrastructure, but rather loses whatever access charge it might otherwise receive. The operator has a weak incentive to invest even if products are differentiated.[33]

32. There is an obvious parallel between this problem and the kind of public policy that may best encourage innovative activities and the dissemination of research and development (R&D) efforts. On the one hand, once an individual firm has acquired knowledge about a new product or a new way to produce something, it is virtually costless to share this information with others. The firm that has made the discovery should therefore share it with others and should be compensated only for the long-run marginal costs. On the other hand, it is clear that such a scheme would seriously erode any incentive to pursue innovative activity in the first place. The question of how best to balance the aim of encouraging innovative activity by protecting intellectual property against the aim of promoting the competition that such protection inhibits has been an enduring source of tension in policy debates. The empirical evidence is far from uniform, but one general finding seems to be robust and relevant to the telecom investment issue: R&D intensity appears to increase in industrial concentration only up to a certain value, after which R&D efforts appear to level off or even decline.

33. This is a typical hold-up problem stemming from contract incompleteness.

Another aspect of this scenario is crucial for the regulator. The access seeker may be trying to become the provider itself so as to start selling access to its rival. In this case, negotiations would be reversed. The two firms could race to be the first to provide the infrastructure; the winning operator would receive access payments rather than paying for access. This creates a reason to preempt rivals and raises incentives to invest. The race to become the common carrier speeds up the operators' choices.

Access issues are of greater concern when the firms that use the infrastructure are direct competitors of the infrastructure owner, as is so often the case in Latin America. If competition effects are extreme, the infrastructure owner will not grant access unless required to do so. Here regulation plays a stronger role. The entrant is obviously keen on obtaining access. Without compensation, however, the incumbent will delay investments. This can be solved by requiring the entrant to bear more of the expense, but the increase in costs might reduce the possibility of entry itself. The regulator should try to manage this tension between investment incentives and timely competition.

The regulator can thus use the access price regime to create competition between industry participants over the provision of facilities. If a firm wins the race to provide infrastructure, it becomes the common provider and receives access payments from other firms. If it loses, it must either pay for access or duplicate the infrastructure. By committing to an appropriate access rule, the regulator can directly determine the difference between winning and losing for operators.

The existing theoretical literature does not offer a general answer to this intricate problem. The trade-off between static and dynamic efficiency that we highlighted at the beginning of this section should not be taken as the only possibility, since regulation interacts with other important variables, such as market structure and entry conditions, competitive behavior of market participants, and technological progress. For instance, the unintended outcome of bad regulation could be to achieve low levels of both static and dynamic efficiency. This could occur in mobile telephony if too little spectrum is made available to a handful of companies that do not compete against each other and that do not need to adopt innovative technologies because they are protected against entry by license conditions. Conversely, some circumstances might promote high levels of both static and dynamic efficiency. When operators compete against each other, they achieve relatively efficient allocations while still securing profits that create the incentive to invest. The presence of strong network externalities can support a case like this one.

Only after unraveling the linkages between entry, investment, competition, and regulation can the regulator understand the pros and cons of basic modes of entry and then promote a particular one. The two main modes are facility-based competition and service-based competition. In telecommunications, local loop unbundling is a special form of service-based competition that is particularly important in the current debate. Under facility-based competition, both the incumbent and the entrant build their own backbones and local loop facilities. Customers can, in principle, subscribe directly to both operators. The only relevant access price is related to call termination on the rival's network. Under local loop unbundling, the entrant leases the incumbent's access facilities. On top of call termination, regulatory oversight should include the line rental fees that the incumbent receives from the entrant.

While the answer to the question of facility-based competition versus local loop unbundling needs to be decided case by case, economic theory helps clarify the main trade-offs. First, if the goal is to promote investment, there is a potential trade-off between ex post extraction of rents and ex ante incentives to invest. Second, facility-based competition may involve unnecessary duplication of infrastructure, and in this case local loop unbundling should be preferred. Facility-based competition would be the better choice, however, if it brings about higher speed, less congestion, and product complementarities. Finally, local loop unbundling gives the regulator additional regulatory instruments. The downside is that regulation also becomes much more intrusive. Facility-based competition allows the regulator to rely more on direct competition than on regulatory intervention. Regardless of how the regulator resolves these trade-offs, flexibility should be allowed in different areas. The regulator should offer a menu of options designed to promote particular entry modes. Operators should be allowed some flexibility to set their access charges subject to constraints on their overall level.

Tips on the Choice of a Regulatory Policy for Access

The choice of an access policy is probably one of most complex issues in the area of telecommunications regulation, and we are not able to touch on all aspects here.[34] The preceding overview of theory and practice allows the following conjectures about the key factors involved. First, regulation can elicit excessive investment or, conversely, can kill investment opportunities. The latter is more likely than the former in Latin America. This might happen, for example, if access prices were prohibitively high, leading to the perpetuation of a monopoly. Second, the willingness to invest is influenced by the perceived risk of investment. The regulator will thus gain by either establishing a set of (possibly changing) access pricing rules or making a commitment to criteria set in advance. Third, the interaction between retail prices and the structure of access prices will have a major impact on incentives to invest in different parts of the telecommunications network. Rebalancing the tariff will eliminate some distortions, but ongoing geographical averaging will limit the location of investment. Finally, flexibility should be encouraged, in terms of both offering entrants a menu of entry modes with possibly differentiated structures of access charges and allowing incumbents to set different charges subject to average constraints.

How can the access pricing debate be put into practice? Regulators should try to employ more sophisticated economic tools and engineering methods to design a structured framework that allows the appropriate use of engineering cost estimates. While this should be the aim of all regulators at least in the medium term, one might realistically ask what they could do in the initial phases when such tools and methods are not yet available. The first thing that regulators should do is to remove most entry barriers, such as exclusivity periods. Entry will often alleviate the regulator's problem of controlling retail prices. In some areas, such as densely populated areas or business districts, the regulator's problem may actually

34. For instance, one may argue that foreclosure is not a great danger once facility-based competition is mature, since operators would have an incentive to successfully conclude commercial negotiations over the interconnection terms. While this is probably true, some regulatory scrutiny would still be needed to restrain various forms of anticompetitive behavior. An operator may be competing for customers, but once it has secured its customers, it effectively has a monopoly power over the calls destined to them (this problem is clearly seen in the context of fixed-to-mobile calls). Even when operators are competing fiercely over both termination and origination of calls, they can still use access prices as an instrument of tacit collusion. Collusive (that is, monopoly) prices can, in fact, be sustained using high access charges because of a raise-each-other's-cost effect (Armstrong, 2002; Laffont and Tirole, 2000).

disappear, since customers may have a choice among competing access providers. As argued above, however, this is unlikely, and the regulation of bottlenecks in telecommunications is quintessential.

Entry will actually exacerbate the access problem, since all entrants will have to rely to some extent on the incumbent's network. Hence, the regulator should first ensure that interconnection is feasible. But at what price? If no information is available at all, the regulator can follow only two routes. It could either look at international benchmarks and set charges similar to those adopted under similar conditions elsewhere or set a discount on the incumbent's retail prices, along the lines of the efficient component pricing rule (ECPR).[35] Neither approach is satisfactory, but there is not much more the regulator can do if it has no other information at its disposal. Benchmarks are not very good because they are based on computations valid for countries with very different economic conditions. ECPR also has limits since it freezes the structure of prices, which can be inefficient if rebalancing has not yet occurred. It further obliges entrants to more or less replicate the incumbent's prices, so they are not very aggressive. Given that these are the only options available for the regulator in its infant phase—precisely when it is weakest—it is perhaps advisable to rely on international benchmarks, since they are much less prone to lobbying from the incumbent. In any case, this phase should be kept as short as possible. The regulator should quickly adopt engineering models, both to determine reasonable figures and, more important, to lay the groundwork for discussion.

When estimates become available, the economic analysis discussed above should be put into practice. Tariff rebalancing, access charges, and service obligations are all intertwined aspects of the same general problem. In this respect, an eventual engineering model would never be a machine that gives the "right" number when needed. On the contrary, it would only set an appropriate order of magnitude. The regulator should further try to decentralize decisions. For instance, the regulator should try to set a price cap mechanism on access charges and ask the incumbent to reduce them on average by a specified percentage every year, reflecting the underlying technological progress. The regulator would thus avoid crunching numbers from the engineering model too often, which would help

35. ECPR only requires calculating the cost of the competitive segment rather than the cost of the bottleneck, which is much more difficult to compute.

prevent regulation from becoming extremely intrusive and ensure that the incumbent had an incentive to adopt cost-reducing technologies that, in the end, would bring prices down. Of course, there is also the risk that competition might be jeopardized if the regulator does not scrutinize the incumbent's behavior. While in principle it would be ideal for the regulator to be able to monitor anticompetitive behavior, this should not be a priority in practice to the extent that the regulator learns to cooperate with the competition agency of the same country.

The Affordability Problem

The concern for affordability is quite strong among policymakers, who are making efforts to bring tariffs in line with international trends. The first issue is that phone lines continue to be the main vehicle to the Internet, and flat rate access to local calls is not standard practice as it is in the United States. Countries are already addressing this problem. In Argentina, for instance, the creation of special Internet price schemes and the reduction of the cost of leased lines have contributed significantly to the diffusion of the Internet. Similar initiatives have been undertaken elsewhere in the region, but while they improve access for the "haves," they do not necessarily do much for the "have nots." For example, the special local connection number for Internet users in Argentina initially was not available throughout the country, forcing provincial users to pay additional long-distance charges. Furthermore, telecommunications penetration is often insufficient in the provinces. Ultimately, basic failures in the implementation of the telecommunications reform contribute to the digital divide. The policy implication is simple: come up with a policy instrument to promote the installation of phone lines where there currently are none.

The main instrument that regulators have used to address the issue of affordable access is to impose universal service obligations (USOs) on operators. Table 10 summarizes Latin America's experience with USOs. According to the ITU regulatory database, over 70 percent of the countries in the region include basic telephony in their definition of universal services, and about a third have now added electronic mail as well. While the table suggests a degree of consensus on the general principles behind USOs, the differences in approaches and definitions across countries point to three main implementation challenges. First, what exactly should be

TABLE 10. Universal Service Obligations (USOs) in Latin America

Country	*Definition of USOs*	*Coverage*	*Obligations*	*Retail scheme*	*Funding mechanism*	*USO fund*	*USO fund source*
Argentina	Yes	General	Incumbent	Special payphone operators; phone shops and private PCOs; telecenters	Cross-subsidies	No	Pay or play
Bolivia	Yes	Rural	Incumbent; regional[a]	n.a.	n.a.	Yes[g]	Government
Brazil	Yes	Rural	Incumbent[b]	Innovative initiatives[e]	n.a.	No	n.a.
Chile	No	n.a.	Special rural license	Special payphone operators; telecenters	Interconnect fees[f]	Yes	Central government
Colombia	Yes	General	Special rural license	n.a.	n.a.	Yes[h]	Operator levy
Dominican Republic	Yes	n.a.	None[c]	Telecenters	n.a.	Yes	2% tax on subsc. bills, international settlements
Ecuador	n.a.	n.a.	Incumbent	Telecenters	n.a.	Plan	World Bank technical assistance
El Salvador	n.a.	n.a.	n.a.	Telecenters	n.a.	n.a.	n.a.
Guatemala	n.a.	n.a.	Special rural license	Special payphone operators; phone shops and private PCOs	Cross-subsidies	Yes	Spectrum auctions
Honduras	n.a.	n.a.	None	Phone shops and private PCOs	n.a.	Plan	n.a.
Peru	Yes	Rural	Incumbent; special rural license	Special payphone operators; telecenters	n.a.	Yes	Operator levy
Mexico	No	Rural	Incumbent	Telecenters	Interconnect fees	No	Virtual fund considered
Nicaragua	n.a.	n.a.	n.a.	Telecenters	Cross-subsidies	Plan	World Bank technical assistance
Venezuela	Yes	Rural	Incumbent; cellular;[d] special rural license	Special payphone operators; phone shops and private PCOs; telecenters	n.a.	n.a.	n.a.

Source: Estache, Wodon, and Foster (2002); data provided by Juan Navajas, the World Bank.

a. Cooperatives with rural obligations.

b. The incumbent operators, with no obligations for the mirror license holders.

c. The Directorate-General of Telecommunications (DGT) has operated rural telegraph system, but it is to be discontinued.

d. Cellular operators are permitted to serve rural areas, and they have service expansion requirements.

e. Virtual telephony.

f. To ensure feasibility, payphone operators are planning to charge higher interconnection fees.

g. Telecommunications law of 1997 has provisions for using the Fondo Nacional de Desarrollo Regional for funding rural telecommunications, no evidence of actual implementation.

h. Social Telephony Fund.

provided and to whom? Second, who should be required to fulfill a USO? Third, who should pay for the costs of a USO?

The exact definition of universal service varies from country to country. The most commonly used version refers to achieving a minimum quality level of a basic package of services to all consumers, at affordable prices. Each element of the specific statements is open to interpretation—what is a minimum quality level? What constitutes a basic package? What prices are affordable? Some countries list a set of services and quality levels that are included in universal service (for example, voice-grade access to the public switched network and touch-tone service), as well as detailed maximum prices that can be charged for specific services and a maximum rate for the average across all services. This exercise is, of course, problematic. Technological progress means that the set of basic services is constantly expanding, and minimum quality levels are ambiguous. For example, wireless services allow greater mobility, but typically have lower sound quality and completion rates.

In spite of their popularity and their very practical relevance, USOs are under increasing pressure in the more academic literature. The first source of pressure appears to be political, although it has solid economics to back it up. A major problem with USOs is that they are blunt. A USO to cover high-cost rural areas at the same price as low-cost urban areas benefits high-income rural consumers at the expense of low-income urban consumers. More precisely, it may be inefficient to effect a particular objective—higher welfare for rural residents—by distorting the prices of particular services. This point has been made formally by Atkinson and Stiglitz, who show that under certain circumstances, the best way to redistribute income is through the taxation of income, not consumption.[36] In their model, consumers differ in their income levels, so their results speak most directly to the issue of subsidies to low-income consumers. It is straightforward, however, to reinterpret their model in terms of low- and high-cost consumers. One of the key conditions required for this result is that low- and high-income consumers have the same relative preferences for consumption goods (that is, the marginal rate of substitution between consumption goods is independent of income). In this case, taxing consumption—which is essentially what occurs when the prices of telecommunications services are altered—to fund universal service is

36. Atkinson and Stiglitz (1976).

unnecessarily inefficient. A better way to redistribute income is to tax income. If the goal is to encourage people to live in high-cost rural areas, the theorem suggests that offering a location-specific income tax break is better than a telecommunications subsidy. The challenge is to find a location-specific tax that is consistent with the social objectives embedded in the USO. When this is impossible, countries tend to have no option but to rely on a sector-specific tax. The latest example is Argentina, where companies are required to put 1 percent of their gross sales into a government-run fund to provide basic phone services in areas that are unattractive to investors.[37]

The second challenge facing USOs comes from the introduction of competition. As demonstrated above, most Latin American telecommunications markets have been opened up to competition. This has consequences for the financing of USOs when USOs are supported by cross-subsidization. This cross-subsidization is sustainable while a single firm operates across the various markets, as was the case in the United States and the United Kingdom until the early 1980s. When a second firm is able to operate, however, it will choose to enter the more profitable sectors—a process known as skimming the market. This has three implications. First, the price distortions required by the USO can lead to inefficient entry. When a USO causes retail distortions, the distortions should be addressed through a retail instrument, such as a tax. This might be implemented in combination with an access charge equal to the marginal cost of access. Use of the access charge alone, both to provide the right entry incentives and to correct the retail distortion, is inferior.[38]

Second, the subsidy required to support the USO is higher than when entry cannot occur; since financing the USO is distortionary, this means that the social cost of the USO is higher. When consumers are heteroge-

37. Changes in the assumptions underlying the Atkinson-Stiglitz theorem will alter the result. For example, the marginal rate of substitution between consumption goods may not be independent of income. In that case, it may be worth taxing those goods preferred by the rich and subsidizing the goods preferred by the poor. Nevertheless, the result is important for emphasizing that USOs must be carefully assessed for their validity and not simply accepted as an all-purpose instrument to address the financing of access. Gasmi, Laffont, and Sharkey (2000) provide a good example on how to evaluate alternative subsidy schemes given various configurations of infrastructure costs and various degrees of efficiency in the fiscal system. (The latter affects the shadow cost of public funds that would have to be paid if direct subsidies were adopted.)

38. See Armstrong (2001).

neous, with some being high cost and others being low cost, a USO subsidy that is set without regard to competition will be too low. Such a subsidy assumes that the operator can earn excess profits from low-cost consumers, which can be used to finance service to high-cost consumers. Competition eliminates these profits and so increases the required subsidy.

Finally, USOs that come in the form of a uniform pricing requirement have strategic effects that regulators need to recognize. Valletti, Hoernig, and Barros show that a USO affects the way in which operators compete.[39] In particular, a uniform pricing restriction creates linkages between markets. This typically makes operators less aggressive in those markets, leading to higher equilibrium prices and deadweight loss.

The tension between universal service and competition represents a considerable challenge for regulators. The case of voice over Internet protocol (VoIP) is instructive. Conflicts such as those described above for Colombia are likely to grow when decisions must be made on whether VoIP leads to direct competition with companies with a USO. The situation is likely to get even more complex as service obligations start to include competitive web-based services such as electronic mail. A promising solution is the use of universal service auctions, in which operators bid for a level of subsidy (competition for the market) and the post-auction market structure is determined by the auction bids. Several Latin American countries have successfully employed this scheme to increase phone penetration in rural areas.

Chile, for example, has used minimum subsidy concessions to expand both electricity and public telephone services to rural communities since 1994. There is competition between regional governments to win central government financing, between rural communities to have their project sponsored by the regional government, and between utility companies to win the concession to serve a particular rural community. Concessions are awarded to the company offering the largest reduction of the maximum allowable subsidy stipulated for each contract. Service expansion is jointly financed by the state, the private sector, and the rural consumer. State contributions are justified because the selected projects have positive social returns but negative private returns. Indeed, this differential defines the maximum allowable subsidy. However, a substantial part of the investment costs are financed by the private operator. The average proportion for

39. Valletti, Hoernig, and Barros (2002).

telecommunications was 72 percent in the period 1995–97. Customers must pay regulated service charges to cover the unsubsidized costs. Concessionaires are free to choose the appropriate technology. Although the government makes certain assumptions about technology choice when computing the maximum allowable subsidy, the winning bidder is free to select its own technological solution. The results of the programs have been encouraging. About 80 percent of the rural population now has access to a public telephone. This progress was achieved at a cost of $2,300 per public telephone. Unit costs have risen over the life of the programs, probably because later projects have been targeted toward more isolated, and hence more costly, communities.[40]

To conclude this section, we summarize the most important issues related to the affordability problem. The first message to remember is that universal service obligations are justified on efficiency grounds even if they are debatable on equity grounds in that there are better tools for achieving redistribution. The justification stems from the fact that USOs can reduce the risk that customers may not subscribe to a network, since they do not take into account the benefit they confer on existing users. Although the marginal consumer confers a small externality, this has to be multiplied by large numbers. This kind of justification for subsidies has its limits, however. In particular, subsidies should be at the margin, and it is not necessary to subsidize the majority of inframarginal customers who will gain access to the network without any inducement. In this respect, targeted programs fare much better than uniform subsidies. There also seems to be room for the introduction of more optional tariffs for local services. A menu of contracts, designed with the needs of the poor and the low-end users in mind, could be designed at a low cost to induce more people to subscribe without having to subsidize the large majority of the population. Subsidizing or maintaining artificially distorted tariff structures is not the only way to increase the subscriber base. As said above, affordability should be interpreted as affordability among incremental users who are considering taking up or dropping the service.

On the more practical side, the experience of the 1990s has clearly shown that regulators should be careful with USOs, as incumbents tend to use them to extract too many concessions. Countries should distinguish clearly between universal availability and universal service guaran-

40. See Estache, Wodon, and Foster (2002) for more details and additional references.

tees. The former is promoted by encouraging investments and removing entry barriers. Only the latter should be explicitly linked to possible costing and financing requirements. The approach should be technologically neutral, enabling wireline and wireless technologies to be used to provide services. Setting a rigid requirement for the functionality of Internet access within the defined universal service package would prevent mobile services from fulfilling the universal service criteria. It is important to maintain incentives for competing networks and technologies to provide part of the universal service provisions.

A final point to remember is that there are many ways of ensuring that costs are kept at a reasonable level. Using auctions to assign USOs can help because the regulator would not need to calculate net costing, but such systems also have problems. It may be difficult to find sufficient participants to bid against the incumbent (in many cases entrants would need to use alternative infrastructure or acquire the use of the incumbent's assets). Furthermore, the incumbent and new entrants face an asymmetry of information, for example, concerning the costs and benefits of serving groups of customers. If an auction is not feasible, then the regulator must calculate the net cost and proceed to financing requirements. Financing these costs imposes distortions, and regulators should try to minimize losses of allocative efficiency. The least distortionary way to finance net costs is probably from the central government budgets. Alternatively, funding could be recovered within the sector, raising a tax from the broadest possible base in order to minimize the impact of the financial burden falling on end-users. The specific solution largely depends on the efficiency of the tax system.

Concluding Comments

This paper has shown that an effective implementation of the regulatory agenda of telecommunications reform can accelerate the adoption of the Internet. It is only part of the solution, however, since income level, income distribution, and access to primary infrastructure are the main determinants of growth in connection to and use of the Internet. Regulation works by cutting costs. Cost cutting requires that the regulators in the region take a much closer look at the design of interconnection rules and the trade-offs involved. It also requires a commitment to developing analytical instruments to sort out the many problems and to generate benchmarks that are more consistent with local issues and the local cost of capital than international benchmarks will ever be for countries in unstable macroeconomic situations. It requires an equally strong commitment to imposing regulatory accounting systems to equalize the information asymmetries that incumbents manipulate to reduce the risks of entry. Finally, it requires a stronger commitment on the part of competition agencies, since in many countries the failure of negotiating interconnection agreements will raise as many competition issues as regulatory questions.

It is going to be a while before regulation manages to do what it is supposed to do. It will require national and international commitments and much more analytical work to turn laws, decrees, and rules into practical instruments with the expected impact on competition and costs. A demand for new laws and new regulation is already emerging with the information revolution, well before the first wave of legal instruments has been fully enforced. The full success of reforms and its fair distribution among all segments of the population will require much more effort from regulators than these have been willing to give so far.

Appendix A: A Brief Overview of Telecommunications Networks

Telecommunications networks are made of different components that can be broadly divided into two main elements, switches and transmission. Switches allow the routing of signals throughout the network, while transmission supplies the capacity to transport the signal in various ways, including wireline transmission (copper wires, cable, optical fiber) and wireless transmission (satellite, cellular, microwave). In addition to transport facilities and routing services, value-added services are typically provided at a higher layer over a network.

Telecommunications is a network industry, meaning that the final products are made of interconnected components supplied at different points over the network. The interdependency at the technological level has an important counterpart at the consumer level. Subscribers want wide-ranging communication devices as long as connectivity is ensured. This phenomenon is known as a network externality, since each subscriber's willingness to pay for telecommunications services increases with the size of the subscriber base that can potentially be contacted. For example, suppose that each individual gains a benefit equal to 1 from being able to communicate with any other individual; and suppose that there are N individuals on the network. The total value of the network is the number of pairings $N(N - 1)$, which is close to N^2 when N is large. This squared relationship between the number of members of a network and the value of the network is known as Metcalfe's law. A large network also generates indirect benefits. The more members participating in the network, the more likely it is that new services will be offered over that network.[41]

Network externalities represent a plausible justification for policies aimed at tackling the affordability problem. A policy of universal access can help induce marginal consumers to connect, and the resulting social benefit will likely be higher than the private benefit given that the benefits extend to existing users. Network externalities also have important strategic implications, since larger incumbents can block entrants by denying them interconnection.

The layered structure of a network is crucial when considering the type of competition that can be envisioned in the industry. The rewards to an operator depend on the degree of interdependence with services offered by operators at other layers. If an operator is integrated, there is less risk that connectivity is jeopardized, but this may lead to excessive market power in the final market. Moreover, this would imply that every operator can supply each required component, which may be unrealistic or may result in a wasteful duplication of resources. Hence, an operator will need to incorporate bottleneck facilities that are vital for the final provision of services offered by other operators. The presence of bottlenecks is the main justification for the introduction of regulation in this market.

The local loop, in particular, is seen as the main bottleneck in the industry, and it is pivotal in the current regulatory process. The local loop represents the connection between the subscriber's premise and the end office. The bottleneck occurs because the link close to the customer premise (the distribution plant) is essentially a fixed cost, in the sense that its cost is not traffic sensitive; it does not vary with the subscriber's usage. If one also includes the local switch, some elements are traffic sensitive (for example,

41. See Katz and Shapiro (1985) and Farrell and Saloner (1985, 1986) for seminal analyses of positive network externalities.

interfaces, which depend on the number of lines), but economies of scale would still predominate.[42]

Appendix B: Glossary[43]

Access charge. Wholesale price to be paid to a network by an interconnecting network for access to a segment of the former network.

Accounting separation. The preparation of separate accounts for different businesses and parts of businesses run by the same company or group of companies, so that the costs and revenues associated with each business or part of a business (and transfers between them) can be separately identified and properly allocated.

Analog. The direct representation of a waveform—as opposed to digital, which is a coded representation. Mainly used over the local loop.

Asymmetric digital subscriber line (ADSL). Uses a technology that transforms a normal telephone line into a high-speed digital line, which enables simultaneous access to telephony services and the Internet. ADSL provides always-on access to the Internet, as well as on-demand TV and video services, at speeds that are ten to forty times faster than a standard 56k modem.

Bottleneck. An input to the production process that cannot be cheaply duplicated.

Bottom-up approach (to modeling of costs). The calculation of costs by identifying and summarizing the costs of individual items of equipment, manpower, and other resources required. Contrasts with the top-down approach, which involves substracting from a known total the costs that are not relevant to the activity in question.

Broadband. A service or connection that allows a considerable amount of information to be conveyed, such as television pictures. Generally defined as a bandwidth greater than 2Mbit/s.

42. On the other hand, long-distance telecommunications represents a favorable area for the development of competition compared with the provision of access and local calls. It is relatively straightforward for an entrant to establish a rival long-distance fiber optic network, possibly using an existing infrastructure, such as canals or railway lines linking major cities or high voltage transmission networks. Microwave technology can also be used as a stop-gap mechanism. This observation applies particularly to high-volume (thick) routes, which are capable of sustaining several operators. Certain low-volume (thin) routes may remain effective monopolies, however.

43. More complete glossaries can be found at www.oftel.gov.uk/publications/glossary/index.htm and www.its.bldrdoc.gov/projects/t1glossary2000/t1g2k.html.

Bundling. The tying of one service or product to the provision of others, including some situations in which the supply of services is linked through the use of discounts.

Call back. The procedure for identifying and authenticating a remote terminal, whereby the host system disconnects the terminal and reestablishes contact.

Carrier preselection. A facility that allows customers to opt for certain defined classes of calls to be carried by an operator selected in advance (and having a contract with the customer), without having to dial a routing prefix or follow any other procedure to invoke such a routing.

Common costs. Costs that cannot be directly attributed to any one product or service but that a company incurs in supplying those products or services.

Copper line. The main transmission medium used in telephony networks to connect a telephone or other apparatus to the local exchange. Copper lines have a relatively narrow bandwidth and so have limited ability to carry broadband services such as video, unless combined with an enabling technology such as ADSL.

Cost plus. A charge that covers the costs incurred by the network operator in providing services for other operators, including a reasonable return on capital.

Cross subsidy. The use of profits made in one market to finance losses in another incurred by pricing below incremental costs.

Current cost accounting (CCA). An accounting convention in which assets are valued and depreciated according to their current replacement cost while maintaining the operating or financial capital of the business entity.

Dial up. A service feature that allows a user to use telephone systems to initiate and effect communications with other computers.

Digital. The coded representation of a waveform by, for example, binary digits in the form of pulses of light—as opposed to analogue, which is the direct representation of a waveform.

E-commerce. The action of buying online or establishing an online store-front. Also refers to technology that speeds up and makes more efficient the transaction of commerce at all stages of the process, from production to delivery.

Efficient component pricing rule (ECPR). A rule for determining interconnection prices, under which the price is composed of the incremental cost of providing the interconnection service plus the profit that the network operator foregoes by selling interconnection to another operator rather than supplying a service to the final customer.

Equal access. The ability for a customers connected to one operator to choose to have their long-distance and international calls carried by another operator, with no extra processes or procedures required.

Facilities-based operator. An operator that builds its own facilities (as opposed to renting them from another operator).

Federal Communications Commission (FCC). The United States regulatory body set up in 1934 to regulate all interstate and foreign communications by wire, radio, and television. Intrastate communications are regulated by state public utilities commissions.

Fixed radio access. A fixed-link telecommunications service that connects the network to the consumer's premises by radio instead of copper line or optical fiber.

Gateway. A facility that adapts the signals and messages of one network to the protocols and conventions of other networks or services.

Geographically averaged prices. Prices established by averaging the costs of network elements across the country so that customers in different areas do not pay different rates.

Historic cost accounting (HCA). A universally recognized accounting convention, in which costs, turnover, assets, and liabilities are generally recorded at the value at which the transaction was incurred, and assets are valued and depreciated according to their cost at the time of purchase.

Incremental costs. The capital and operating costs that arise as a result of the provision of the increment. In contrast to fully allocated costs, incremental costs include only those costs that are caused by the provision of the increment.

Integrated services digital network (ISDN). A network based on the existing digital PSTN that provides digital links to customers and end-to-end digital connectivity between them.

Interconnection services. Services provided by one telecommunications organization to another for the purpose of conveying messages and information between the two systems, including any ancillary services necessary for the provision and maintenance of such services.

Interface. A set of technical characteristics describing the point of connection between two telecommunications entities, for example, between two telecommunications networks or between a telecommunications network and customer apparatus.

Internet. A global network of mostly narrowband networks that is accessed by users with a computer and a modem via a service provider.

Internet host. A computer that provides end users with services such as computation and database access and that usually performs network control functions.

Internet protocol (IP). Packet data protocol used for routing and carrying messages across the Internet.

Internet service provider (ISP). A firm that provides Internet connection to companies or individuals via dial-up, ISDN, or other connection technology. In the United States, ISPs are classified as enhanced service providers.

Leased lines. A fixed, unswitched communication link between two points that carries speech, data, or image communications for customers' exclusive use. Also known as private circuits.

Local access. The connection between the customer's premises and the local PSTN exchange.

Local loop. The access network connection between a customer's premises and the local exchange. This usually takes the form of a pair of copper wires.

Local loop unbundling. An access requirement mandated in the European Union in December 2000. It requires those operators designated as having significant market power to give other telecommunications companies access to their local networks (that is, the telephone lines that run from a customer's premises to the local telephone exchange).

Long-run incremental costs (LRIC). Costs that arise in the long run as a result of providing a given increment, for example, an additional quantity of telephone numbers. Long-run costs assume that the supply of numbers is variable (not fixed).

Low-user scheme. A program whereby a customer with a low call bill is offered a discounted online rental.

MBit/s. Mega (million) bits per second. A measure of the speed of transfer of digital information.

Modem. A device that both modulates and demodulates signals. In communications, a modem is used for converting digital signals into, and recovering them from, analogue signals suitable for transmission over analogue communications channels.

Narrowband. A service or connection allowing only a limited amount of information to be conveyed, such as for telephony. This contrasts with broadband, which allows a considerable amount of information to be conveyed.

Network operator. The operator of a telecommunications network that has a public telecommunications operator (PTO) license and provides network services.

Number portability. Enables a customer to change operators but retain the same number, provided the customer remains at the same address.

Oftel. Office of Telecommunications, the regulator in the United Kingdom.

Optical fiber. Cable made of glass fibers through which signals are transmitted as pulses of light. It is a broadband medium that can easily provide capacity for a large number of channels.

Originating network. The network to which a caller who places a call is directly connected.

Packet service. A service involving the transmission of data in the form of discrete blocks (packets) of information and, if necessary, the assembly and disassembly of data in this form.

Price cap. Regulation that sets a ceiling on the average price that can be charged by the regulated firm, but allows some flexibility in the price structure.

Price floor. The level that an incumbent operator must price at or above if its prices are not to be regarded as anticompetitive.

Public switched telephone network (PSTN). The telecommunications networks of the major operators, on which calls can be made to all customers of all PSTNs.

Radio spectrum. The range of wavelengths used, for example, for broadcasting radio, terrestrial television, and satellite television. Usable wavelengths range from about 100 kHz to about 400 GHz, although there are as yet no broadcasts above about 12 GHz.

Router. A special-purpose computer that processes the IP information to deliver a message.

Service provider. Entities that provide telecommunications services—or services with a telecommunications service component—to the public at large over fixed or mobile networks but that do not own or operate telecommunications networks.

Stand-alone costs. The costs to a single-product firm of providing a service. The stand-alone costs of a service exceed the incremental costs to a multi-product firm if there are economies of scope.

Switch. A mechanical, electromechanical, or electronic device for making, breaking, or changing the connections in or among circuits.

Switched. Relates to a telecommunications network comprising at least one exchange and capable of routing signals and messages from one line to all other lines constituting the network.

Telecommunications network. Transmission systems and, where applicable, switching equipment and other resources that permit the conveyance of signals between defined termination points by wire, radio, optical fiber, or other electromagnetic means.

Terminating network. The network to which a customer who receives a call is directly connected.

Transmission. The dispatching for reception elsewhere of a signal, message, or other form of information by any means (such as by telephone, radio, television, or fax) via any medium (such as wire, cable, microwave, optical fiber, or radio frequency).

Universal service. The basic level of telecommunications services that should be available to all customers.

Universal service obligation (USO). A provision in some licenses requiring the licensee to provide certain services to all specified persons.

Value added service. Any telecommunications service that involves as an integral part of the service the provision of features or capabilities that are additional to the conveyance of the information transmitted (including switching).

Voice over Internet protocol (VoIP). A set of facilities for managing the delivery of voice information using the IP. It entails sending voice information in digital form in discrete packets rather than in the traditional circuit-committed protocols of the PSTN.