

Research Article

The Microtelco Opportunity: Evidence from Latin America

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Abstract

ICT networks and services are not effectively reaching the poor, particularly those living in rural areas. Public subsidies for traditional operators to cover the difference between tariffs and cost-recovery levels have proved limited in addressing this continuing gap. This article explores the role that could be played by a largely unnoticed set of actors we call microtelcos—small-scale telecom operators that combine local entrepreneurship, innovative business models, and low-cost technologies to offer ICT services in areas of little interest to traditional operators. Through a series of case studies from Latin America, we document how microtelcos combine organizational and informational advantages that allow them to service the poor effectively and with limited access to public subsidies. In fact, we show that they have done so despite a less than favorable regulatory environment. The article examines the case for microtelcos as an effective alternative to address the ICT needs of the poor and suggests how existing regulatory obstacles may be removed so that microtelcos could be more effectively harnessed to bridge continuing access gaps.

Introduction

It is widely documented that, despite major gains during the past decades, ICT networks and services are not effectively reaching the poor, particularly those living in rural areas (ITU 2006). Since the end of the telecom monopoly era, a common answer to this problem has been to create incentives for large operators to enter commercially unattractive markets, with public funds often covering the difference between tariffs and cost-recovery levels (Dymond and Oestman 2003). In Latin America, for a variety of reasons (including lack of adequate government funding, regulatory weakness, lack of transparency, and high administration costs), these policies have achieved only modest results (see Wallsten and Clarke 2002; Stern 2006).

This article explores the role that could be played by a largely unnoticed set of actors we call microtelcos—small-scale telecom operators that combine local entrepreneurship, innovative business models, and low-cost technologies to offer an array of ICT services in areas of little interest to traditional operators. Since the market reforms undertaken during the 1990s, it is apparent that the provision of ICT services is no longer limited to large operators—be they public or private. Today, a variety of small-scale market entrants (including cooperatives, municipal governments,

We would like to thank Peter Cowhey, Christian Sandvig, Peter Stern, Bruce Girard, and Francisco Proenza, as well as two anonymous reviewers, for their comments and contributions to earlier drafts. The research was funded in part by the International Development Research Centre.

community organizations, universities, and local entrepreneurs) participate in the deployment and operation of public ICT networks. This is perhaps most noticeable in areas unattractive to large operators, where a variety of unorthodox arrangements exist to serve high-cost or low-income communities.¹

This article examines the case for microtelcos as a viable alternative to existing organizational arrangements for extending the coverage and affordability of ICT services to the poor. We show how a variety of microtelcos are effectively operating in Latin America, despite a less than favorable regulatory environment and little access to public subsidies. Whereas conventional analyses emphasize the advantages of scale in the deployment and operation of telecom networks, we argue that new low-cost technologies undermine these advantages, particularly in thin markets. This enables efficient entry by small-scale competitors with hybrid organizational arrangements, better knowledge of local demand for ICT services, and strong community links that allow mobilization of nonmarket inputs.

Our case is built upon the analysis of a diverse set of microtelco experiences in Latin America. We deliberately selected our case studies to maximize diversity in terms of organizational arrangements, local conditions, and regulatory framework. Hence, the cases are not meant as a valid sample from which to draw generalizable results, but rather to suggest the conditions under which different microtelco models could be replicated and sustainable over time and to hint at necessary policy reforms that would enable microtelcos to flourish where others fear to tread. We drew our case study data from a combination of primary and secondary sources, which we combined with an exhaustive survey of the regulatory environment for key microtelco-enabling technologies such as unlicensed wireless local area networks (WLANs) and VoIP.

The article is organized as follows. In the first section we discuss the theoretical case for microtelcos as a viable alternative to extend networks to thin—mostly rural—markets. Drawing from the work of Ostrom (1996) and others, we argue that there is a large scope for cooperative arrangements

between different sets of actors (municipal governments, universities, local entrepreneurs, community organizations, etc.) in the delivery of ICT services in these markets. Next we discuss how technological innovations are enlarging the scope of action for microtelcos, enabling the provision of network services at a much smaller scale (including self-provision). We then present case studies drawn from across Latin America and discuss the findings from our survey of the regulatory environment for microtelcos in the region. We conclude with recommendations for creating an enabling regulatory framework that would enable experimentation with a broader range of organizational models for the delivery of ICT services to the poor.

The Theoretical Case for Microtelcos

Public services can be delivered in a variety of ways. For many decades, most countries relied on large state-owned utilities to provide basic infrastructure services such as electricity, water, and telecommunications. A major paradigm shift took place during the last decades of the twentieth century, paving the way for the privatization of many public utilities and far-reaching regulatory reforms aimed at opening markets to competition. The shift was particularly marked in the telecommunications industry, where rapid technological innovation contributed significantly to undermine existing monopoly regimes.²

These changes unleashed an unparalleled wave of innovation and investment in the ICT industries, first in the developed world and later in developing economies; however, these large-scale reforms did not alter the fundamental problems in servicing the poor. It is widely recognized that, even in the presence of cost-based subsidies, large private operators are no more likely to serve high-cost or low-income customers than were state-owned utilities (Rosston and Wimmer 2000). This should not be surprising. Ultimately, whether in public or private hands, large operators face similar challenges: low and often seasonal incomes, low population density in rural areas, lack of reliable information about customers and

1. This has also been the case in developed countries such as the United States, where for example the lack of adequate broadband internet access has prompted some local governments to build municipal broadband networks (Gillett, Lehr, and Osorio 2004), as well as spurred grassroots network deployment through community Wi-Fi initiatives (Sandvig 2004).

2. There is a vast literature that documents these changes. For an overview see Noll (2000).

their demand preferences (including willingness to pay), lack of credit assessment mechanisms (including a formal addressing system), and lack of complementary infrastructure (such as electricity and roads), among others (Trémolet 2002).

Further, other factors discourage traditional operators from tailoring services to the poor. The shared costs structure of telecom networks means that providing more and better services to the more profitable customers increases the cost of provision to all—even to those requiring less quality at more affordable prices. In many cases, tariff and engineering regulations based on the average customer may not be adequate for the poor, discouraging low-cost entry (Estache, Gomez-Lobo, and Leipziger 2001). The availability of cost-based subsidies deters large operators from seeking more efficient price/quality combinations to serve the poor.³ Finally, in a competitive environment, risk-averse incumbents lack incentives to make investments in thin markets with significant information problems and high opportunity costs.

Therefore, whereas large private utilities are well suited for building network backbones and retailing services in most markets, their organizational advantages tend to diminish as we approach the last-mile segment in high-cost or low-income areas. Microtelcos, by contrast, often thrive under these conditions because they rely on a different set of inputs and organizational arrangements. Because their core business is to serve customers unattractive to large operators, they actively seek alternative combinations of capital, labor, and technology that lower costs and maximize returns on the basis of their knowledge of local conditions and demand preferences. As we shall see, this involves deploying new low-cost technologies, bundling ICTs with related services (such as training, financial, and legal services), taking advantage of related infrastructure (such as roads and water systems), and finding business models (including payment collection mechanisms) appropriate to poor customers.

In pursuing these goals, microtelcos often cooperate with a variety of actors that have a comparative advantage in performing the various tasks involved in the provision of ICT services to the poor. This type of cooperation in the delivery of services is often referred to as *coproduction* (Ostrom 1996). Coproduction emphasizes the potential complemen-

tarities that exist between different actors (including end users) in the delivery of a service or the production of public goods. These arrangements, which are widely documented in the irrigation (Lam 1996), sanitation (Watson 1995), and transportation sectors (Joshi and Moore 2004), tend to emerge when governments fail to deliver adequate levels of service and when market conditions are unfavorable for private investments.

Cooperative arrangements are of course not new in the ICT industry. This is how much of rural America was wired for telephony in the early twentieth century, when farmers connected their barbed-wire fences with those of their neighbors to create telephone circuits (Fischer 1992). Similarly today, end users are pooling antennas located in their roofs to create mesh Wi-Fi networks, seizing this opportunity to deploy and control their local network (Sandvig 2004). In all these examples, the key has been to create appropriate incentives and coordination mechanisms that allow various local actors to participate jointly in the planning, building, and maintenance of infrastructure networks.

A key advantage for microtelcos is their ability to activate local resources through coproduction arrangements with local organizations or potential clients. For example, labor for infrastructure building and maintenance can often be contributed by customers themselves, often at little opportunity costs given high levels of underemployment in many poor regions. Further, local organizations typically control land and structures that represent valuable assets for an operator to deploy cables or site antennas. Whereas the transaction costs for a large commercial operator to assemble access to these individual sites may be prohibitive, a microtelco with deep local ties can prove more successful at creating coproduction arrangements with potential customers and local institutions that control these assets.

Municipal governments are another key partner in these arrangements. In Latin America, as in other developing regions, the strengthening of democratic institutions has been accompanied by decentralization efforts aimed at increasing local government autonomy, creating a more enabling institutional setting for the delivery of public services at the municipal level. As the examples discussed below reveal, the role played by local governments in

3. This is not the case, however, with smart subsidies, which are increasingly used by telecom funds in Latin America and elsewhere (see Wellenius 2001).

microtelco projects in Latin America varies widely, as it does elsewhere (see Gillett, Lehr, and Osorio 2004). In many cases, provincial authorities have been instrumental in aggregating demand, developing e-government applications, facilitating planning, and providing training to potential customers. In other cases, municipalities have cofinanced infrastructure investments through a variety of partnerships with private operators. Yet in others local authorities have engaged in the building and operation of a noncompetitive network segment (e.g., a fiber backbone) on a wholesale basis.

The diversity in coproduction strategies revealed by the microtelco cases discussed below suggests that the optimal organizational arrangement for the extension of ICT services into underserved areas, and thus the combination of inputs contributed by the actors involved, will vary according to local conditions. Success therefore depends on intimate knowledge of the local context, on the ability to trigger cooperative behavior from the various parties, and on appropriate governance mechanisms. In each particular situation, the preexisting institutional context will favor specific kinds of arrangements, and we follow the resulting taxonomy in presenting our case studies.

The Enabling Role of New Technologies

The deployment of telecommunications networks, like most large infrastructure projects, has traditionally required significant upfront investments. The networks benefited from large-scale economies but the architecture had to be carefully planned in advance because resources could not easily be redeployed. The process involved making many *ex ante* assumptions about how services would be used, by whom, and at what price. As a result, ICT networks were typically built by large operators (mostly public in the past; mostly private today) who were positioned to assemble the financing and manage the risks involved in network development.

However, recent innovations in wireless communication and service applications are challenging these premises. These innovations are significantly

reducing the minimum efficient scale of telecom providers, allowing a variety of new actors, from small entrepreneurs to municipalities to user cooperatives, to enter the market. A leading example is the combination of new WLAN technologies such as Wi-Fi with wireless backbone solutions such as VSAT or the emerging WiMax standard. Low-cost WLAN systems have been deployed by small entrepreneurs and cooperatives to service rural communities in Africa, South Asia and Latin America at a cost several orders of magnitude below that of comparable wired solutions (Best 2003; Galperin 2005). Many small and midsized cities are taking advantage of these innovations to extend Internet access from a few broadband connections in government buildings to the entire community, thus lowering per user costs. Local entrepreneurs are tinkering with the technology to build point-to-point links over several kilometers to connect communities that lack adequate wired backhaul infrastructure (or to bypass links controlled by incumbents).

The much flatter cost curve of WLAN technologies undermines the comparative advantages of large operators in the deployment of local networks. While upfront costs are reduced, WLAN networks are also more easily scalable or redeployed, allowing microtelcos to make modest initial investments and scale up later following demand. Instead of poles and wires, WLAN technologies take advantage of a natural resource underutilized in many poor areas: the radio spectrum. Therefore, market entry is less defined by firm size than by spectrum management policies. Small wireless ISPs (WISPs) have flourished in countries where governments have opened frequency bands for unlicensed use, particularly in areas underserved by traditional operators.⁴ In other cases, they have taken advantage of regulatory gray zones to circumvent unfavorable rules for spectrum access and use (see Samarajiva in this issue).

Furthermore, new mesh networking protocols are enabling the growth of condominium-style networks. This emerging architecture is based on end users both receiving and relaying data from peer users, resulting in a cooperative network that can span a large area with only a few broadband links. This

4. In the U.S., which first allowed unlicensed operation of radio devices and today provides over 550MHz of spectrum on a license-exempt basis, there are an estimated 6,000 mom-and-pop WISPs servicing rural and other areas underserved by traditional broadband operators (FCC Wireless Broadband Access Task Force) Report, GN Docket No. 04-163, February 2005.

type of architecture is well suited in cases where backhaul links are scarce (and expensive), as is the case in many rural areas, as well as where spectrum is congested (e.g., in urban slums), since each network node need only transmit as far as the next node (which also minimizes power requirements, another concern in many poor areas). Another advantage is robustness: when each end user is connected to several others, multiple data routes may be available, thus bypassing failed nodes. Although the technology is still emerging, pilot projects are already operational in Africa and elsewhere.⁵

New low-cost applications are having similar effects at the services layer. A leading example is voice over IP (VoIP), which refers to a family of technologies that allow packetization and routing of voice communication over an Internet protocol (IP) network instead of a traditional circuit-switched network. There are many advantages to IP telephony, including lower costs and more efficient use of facilities, and many large operators are migrating calls from conventional PSTN to IP networks (Graham and Ure 2005), but the technology is particularly relevant to microtelcos because it enables provision of telephony at a fraction of the investment needed to build and maintain a traditional telephone network (infoDev 2005). Another advantage is that IP telephony is largely based in nonproprietary standards, and much of the equipment is available off-the-shelf for adaptation to local conditions.

A number of technological innovations are thus eroding the economic advantages hitherto enjoyed by large telecom operators, enabling microtelcos to extend ICT services further out into areas unattractive to conventional operators. These technologies share a number of advantages, among them lower costs, modularity based on open standards, less regulatory overhead, simple configuration and maintenance, scalability, and support for multiple applications. However, whether microtelcos are able to take advantage of these innovations depends to

a large extent on an enabling policy and regulatory environment. As our findings and other articles in this issue reveal (see particularly Proenza), this is not always the case.

Case Studies from Latin America

This section presents selected microtelco cases from across the Latin American region that reflect different organizational arrangements: telephony cooperatives (Argentina), small-scale private operators (Colombia), community networks (Peru), and municipal network initiatives (Brazil and Argentina). As noted, they are not intended to represent an exhaustive sample of microtelcos in the region. Rather, they are intentionally chosen to highlight the potential for a variety of nontraditional approaches to network deployment and operation, all of which have evolved in the shadow of the dominant operators and largely unnoticed by national policymakers, yet are proving effective at filling in the gaps left by traditional market as well as public subsidy arrangements.

Telephone Cooperatives (Argentina)

A long-established model for microtelcos in Latin America and elsewhere (particularly in the United States) is the telephone cooperative. This model is found for the most part in rural areas, where telephone cooperatives first emerged as the offspring of agricultural cooperatives established for various other purposes.⁶ In Argentina, telephone cooperatives emerged in the early 1960s from efforts by local residents in areas poorly served by the former state-owned operator ENTEL. Although not supported by the government, cooperatives were tolerated by ENTEL because they operated in areas considered unprofitable and brought modest revenues through tariff-sharing agreements.⁷ By 1965, more than 100 telephone cooperatives were operating across the Argentine territory.

When telecom reforms began in 1990, there

5. For example, the Akwapim Community Wireless Network in Eastern Ghana has deployed an open-architecture mesh network that uses WiFi technology to provide Internet access to schools, businesses, and community activity centers over a 20-km range.

6. The notable exception is Bolivia, where cooperatives also service the major urban areas. The case is nonetheless atypical, for Bolivia's telephone cooperatives are not the product of organized efforts by users but were rather created by the government in 1985 to replace the incumbent municipal telephone companies (Calzada and Dávalos 2005).

7. For much of the monopoly era (until 1990) the revenue-sharing agreement for long-distance calls between ENTEL and the cooperatives worked as follows: 60% corresponded to ENTEL, whereas the remaining 40% corresponded to the local cooperative.

Table 1. Cooperative fixed lines versus total fixed lines, 1990–2005

	1990	2005	Total Growth	CAGR*
Total fixed lines	3,797,336	7,904,125	108%	5.4%
Cooperative fixed lines	93,025	500,000	437%	12.8%
Cooperative share	2.5%	6.3%	—	—

Source: Goussal (2005).

*Compound Annual Growth Rate.

were more than 300 telephone cooperatives, many of which were part of multiservice utilities that provided electricity and water services as well. With the privatization of ENTEL, telephone cooperatives faced a period of uncertainty until 1992, when the government granted existing cooperatives a local telephony license on similar terms to those granted to the new private incumbents (including a seven-year exclusivity period). In 1999, faced with the imminent expiration of the exclusivity period, telephone cooperatives joined forces to enter the long-distance and public telephony markets through the creation of a private enterprise (TECOOP). By 2004, TECOOP operated approximately 230 public telephones, most of them located in remote areas.

Evaluating the performance of Argentine telephony cooperatives is difficult because of the sheer diversity of cases. Two-thirds of the cooperatives operate in small communities with less than 10,000 inhabitants, and the majority of them (57%) service fewer than 500 subscribers, but there are a handful of “large” cooperatives with more than 5,000 subscribers. On the basis of the available data, it is clear that cooperatives have played a key role in extending basic as well as advanced ICT services outside the main urban areas. Table 1 shows how cooperative lines have grown at a much faster pace than the overall fixed-line market since 1990, and today account for more than 6% of the lines.

In many of the poorest provinces, however, their contribution is more significant. For example, in the northern province of Jujuy (the poorest measured by GDP per capita) cooperative lines represented 53% of total installed lines in 1998.⁸ Standard performance measures reveal that in most cases telephone cooperatives compare favorably with traditional operators despite serving the less desirable markets. As Table 2 reveals, average teledensity in the territories served by cooperatives was only moderately lower

than in markets served by traditional operators (which include all major urban centers). In fact, if one disregards the Buenos Aires market (where the gap is higher because of the relatively high teledensity around the capital city), the difference in teledensity between the markets served by the incumbents and the ones served by the cooperatives was relatively small.

Part of the success of the Argentine telephone cooperatives is explained by faster technological adoption, motivated by the need to service customers in low-density areas at the lowest possible cost. Telpin, a cooperative in a relatively wealthy community south of Buenos Aires, installed the first digital exchange in Argentina in the early 1980s, which enabled provision of value-added services that incumbents only offered after privatization (Finquelievich and Kisilevsky 2005). Cooperatives have also pioneered wireless last-mile and backhaul solutions. Wireless local loop (WLL) systems have been deployed by cooperatives in the provinces of Chubut, Neuquén, and Córdoba, allowing fast network roll-out at a fraction of the cost of traditional copper. More recently, Wi-Fi has been the technology of choice (rather than xDSL) for cooperatives providing broadband Internet access services.

Cooperatives have also been eager to enter the wireless telephony market, because competition from wireless carriers has significantly affected revenue growth. The main efforts are centered around the acquisition of a national wireless license through Comarcoop, a joint venture formed by several telephony and electricity cooperatives. There are also more localized efforts such as that of CoTeCal, a telephone cooperative in the remote Patagonia city of El Calafate, which has partnered with Chinese electronics manufacturer Huawei and the provincial government to test CDMA450, a third-generation cellular telephony system better suited to service

8. Source: Secretaría de Comunicaciones (SECOM).

Table 2. Teledensity in cooperative territories versus total teledensity (1998)

Province	Teledensity in cooperative territories (A)	Total province teledensity (B)	(B – A)
Buenos Aires	16.0	22.0	-6.0
Catamarca	6.5	9.1	-2.6
Chaco	6.7	7.2	-0.5
Chubut	17.3	19.8	-2.5
Córdoba	15.1	18.4	-3.3
Formosa	10.3	4.5	5.8
Jujuy	7.7	6.3	1.4
La Pampa	20.6	19.4	1.2
Neuquén	14.8	13.4	1.4
Río Negro	10.1	15.9	-5.8
San Luis	13.1	13.5	-0.4
Santa Cruz	15.2	14.2	1.0
Santa Fe	15.6	18.9	-3.3
Total	14.2	19.2	-5.0
Total w/o Buenos Aires	13.1	15.5	-2.4

Source: Authors' calculations based on SECOM data.

scarcely populated areas than traditional PCS systems.⁹

It is also important to acknowledge the spillover benefits to the community as a whole associated with the telephone cooperative model. Telephone cooperatives have a significant involvement in ICT training and dissemination activities (which also serve to boost demand for value-added services), while many of them have also engaged in local content development (typically community portals) in association with various community organizations and local governments (Ó Siochrú and Girard 2005). Despite the lack of access to public subsidies, many cooperatives also set special tariffs for low-income residents whereas others provide free services (particularly Internet access) to public schools and libraries. These arrangements thus involve benefits that are not easily measurable but represent significant contributions to community actors external to them.

Community Networks (Peru)

A number of microtelcos have emerged from established community-based organizations (CBOs) that

were created for purposes other than the provision of ICT services. A project in the Chancay-Huaral valley of Peru illustrates this model.¹⁰ The Chancay-Huaral River irrigates a large area of small-scale farming on the sides of the valley. Although the area has potential wealth because of its good land, abundant water, and proximity to the markets of Lima and the north of the country, the inhabitants of the valley have little or no access to public services and the communications infrastructure available to them is at best precarious.

CEPES, a Peruvian NGO, reasoned that there was a connection between the lack of communication and services and the fact that farmers tended to grow the same crops regardless of market prices. They also noted that the lack of communications created problems for the efficient management of the waters of the Huaral River, a common resource used by the valley's farmers (about 6,000 in total) and managed by the Water Users Board, a cooperative organization of the seventeen irrigation commissions spread throughout the valley. To address

9. CDMA450 works on a lower frequency band (450 MHz) and thus requires considerably fewer towers to cover an extensive area.

10. Thanks to Bruce Girard, Peter Stern, and Miguel Saravia, who provided valuable information about this case in personal communications and unpublished notes. For details on the case see Ó Siochrú and Girard (2005).

these problems, CEPES proposed to establish an agricultural information and communication system for the valley, providing farmers with training and access to information that would enable them to make better decisions and facilitating communication among the irrigation commissions to improve water management. Because the available communications infrastructure was inadequate, a Wi-Fi network was deployed joining twelve villages in the valley and connecting them to the Internet through a shared 512-kbps link.

Although the project was initiated by CEPES, the structure and financing of the initiative reveal a partnership arrangement between different actors. The initial cost (about U\$200,000) was jointly financed between the Ministry of Agriculture, FITEL (Peru's telecom development fund), and the Water Users Board, which was also selected as the owner/operator of the network because of its experience in managing infrastructure and its close contact with local farmers. Beyond infrastructure deployment, the project emphasized the development and maintenance of a database of agricultural information, the training of farmers in the effective use of agricultural information, and the strengthening of local capacity for obtaining, distributing and using agricultural information.

As the project became operational, it also evolved to better meet local demand for ICT services. IP telephony quickly took on a central importance, not only for linking the local Irrigation Commissions and the board but also for general use by local residents (although the need to obtain a telecom operator license for terminating calls outside the local network limited its expansion). Providing access to other local residents (i.e., beyond farmers themselves) also became a priority, and provided a desirable revenue source (farmers themselves are not charged). Each access center is administered by the local irrigation commission, which is also responsible for infrastructure maintenance and financial sustainability.

The Chancay-Huaral project illustrates a number of the success factors of the CBO-driven microtelco model. First, it is important to note that new WLAN

technologies allowed critical flexibility in terms of multiservice provision and the rapid scaling of the network with a modest initial investment (about U\$16,000 per village). The provision of services to other residents highlights the ability to rapidly adapt to local needs. Although the decision to migrate from a specialized agricultural information system to a generic access provider stems in part from an interest to contribute to community development, it is also part of a long-term sustainability plan based on cost-sharing by public, private, and civil society partners. Finally, preexisting coordination mechanisms among the irrigation commissions provided the basis for the cooperative management of the network.

Municipal Networks (Brazil and Argentina)

Municipal network projects have attracted much publicity (both good and bad) as of late.¹¹ Many question local government involvement in the provision of ICT services as the new face of the old state-utility model, noting its poor record of service quality, innovation, and network extension. Yet a closer look reveals significant differences. First, the new breed of projects is led by local rather than national authorities. Second, municipal network initiatives tend to be integrated with broader local development strategies.

This is the case of Pirai, a rural municipality of about 25,000 in the state of Rio de Janeiro, Brazil. The Digital Pirai project was started in the late 1990s, when the municipality received a small grant from the federal government to modernize its local tax office. At the time, the entire local government ran on two phone lines and two computers. While part of these resources were earmarked for a hybrid fixed-wireless IP network to connect various government offices, local authorities realized that broadband connectivity could be extended to a much larger area at little extra cost. A community committee was then formed, which included municipal authorities and representatives from CBOs and the private sector, to chart a more ambitious plan that would extend wireless connectivity to much of the Pirai territory. The project was conceived as the cor-

11. It is important to distinguish municipal networks from municipal e-government initiatives. Broadly speaking, municipal e-government concerns the provision of local government services over an existing network platform, as well as the use of ICTs to improve internal government operations. By contrast, our attention is on municipal network projects where the local government is involved—in a variety of ways—in the deployment and/or operation of the ICT infrastructure.

nerstone of a broader plan to diversify the local economy and attract new investments following privatization (and significant layoffs) of the state-owned power utility, then the largest local employer.

The community committee proved critical in securing partnerships with universities, NGOs, and private firms, all of which contributed critical inputs. The project focused on four areas: e-government (the original remit of the initiative), education (including distance education in partnership with a consortium of public universities), public access points (including training in partnership with various NGOs), and SME adoption.

Funding represented both a challenge and an opportunity. Because the city found it impossible to obtain further grants from the federal government to deploy and operate the network, it was forced to seek new cooperation arrangements with civil society organizations and the private sector. The city formed partnerships with local businesses as well as a competitive telecommunications company to finance infrastructure deployment. The Pirai branch of CEDERJ, a consortium of public universities offering online courses, agreed to create an educational technology center on its premises to oversee implementation and develop applications. The network was turned on in February 2004. As of May 2006, it connected all public buildings, 21 schools (including several in neighboring villages), two telecenters, and a community center.

The lessons from the Pirai case point to several success factors. First, the lack of public subsidies (beyond the small grant to modernize tax collection) forced local leaders to draw in resources through cooperative arrangements with a variety of actors from the private and civil society sectors (both local and otherwise). Inputs were thus assembled through a combination of in-kind contributions, partnerships, and the city's modest budget. Second, the use of low-cost technologies at the transport (i.e., WLAN) and terminal (i.e., open-source software) layers dramatically reduced upfront costs, allowing Pirai to provide broadband services where traditional cable and xDSL operators could not justify investments.¹² Finally, local leadership, good governance and strong social capital enabled collective planning and

management of the project, contributing to better match services with local needs.

There is evidence that the case for municipal networks is stronger when the local government is already providing other public services (e.g., electricity and sanitation), since economies of scope often allow provision of ICT services at minimal extra costs (Gillet et al. 2004). The case of the SICOMU (Sistema de Comunicaciones Multimediales) initiative in the Argentine province of La Pampa is a fitting example. It also illustrates the combination of market failures, economies of scope, and internal government needs that often drive the municipal microtelco model. The SICOMU project began as an appendix to the construction of a large aqueduct undertaken by the provincial government. Having contracted for more than 1,300 kilometers of aqueduct building and secured the necessary rights of ways, provincial authorities decided to lay fiber alongside the aqueduct.

The fiber network was initially conceived as an intranet that would support the internal control systems for the operation of the aqueduct. However, it soon became evident that excess capacity could be used to service municipalities along the aqueduct route with minimal incremental investments in feeder lines. The provincial government thus enlisted 21 municipalities to participate in the project, most of them rural communities with few other connectivity alternatives. While the provincial government operates the network backbone (the fiber along the aqueduct and feeder lines), each of the municipalities is responsible for extending the network to local government offices, hospitals, schools, and public libraries, as well as selecting and managing the services provided at the local level.

Other local actors also provided important complementary assets. The state university (Universidad Nacional de La Pampa) has been utilizing the network for a variety of distance education initiatives. The local branch of the National Institute for Agricultural Technology (INTA) has made available online consultation and support services to local farmers. In addition, about half of the total network capacity is being offered as dark fiber to third parties for the commercialization of services in all or parts of the network. This is expected to offset a substantial part

12. According to estimates by Franklin Dias Coelho, general project coordinator of Pirai Digital, this allowed the city to reduce deployment and operation costs by a factor of eight (personal interview).

of the operating costs of the project. Local electricity cooperatives have already contracted to begin offering IP telephony services.

Whereas the public utilities of the past financed, built, and operated the entire network, municipal network projects today are more likely characterized by different degrees of cooperation with the private sector, CBOs, and civil society (oftentimes educational) organizations. They aim at facilitating investments in underserved areas rather than competing with established operators. The examples also suggest how, as one of the largest users of ICT services in the community, local governments benefit from financing and/or managing their own infrastructure where private operators fail to invest adequately. Many municipal networks have emerged from the need to equip local government offices and public entities (schools, libraries, police stations, health centers, etc.) with better ICT access, later evolving into broader initiatives that service local businesses and residents. They suggest a broader menu of options for municipal and provincial authorities to have an array of roles to play in spurring ICT development at the local level.

Small Private Operators (Colombia)

While Colombia is among the few nations in the regions that have not fully privatized its legacy operator, the liberalization of the telecommunications market in 1994 has resulted in significant private investments in the sector. A large part of these investments has flowed into mobile telephony as well as into the legacy municipal operators, which have been privatized to varying degrees.¹³ Yet market reforms have also resulted in the emergence of a number of small private operators, many of them serving areas poorly served by the incumbents. Whereas some of these operators are affiliates of larger firms with presence in various local markets, others are the product of independent efforts by small entrepreneurs who bear the majority of the risks themselves.

The evidence suggests that small-scale private operators are gaining ground in the Colombian telephony market. While the total number of fixed lines roughly doubled between 1994 and 2002, the num-

ber of lines controlled by small operators more than tripled in the same period, increasing their share from 7% in 1994 to 11% in 2002.¹⁴ The data also reveal that the performance of small-scale operators compare favorably with incumbent firms. The quality index computed by the Colombian regulator (which is factored into price regulations) reveals that small operators consistently outperform larger operators as measured by traditional quality indicators (faults per 100 lines, average days to obtain new connection, average days to repair a faulty line) as well as subscriber satisfaction surveys.¹⁵

Small private operators nonetheless still face a myriad of challenges, even when serving areas neglected by incumbents, as the case of TELEOCSA illustrates well. The birth of TELEOCSA dates back to the early 1990s, when a group of community leaders from Puente Piedra, a small town near the capital city of Bogotá, approached the national operator (Telecom) to request the extension of local telephony services to the community. Lacking the capital and the incentives to fulfill the request, Telecom instead proposed that local residents purchase the equipment (including switches and cabling), deploy the network, and later transfer ownership of all facilities to Telecom, which would then operate the network and provide interconnection with its long-distance lines.

Lacking alternatives, community leaders agreed to these terms and the project was started soon after. With the opening of the telecommunications market in 1994, community leaders changed course and decided to create a private local operator rather than transfer ownership to Telecom. A year later, TELEOCSA was incorporated and obtained a local operator license. What ensued was a protracted regulatory battle between the new company and Telecom, which not only refused to interconnect but asserted ownership over TELEOCSA's facilities, even when the totality of the investment was borne by local residents. At its peak in 2002 TELEOCSA had 1,200 subscribers, but after several unsuccessful attempts to obtain interconnection with Telecom's long-distance network the project was ended in November 2004.

13. For further details see Uribe Botero (2005).

14. Source: CRT.

15. In 2001 for example, the average quality index score (on a 100-point scale) for small operators was 90.1, compared to 89.4 for medium-size operators and 87 for large operators. Source: own calculations based on CRT (2002).

This case illustrates the well-documented need for a vigilant regulator to protect new entrants from anticompetitive strategies by the incumbents in control of higher-level facilities. This general case is particularly relevant for microtelcos, which cannot bargain effectively with incumbents and typically lack the resources or expertise to wage lengthy regulatory or judicial battles. The key ingredients of a regulatory framework that encourages microtelco initiatives are discussed in the next section.

The Need for an Enabling Regulatory Environment

Regulatory constraints have long been a major barrier to entry in the ICT markets of Latin America. This is particularly true for microtelcos, which typically lack the organizational and financial resources to bargain effectively with incumbents, navigate administrative processes, and advocate for more favorable regulatory treatment. Having identified a number of key technological enablers for microtelco initiatives, we proceeded to survey national rules relating to these low-cost technologies, in particular unlicensed WLANs and VoIP. As reported below, our findings indicate that microtelcos face a myriad of regulatory barriers that often discourage entry, limit scalability, and constrain experimentation with new technologies and business models better suited to service the poor.

First, access to unlicensed spectrum for the deployment of Wi-Fi and other low-cost WLAN technologies is still limited. Our findings from a survey of 25 countries in the region indicate that, while the vast majority (82%) of the countries have taken steps to allow for unlicensed WLAN deployment in the 2.4-GHz band, about a third of them still require public access points to be registered with the telecom authority.¹⁶ Although these results are somewhat encouraging, in many countries power restrictions significantly limit deployment opportunities. Overall, a third of the countries have set power

limits for Wi-Fi transmitters below 1W (the FCC standard), thus limiting the potential signal reach to a few hundred meters at best (although in certain cases such as Brazil and Peru exceptions are made for the less populated areas).¹⁷

In the 5-GHz band, the situation is less encouraging. About two-thirds of the countries (68%) allow unlicensed operation in the upper portion of the band (5.725–5.850 MHz), and of those 40% require access point registration. Moreover, of the countries where unlicensed use is authorized, 40% of them restrict power below 1W (the FCC standard).¹⁸ In the lower portion of the band (5.150–5.350 MHz), only about a third (35%) of the countries in the region authorize unlicensed use in these frequencies, and in most of these cases operation is limited to indoor spaces.¹⁹ Finally, only Brazil, Panama, and Colombia have so far authorized unlicensed use in the middle portion of the 5-GHz band (5.470–5.725 MHz). Although this is expected to change in the medium term as these frequencies have only recently been designated by the ITU for WLAN devices, there are less encouraging cases such as Mexico, where telecom authorities have recently designated the band for licensed use exclusively.²⁰

A second regulatory constraint is the lack of technological neutrality. In the name of consumer protection, ICT services are too often subject to overly strict quality of service and engineering standards that preclude microtelcos from deploying low-cost solutions. This discourages seeking price/quality combinations better suited for the poor and reduces opportunities for bypassing essential facilities controlled by incumbents. The case of VoIP is illustrative. Our survey of 18 countries in the region found that less than half of them (38%) have authorized the use of IP networks to provide telephony services. Interestingly, only a handful explicitly prohibit the use of VoIP: in most cases, the technology is in a legal limbo, neither completely legal nor illegal. This has hardly prevented many local entrepreneurs from of-

16. Detailed survey results can be found at www.wilac.net.

17. In Brazil for example, while the power limit is set at 400 mW, up to 1 W is allowed in areas with less than 500,000 inhabitants.

18. These power restrictions represent an even more serious constraint for service providers because of the propagation characteristics of radio signals at 5 GHz.

19. While indoor-only use is the international norm in the 5.150–5.250-MHz portion of the lower 5GHz band, many countries allow for outdoor use in the 5.250–5.350-MHz range.

20. See *Diario Oficial*, March 14, 2006.

fering VoIP services. In most countries in the region, telecenter operators offer long-distance calls over broadband connections at a fraction of the cost of incumbent carriers. Yet lack of legal protection has discouraged further investments, and reports of government crackdowns on establishments and firms offering VoIP services on the gray market are not uncommon (see Proenza in this issue).

A third constraint relates to licensing rules that often discriminate against microtelcos, either implicitly by requiring lengthy administrative procedures that microtelcos are unable to navigate, or explicitly by preventing nontraditional operators from controlling network components or supplying services. As an example, telephone cooperatives in Argentina are legally barred from offering broadcasting and other complementary services, thus preventing bundling strategies. In Peru, the Chancay-Huaral project discussed above was prevented from terminating voice calls in the PSTN because of the lack of a telecom operator license. Until recently, obtaining such a license entailed a lengthy administrative procedure that also triggered a number of financial obligations, including a contribution of 1% of operating revenues to the Peruvian telecommunications development fund. It is nonetheless encouraging that many nations are moving towards differentiated licensing regimes with less burdensome requirements for rural and underserved areas (this has recently been the case in Peru and Argentina, among others).

A fourth constraint is the limited access to public subsidies. When traditional carriers service poor or distant communities, subsidy payments are often available through universal service and telecom development funds. In some cases, the administration of these funds discriminates against microtelcos by aggregating targeted areas and requiring centralized project management. The unintended result is that only large operators with a regional or national presence are able to compete for subsidies. Although this reduces administrative costs, it also jeopardizes long-term sustainability because services are dependent on the availability of external subsidies and unresponsive to local needs. Centralized projects are also more vulnerable to political patronage, as was the case with the CTC initiative in Argentina (Galperin 2005).

Finally, the provision of telecommunications services at the local level requires access to switching facilities and trunk lines controlled by incumbent op-

erators. Like many other new entrants, microtelcos often face discriminatory access to these facilities. Although Latin American regulators are increasingly engaged in the oversight of interconnection contracts between incumbents and new entrants, their limited resources pose challenges to effective implementation. As the case of TELEOCSA illustrates, limited attention to issues of non-discriminatory access to essential facilities discourages entry by increasing the regulatory risks associated with last-mile infrastructure deployment.

Conclusions

The debate about how to extend ICT services to underserved areas has generally overlooked the important role that could be played by small-scale local operators. As the cases discussed reveal, these operators are effectively servicing areas of little interest to traditional operators based on a variety of unorthodox organizational arrangements that involve cooperative efforts between government, private, and civil society actors. We suggest this warrants more regulatory sympathy for nontraditional service provision arrangements that better fit the diversity of operational situations in thin markets. Current experience suggests that microtelcos constitute a viable alternative for ICT service delivery in markets which fail to attract adequate private investments, and whose long-term sustainability and social returns may in fact be higher than traditional subsidy schemes.

The case studies discussed here also suggest the need for leveraging the diversity of microtelco arrangements. Among a number of local conditions that determine the optimal organization and combination of inputs for microtelcos, institutional factors remain critical. When good local governance exists (as in the Pirai case), municipal networks offer a promising alternative. When strong CBOs are present (as in the Chancay-Huaral case), microtelco projects may benefit from building upon their integration within the economic and social fabric of the community. In many cases private entrepreneurship can be effectively activated (as in the TELEOCSA case), but this requires active regulatory vigilance to prevent anticompetitive maneuvering by incumbents.

Further research is clearly needed to ascertain the long-term feasibility of the different microtelco mod-

els identified here, including options for scaling and complementarities with existing local franchise models. Yet we believe the available evidence calls for broadening the current menu of policy alternatives for network deployment and operation in underserved areas. As noted, existing rules—often unintentionally—handicap microtelcos, forcing them to operate in regulatory gray zones that discourage investments as well as long-term planning. Removing these regulatory obstacles would encourage further experimentation with local organizational arrangements better suited for bringing ICT services to the poor on a sustainable and development-oriented basis. ■

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