Diversifying Network Development: Microtelcos in Latin America and the Caribbean[1]

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Abstract

The problem discussed in this paper is the failure of ICT networks and services to effectively reach the poor, particularly those living in rural areas, in Latin America and the Caribbean. The conventional answer to this problem has been to create incentives and offer public subsidies for traditional operators to cover the difference between tariffs and cost-recovery levels. This paper examines a different answer. We suggest that microtelcos - small-scale telecom operators that combine local entrepreneurship, municipal efforts, and community action - can play an important role in extending ICT services in the region, particularly in areas unattractive to large private operators. In fact, we show that a variety of microtelcos are effectively servicing many of these areas, despite a less than favorable regulatory environment and little access to public subsidies. The paper examines the theoretical case for microtelcos as an effective alternative to address the ICT needs of the poor, presents examples of microtelcos drawn from across the region, and suggests how existing regulatory obstacles for microtelcos may be removed.

1. Introduction

It is no longer adequate to view the provision of information and communication technology (ICT) services as a dichotomy between public utilities and large private operators. In both developed and developing nations, a diversity of organizations (among them cooperatives, municipal governments, universities and local entrepreneurs) participate in the deployment and operation of ICT networks. This is most noticeable in markets unattractive to traditional operators, where a variety of local arrangements exist to service high-cost or low-income communities. These arrangements are often hybrids of small-scale entrepreneurship, municipal efforts, and community action. What distinguishes them from traditional operators is the local scale, the use of low-cost technologies and innovative business models, and the strong community links. We refer to them as microtelcos.

The problem discussed in this paper is the failure of ICT networks and services to effectively reach the poor, particularly those living in rural areas, in Latin America and the Caribbean. After over a decade of market-driven reforms in the telecommunications sector, it has become clear that large private operators are no more likely to serve economically unattractive areas with sparse populations or low incomes than the public operators of the past. In many countries in the region, the gap between urban and rural ICT infrastructure has increased since the outset of reforms.[2] Where networks do reach – particularly in the case of mobile telephony – coverage does not mean access since the rural poor are often unable to afford services engineered for wealthier urban customers.

The conventional answer to this problem has been to create incentives for traditional operators to service unattractive areas and offer public subsidies to cover the difference between tariffs and cost-recovery levels. While these policies have a respectable record in the developed world, the experience in Latin America is at best mixed (Estache, Manacorda, Valletti, 2002). Efficient administration of universal service programs has

[2] See Galperin (2005).

proven a difficult task for the newly created industry regulators, many of which lack adequate resources. Even when these programs are successful, the level of funding limits large-scale replications. It is widely acknowledged that the resources needed to address existing ICT infrastructure needs far outstrip available public subsidies in the region.

This paper examines a different answer to this problem. We suggest that microtelcos can play an important role in extending ICT coverage in the region, particularly to high-cost or low-income areas unattractive to large private operators. In fact, we show that a variety of microtelcos are already servicing many of these areas, despite a less than favorable regulatory environment and little access to public subsidies. Their advantage lies in the mobilization of local resources, such as in-kind labor and private rights of way, as well as in the use of new low-cost technologies and innovative business models. Furthermore, much like their close cousins in water, electricity, and sanitation, microtelcos have a development impact that goes beyond the provision of services, for local ownership and management has been consistently found to spur entrepreneurship and nurture social capital (Dongier et al., 2003).

The paper is organized as follows. In the first section we discuss the theoretical case for micotelcos as an effective alternative to address the ICT needs of the poor. Drawing from the work of Ostrom (1996) and others, we argue that there is a large scope for co-production in the delivery of ICT services between municipal government, community-based organizations (CBOs), and the private sector. Next we discuss how technological innovations are significantly enlarging the scope of action for microtelcos. We then introduce a taxonomy of microtelcos and present examples drawn from across the region. Based on the results of a regional survey of the rules governing deployment of low-cost solutions for local access networks, we argue that an enabling regulatory framework for microtelcos is lacking. We conclude with recommendations for creating such a framework.

2. The Co-production of ICT Services

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 20th century, paving the way for the privatization of many public utilities and far-reaching regulatory reforms aimed at open markets to competition. The shift was particularly marked in the telecommunications industry, where rapid technological innovation also contributed significantly to undermine monopoly regimes.[3] It is without a question that 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, after two decades of reforms the limitations of the new paradigm are now becoming clear.

It is widely recognized that large private operators are no more likely to serve high-cost or low-income customers than were state-owned utilities. This should not be surprising. Ultimately, whether in public or private hands, large utilities face similar challenges in servicing these areas: low or fluctuating incomes, low (and often decreasing) population density, lack of reliable information about customers and 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. Other factors further discourage large private operators from tailoring service 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, rigid regulations on tariffs and engineering standards further discourage price/quality differentiation. Lastly, the availability of cost-based public subsidies sometimes deters large operators from seeking more efficient alternatives to serve the poor.[4]

[3] There is a vast literature that documents these changes. For an overview see Noll (2000).
[4] This is not the case however with smart subsidies which are increasingly used by telecom funds in Latin America and elsewhere (see Wellenius, 2001).

Therefore while large private utilities are well suited for building network backbones and retailing services in wealthy urban areas, their organizational advantages tend to diminish as we approach the last-mile segment in high-cost or low-income communities. Large utilities lack either the flexibility or the incentives to seek alternative combinations of inputs better suited to serve poor customers. Microtelcos, by contrast, thrive on creative entrepreneurship. Because their core business is to serve customers unattractive to large operators, they actively seek combinations of capital, labor and technology that maximize returns based on their knowledge of local conditions and demand preferences. This involves deploying 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 local conditions.

A key factor is that not all inputs necessary to optimize last-mile service delivery to the poor can be mobilized efficiently by large private utilities. 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. There are abundant examples of community members volunteering to set up towers, string cables, and construct facilities necessary for community network projects. It is also the case that while potential customers in these areas typically lack financial resources, they often control critical rights of way for wiring and antenna siting. Condominial lines running through household yards (and thus owned and maintained by customers themselves) have long served to extend urban sanitation networks in Brazil and Bolivia (Watson, 1995; Foster and Irusta, 2003). This is also how much of rural America was wired for telephony in the early 20th century (Fischer, 1992). Today, low-cost wireless technologies are renewing opportunities for end-user deployment and control of the first segment of the network.

Municipal governments are another important actor in the provision of ICT services in these areas. In Latin America, democratic changes since the 1980s have been accompanied by decentralization programs aimed at increasing local government

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

Different organizations thus have a comparative advantage in each of the tasks involved in the provision of ICT services to the poor. The concept of co-production captures this well. Co-production refers to the potential complementarities that exist between different organizations in the delivery of a service (Ostrom, 1996; Gerrard, 2000). Figure 1 illustrates this potential in the delivery of wireless broadband services. Large private operators are well positioned to build backhaul and switching facilities, though they are often reluctant to extend services into urban slums or rural areas. Local entrepreneurs or cooperatives, by contrast, can effectively aggregate local demand, manage risks, and mobilize resources, experimenting with input combinations that better suit local needs. This often requires active support from local authorities to facilitate coordination, stimulate demand, and operate essential facilities.

Microtelcos are best positioned to take advantage of co-production because in each case the optimal combination of inputs contributed by local government, civil society, and the private sector will vary according to local conditions. For example, condominial systems and service cooperatives are better suited in cases where strong CBOs are already present (as in the case of the Chancay-Huaral project discussed below). Municipal network projects offer an alternative when strong local institutions exist (as in the Piraí case discussed below), when fiscal revenues are decentralized, or when the municipality is already involved in the delivery of other public services. Local entrepreneurship and capital may be activated when an enabling regulatory environment is present, and when

complementary services (backhaul lines and e-government application for example) are available. The most effective co-production arrangement for the provision of ICT services to the poor will thus depend on the institutional attributes of each community.

3. The Enabling Role of New Technologies

Laying telecom wires is not unlike paving roads. It requires large upfront investments, economies of scale are pervasive, and the architecture of the network has to be carefully planned in advance because resources are not easily redeployed. The process involves making many ex ante assumptions about how services will 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 able to assemble the financing and manage the risks involved in network development. Recent innovations in wireless communication and service applications are nonetheless 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 wireless local area networking (WLAN) technologies such as Wi-Fi with wireless backbone solutions such as VSAT or the emerging WiMax standard for the provision of Internet access in remote areas.[5] Low-cost WLAN systems have been deployed by small entrepreneurs and cooperatives to service rural communities in 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 mid-sized 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

[5] For a detailed discussion of these technologies see chapter * (Kim's chapter).

point-to-point links over several kilometers to connect communities that lack adequate wired backhaul infrastructure (or to bypass links controlled by incumbents).[6]

The much flatter cost curve of WLAN technologies undermines the comparative advantages of large operators in the deployment of local networks for broadband Internet access. 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 allocation 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.[7]

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 network that can span a large area with only a few broadband links. This type of architecture is well suited in cases where backhaul links are scarce (and expensive), as is the case in many poor areas, as well as where spectrum is congested, 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. And as more nodes are added, total network

[6] There are also number of last-mile wireless alternatives, and the selection of the technology will often depend on factors such as geography, population density and services required. One promising technology used by microtelcos in Brazil and Argentina is corDECT. Developed at the Indian Institute of Technology, corDECT is a wireless local loop (WLL) technology designed to provide cost-effective, simultaneous high-quality PSTN compatible voice and high speed data connectivity for rural areas. With corDECT, rural connectivity costs are reduced from U$1,500 to about U$300 per line (Jhunjhunwala, 2000). The corDECT system is also highly modular - a single switch system can economically scale from 100 to 5,000 subscribers.

[7] 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, 2005).

capacity grows (Benkler, 2002). While the technology is still emerging, pilot projects are already operational in Africa and elsewhere.[8]

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. 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 (Graham and Ure, 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 and other new entrants are able to take advantage of these innovations depends to a large extent on the existence of technologically-neutral market rules, which as we shall see below is not always the case in Latin America and the Caribbean.

4. Microtelcos in Latin America: Case Studies

Critics often contend that arrangements other than large private utilities are inefficient and provide suboptimal public services (high tariffs, low quality) to the poor. In the next section we provide ample evidence to the contrary. Our findings, based on

[8] See www.meraka.org.za for pilots in rural Africa.

case studies from across the region that reflect different organizational arrangements, indicate that a variety of microtelcos are effectively servicing areas of little interest to traditional operators, providing affordable services and more generally acting as a catalyst for sustainable development in the communities they serve.

4.1. Telephone cooperatives (Argentina)

A long-established model for microtelcos in Latin America and elsewhere 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.[9] 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. While not supported by the government, cooperatives were tolerated by ENTEL since they operated in areas considered unprofitable and brought modest revenues through tariff-sharing agreements.[10] By 1965, over 100 telephone cooperatives were operating across the Argentine territory.

When reforms began in the telecom sector in 1990, there were over 300 telephone cooperatives, many of which part of multi-service 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 (which included 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 subsidiary (TECOOP). By 2004, TECOOP operated approximately 230 public telephones, most of them located in remote areas.

[9] 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).

[10] 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, while the remaining 40% corresponded to the local cooperative.

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 less than 500 subscribers (although there are a handful of "large" cooperatives with over 5,000 subscribers). Overall, our findings indicate that telephone cooperatives have played a key role in extending basic as well as advanced ICT services outside the main urban areas. With over 600,000 subscribers, cooperatives account for about 8% of the Argentine fixed telephony market. In many of the poorest and more isolated provinces, however, their market share is much higher. In the Province of Jujuy for example, cooperative lines represent 53% of total installed lines, while in Formosa they account for 46%.

Standards measures reveal that in most cases telephone cooperatives compare favorably with traditional operators despite serving the less desirable markets. As Table 1 shows, average teledensity in the markets served by cooperatives is only moderately lower than in areas served by traditional operators (which include all major urban centers). This is remarkable if one considers that, on average (and regardless of income), a rural household in Latin America is ten times less likely than an urban one to have a telephone line.[11] 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 areas served by the incumbents and the areas served by the cooperatives is relatively small.

Our case studies also reveal that average prices for services provided by cooperatives tend to be similar or lower than those of large operators. In fixed telephony services, average connection costs are 32% lower for cooperatives. Prices for dial-up Internet access services are comparable with those of larger operators, despite higher provision costs due to lack of competitive leased lines in rural areas (nonetheless prices for xDSL services were found to be significantly higher). Part of the cost advantage is explained by faster technological adoption. Motivated by the need to service customers in low-density

[11] Wallsten and Clarke (2002).

areas at the lowest possible cost, cooperatives are constantly seeking for lower-cost technologies appropriate for their business models. 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 a host of value-added services which the incumbent only offered after privatization (Finquelievich and Kisilevsky, 2005).

Cooperatives have also pioneered wireless last-mile and backhaul solutions. Local loop systems based on corDECT have been deployed by cooperatives in the provinces of Chubut, Neuquen, and Cordoba, allowing fast network roll-out at a fraction of the cost of traditional copper. Wi-Fi has been the technology of choice for many cooperatives providing broadband Internet access services. Cooperatives have also been eager to enter the wireless telephony market, since competition from wireless carriers has significantly affected revenue growth. The main effort is 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 giant Huawei and the provincial government to test CDMA450, a third-generation cellular telephony system better suited to service scarcely-populated areas than traditional PCS systems.[12]

It is also important to acknowledge the spillover benefits to the community as a whole associated with the telephone cooperative model. Our findings indicate that cooperatives have a significant involvement in ICT training and dissemination activities (which also serve to boost demand for value-added services), while many cooperatives have also engaged in local content development (typically community portals) in association with various CBOs and local governments. Despite the lack of subsidy payments from the government, many cooperatives set special tariffs for low-income residents while others provide free services (particularly Internet access) to public schools and libraries. Finally,

[12] CDMA450 works on a lower frequency band (450MHz), and thus requires considerable fewer towers to cover an extensive area.

telephone cooperatives promote local capacity building and nurture community solidarity, two important ingredients long identified by development scholars as critical for empowering the poor (Birchall, 2003).

4.2. CBO-driven networks (Peru)

Recently, a number of microtelcos have emerged from existing CBOs created for purposes other than the provision of ICT services. A project in the Chancay-Huaral valley of Peru illustrates this deployment and ownership model. The Chancay-Huaral river irrigates a large areas of small-scale farming (95% of farms have less than 10 hectares of land) on the sides of the valley. While the area has potential wealth due to its good land, abundant water and proximity to the markets of Lima and the north of the country, farmers have not been able to adapt their production to the fluctuations of the agricultural markets. Additionally 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 river Huaral, a common resource used by the valley's farmers and managed by the Water Users Board, a cooperative organization of the seventeen Irrigation Commissions spread throughout the valley (which are in turn composed by farmers themselves, about 6,000 in total). To address 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 line and a VSAT link.

The desertification of Peru's coastal areas is a serious problem, and thus the local Irrigation Commission, which manages irrigation and other uses of water, is one of the most important CBOs for communities along the Chancay-Huaral valley. While the project was initiated by CEPES and funded by Peru's telecom development fund (FITEL), the Chancay-Huaral Water Users Board was selected as the owner/operator of the network because of its experience in managing infrastructure, its close contact with local farmers, and the presence of the Irrigation Commissions in each of the valley's villages. 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. Providing access to other local residents (beyond farmers themselves) also became a priority. Since available bandwidth far exceeds the needs of the Irrigation Commissions, a number of local institutions such as schools were invited to join the network. The Board is currently working to extend connectivity for other CBOs, public offices, and private entities, as well as to set up telecenters for the public at large.

While not immediately replicable, the Chancay-Huaral project illustrates a number of the advantages of the CBO-driven microtelco model. The adoption of IP telephony and the scaling of the network reveals the ability to rapidly adapt to community needs. While the decision to provide connectivity to other institutions and individuals stems in part from an interest to contribute to community development, it is also part of a sustainability plan based on cost-sharing by public, private, and civil society partners. Inter-local cooperation has also been critical, for each village is responsible for local network maintenance, with training provided by CEPES. In addition, new WLAN technologies

have allowed flexibility in terms of service provision and scaling of the network with a modest initial investment.[13]

4.3. Municipal networks (Brazil and Argentina)[14]

Municipal network projects have attracted much publicity (both good and bad) as of late. 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. To begin with, the new breed of projects is led by local rather than national authorities. Under the right circumstances, the delivery of public services has been recognized to be more effectively organized at the local level (Azfar and Cadwell, 2003). Municipal network projects often start from this principle, delivering services tailored to local needs and integrating ICTs with broader economic and social development activities.

This is the case of Piraí, a rural municipality of about 25,000 inhabitants in the State of Rio de Janeiro, Brazil. The Digital Piraí 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 different 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 Piraí territory. The project was conceived as the cornerstone of a broader plan to diversify the local economy and attract new investments

[13] The initial investment reached U$33,600, or about U$2,800 per village.
[14] 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 provided by third parties, 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 different ways – in the deployment of the infrastructure and the delivery of ICT services to the public.

following privatization (with 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, which contributed to the project with equipment, application development, and expertise in the deployment and operation of the municipal network. 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. To date, the network has over 50 broadband nodes, connecting all local government offices and most of the public schools and libraries. There is also a growing number of public access points, and a private company with majority municipal ownership has been formed to commercialize services to households and businesses.

The lessons from the Piraí case point to several success factors. First, the lack of public subsidies (beyond the small grant to modernize the tax office) forced community leaders to draw in resources through cooperation 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 Piraí to provide broadband services where traditional cable and xDSL operators could not justify investments.[15] 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.

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. A good example is the

[15] According to estimates by Franklin Dias Coelho, general project coordinator of Piraí Digital, the city was able to reduce deployment and operation costs by a factor of eight (personal interview).

SICOMU (Sistema de Comunicaciones Multimediales) initiative in the Argentine province of La Pampa. This case illustrates the combination of market failures, economies of scope, and internal needs that often drive the municipal microtelco model. The project began as an appendix to the construction of a large aqueduct undertaken by the provincial government. Having contracted for over 1,300 kilometers of aqueduct building and secured the necessary rights of ways, provincial authorities decided to lay telecom fiber alongside the aqueduct.

The 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 utilized 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 (which range from e-government applications to IP telephony).

Other local actors also provide important complementary assets. The local university (Universidad Nacional de La Pampa) is utilizing the network for a variety of distance education initiatives (the university's only campus is located in the provincial capital of Santa Rosa). 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 of the operating costs of the project. Local electricity cooperatives have already contracted to begin offering telephony services.

Whereas the public utilities of the past financed, built, and operated the entire network, municipal ICT projects today are more likely characterized by different degrees of

cooperation with the private sector, CBOs, and other organizations (oftentimes educational institutions). Our findings indicate that municipal network projects aim at facilitating investments in underserved areas rather than competing with established operators. They 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. While further research is needed, preliminary findings suggest that both municipal and provincial authorities have an array of roles to play in spurring ICT development at the local level.

5. The Need for an Enabling Regulatory Environment

Regulatory constraints have long been a major barrier to entry in the ICT markets of Latin America and the Caribbean. This is particularly true for microtelcos, since they typically lack the organizational and financial resources to bargain effectively with incumbents, navigate administrative processes, and advocate for more favorable regulatory treatment.[16] Despite ongoing reforms, our findings indicate that microtelcos face a myriad of regulatory barriers that discourage entry, limit scalability and constrain experimentation with new technologies and business models better suited to service the poor.

Spectrum access. Our case studies suggest that Wi-Fi and other WLAN technologies represent key enabling technologies for microtelcos, having been deployed to provide a variety of services (from broadband Internet access to VoIP) in different social and geographic contexts. This is however premised on the availability of the frequency bands in which these technologies operate (2.4GHz and 5GHz). International experience reveals that spectrum policies that provide for unlicensed access to these bands empower

[16] There are of course exceptions, such as FECOTEL, a well-organized trade association representing over 300 telephone cooperatives in Argentina.

microtelcos by facilitating rapid infrastructure deployment without the lengthy administrative procedures traditionally associated with wireless networks (Galperin and Bar, 2004).

In recent years, countries in the Latin American and Caribbean region have been reforming spectrum administration to allow for increased unlicensed use by low-power devices (such as Wi-Fi radios) in these bands. However, our findings from a survey of 25 countries in the region reveal that significant roadblocks persist.[17] The vast majority (82%) of the countries in the region have taken steps to allow for unlicensed WLAN deployment in the 2.4GHz band, though about a third of them still require public access points to be registered with the telecom authority. While this is encouraging, in many countries power restrictions significantly limit outdoors deployment opportunities (and thus the appeal of the technology for new service providers). Overall, a third of the countries have set power limits below 1W (the FCC standard), thus limiting the potential reach of Wi-Fi signals to a few hundred meters at best (although in certain cases such as Brazil and Peru exceptions are made for the less populated areas).[18]

In the 5GHz band, the situation is less encouraging. About two-thirds of the countries (68%) allow unlicensed operation in the upper portion of the band (5.725-5.850MHz), and of those 40% require equipment registration with the telecom authorities. Moreover, of the countries where unlicensed use is authorized, 40% of them restrict power below 1W (the FCC standard).[19] In the lower portion of the band (5.150-5.350MHz), 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.[20] Finally, only Brazil, Panama and Colombia have so far authorized unlicensed use in the middle portion of the 5GHz band (5.470-5.725MHz). Although this is expected to change in the medium term as these frequencies have only recently been designated by the ITU for WLAN devices,

[17] The database is available from the authors upon request.
[18] In Brazil for example, the power limit is set at 400mW for areas with more than 500,000 inhabitants, raising to 1W for areas below 500,000.
[19] These power restrictions represent an even more serious constraint for service providers because of the propagation characteristics of radio signals at 5GHz.
[20] While indoor-only use is the international norm in the 5.150-5.250MHz portion of the lower 5GHz band, many countries allow for outdoor use in the 5.250-5.350MHz range.

there are less encouraging cases such as Mexico where telecom authorities have recently designated the band for licensed use exclusively.

Licensing. Licensing rules often discriminate against microtelcos, either implicitly by requiring lengthy administrative procedures that microtelcos are unable to navigate, or explicitly by preventing non-traditional 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 (obtaining such a license entails a lengthy administrative procedure which also triggers 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 a differentiated licensing regime with less burdensome requirements for rural and underserved areas (this is the case of Peru and Argentina, among others).

Lack of technological neutrality. In the name of consumer protection, ICT services are sometimes 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 not prevented many local entrepreneurs from offering 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. Analysts estimate that Latin

America accounts for 35% of global VoIP traffic (compared to 9% of PSTN).[21] Yet lack of legal protection has discouraged further investments, and reports of government crackdowns on establishments and firms offering VoIP services on the grey market are not uncommon.

Another illustrative case are the service restrictions placed on the use of WLAN technologies. As discussed, in several cases the use of WLAN technologies is restricted to indoor spaces or private use, thus reducing the value of WLAN solutions as a last-mile access alternative for microtelcos. This was the case, until recently, of the 2.4GHz band in Peru, which required the Water Users Board in Chancay-Huaral to seek a special waiver from OSIPTEL (the Peruvian regulator) to deploy its network (the rules have since then been modified to allow outdoors deployment in underserved areas). There are also cases in which specific services are prohibited, such as in Argentina where regulators have recently prohibited the supply of telephony services over WLANs in the major metropolitan areas. As innovations continue to enhance the reach and capacity of wireless solutions, incumbents will attempt to seek protection against disruptive technologies, which will require increased regulatory vigilance to accepted principles of technological neutrality.

Lack of financing. For traditional carriers servicing 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 centralizing project management functions. The unintended result is that only large operators with a regional or national presence are able to compete for funds. This was for example the case of the Compartel program in Colombia, where in 1999 a large contract for the development of community telecenters was split between Gilat (670 telecenters) and Telefónica (270 telecenters). While this reduces administrative costs, it also jeopardizes long-term sustainability since services are dependent on the availability of external subsidies and unresponsive to local needs.

[21] Source: Telegeography (2004).

Centralized projects are also more vulnerable to political patronage, as was the case with the failed CTC initiative in Argentina (Galperin, 2005).

Access to essential facilities. The provision of telecommunications services at the local level requires access to switching facilities and trunk lines often controlled by incumbent operators. Like many other new entrants, microtelcos often face discriminatory access to these facilities. While 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. For example, a recent study found that few nations in the region provide guidance to the pricing and interconnection arrangements between incumbents and new entrants in the provision of broadband Internet access services (Regulatel, 2005). Lack of regulatory attention to issues of non-discriminatory access to essential facilities discourages entry by increasing the risks associated with last-mile infrastructure deployment.

6. Conclusions

Over the past decades, market reforms in the ICT sector have served as a powerful engine for infrastructure investments in developing nations. In Latin America and the Caribbean, as in many other developing regions, more people have gained access to ICT services during this period than in the five decades that preceded these reforms. There is little doubt that this has benefited the region's poor in a number of ways, making ICT services more accessible and affordable. And yet there continues to be large numbers of people and communities without access to basic ICT services in the region. While further reforms are clearly needed in many cases, the limitations of this strategy to bring affordable access to the most disadvantaged are becoming apparent.

One of the problems has been the lack of attention to microtelcos in these reforms. While large private operators are well poised to undertake large capital projects involving extensive risks, their advantages tend to diminish as we approach areas with small or negative private returns. Microtelcos, on the other hand, are well positioned to take

advantage of co-production strategies, combining inputs from local entrepreneurs, municipal authorities, and CBOs to address ICT demand in communities unprofitable to traditional operators. They thus represent a viable alternative to traditional subsidy schemes, an alternative with potential development spillovers well beyond the mere provision of ICT services.

So far, policymakers have failed to acknowledge the important role microtelcos are already playing in the region. Overall, our findings suggest that a level playing field for microtelcos vis-à-vis large private operators is lacking. There is however evidence that the mood in governance is changing. Principles such as technological neutrality, open access to essential facilities, and a public good rationale in certain ICT network components are beginning to take hold. There is also increasing recognition among policymakers that, alongside with traditional operators, public-private-community partnerships have an important role to play in extending networks and services to the poor. While this paper has sought to contribute to this recognition, much remains to be understood about the role microtelcos can play in extending ICT services, and more broadly in contributing to much needed poverty relief efforts in the region.

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Figure 1: The co-production of wireless broadband services

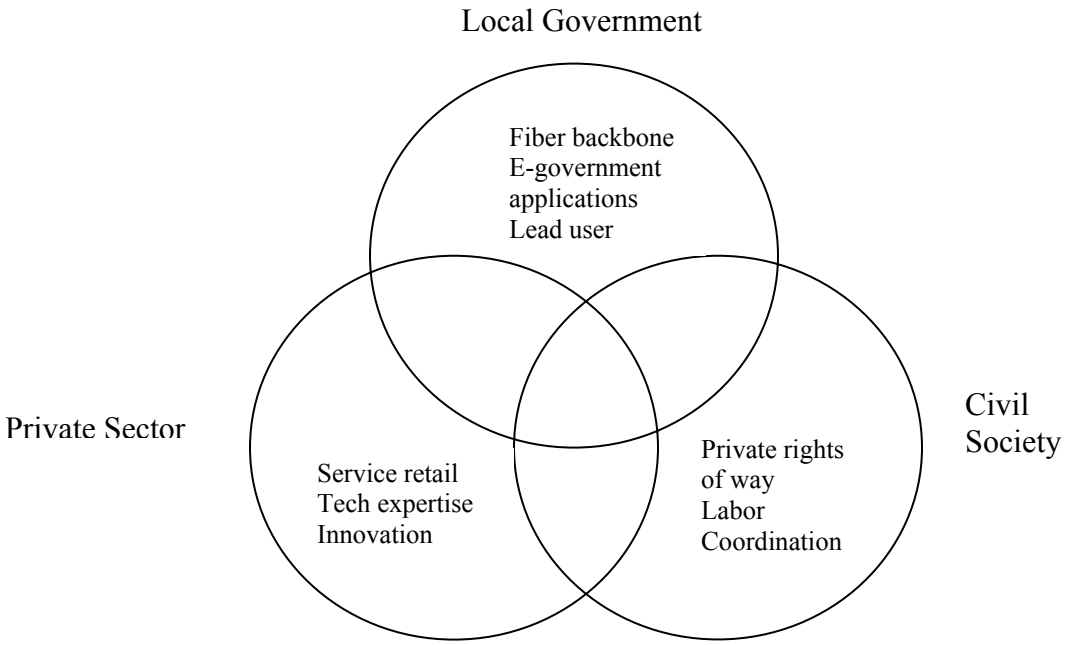

Table 1
Teledensity in Cooperative Territories vs. Total Teledensity (1998)

Province	Population in cooperative territories	Cooperative subscribers	Teledensity (A)	Total Province Teledensity (B)	(B-A)
Buenos Aires	686,736	109,568	16.0	22.0	-6.0
Catamarca	36,939	2,399	6.5	9.1	-2.6
Chaco	25,000	1,658	6.7	7.2	-0.5
Chubut	9,700	1,679	17.3	19.8	-2.5
Córdoba	183,950	27,837	15.1	18.4	-3.3
Formosa	82,000	8,472	10.3	4.5	5.8
Jujuy	146,000	11,285	7.7	6.3	1.4
La Pampa	7,265	1,493	20.6	19.4	1.2
Neuquén	128,000	18,884	14.8	13.4	1.4
Río Negro	25,200	2,547	10.1	15.9	-5.8
San Luis	39,980	5,251	13.1	13.5	-0.4
Santa Cruz	59,100	8,966	15.2	14.2	1.0
Santa Fe	268,054	41,813	15.6	18.9	-3.3
Total	**1,698.284**	**241,852**	**14.2**	**19.2**	**-5.0**
Total w/o Buenos Aires	**1,011,548**	**132,284**	**13.1**	**15.5**	**-2.4**

Source: Secretaría de Comunicaciones (SECOM).