Abstract

This paper describes some policies followed in developing countries for the provision of telecommunications services in rural areas. These policies significantly differ from those typically implemented in developed countries in their fundamental objectives, the technological strategies deployed, and the market and institutional environments they rest on. A review of some representative experiences suggests that thinking about public utility reforms in this part of the world is a quite peculiar exercise. We point out some economic and institutional characteristics of these countries that we believe normative analysis of the reforms should explicitly take into account.
1 Introduction

During the last two decades, academic and industry observers of the network industries development dynamics throughout the world have witnessed pervasive efforts to construct a normative theoretical framework that can provide useful practical guidance for public utility reforms.\textsuperscript{1} The reflection initiated in this paper takes its roots in our conviction that, when it comes to developing countries, there is clearly a need to amend this intellectual corpus so as to account for the specific characteristics of their markets and institutions. We illustrate our point by revisiting some of the prominent questions surrounding the concept of universal service which historically has been developed for advanced economies. More specifically, we review some representative developing countries’ experiences in the definition and implementation of universal service with the purpose of investigating the impact of the structuring of markets and institutions on the performance of universal service policies.

It is striking that despite the importance of the issues involved, the literature on universal service specific to developing countries is generally thin and has essentially come out of industry and development institutions such as the International Telecommunication Union (ITU) and the World Bank. There clearly is a need to bring academic tools of analysis closer to this rich “institutional” literature. As indicated above, however, for this endeavor to be fruitful at all, it is important that the specific characteristics of developing countries be given due attention. These countries’ economies provide us with enough motivation to explore two directions in which we believe that thinking about public utility reforms in the developing world is of peculiar interest. These are discussed in turn.

While the concept of universal service in developed countries defines a minimum level of service that has to be provided to a typical individual household, for developing countries the notion of universal access, which

\textsuperscript{1}The literature that has formalized and analyzed issues raised by incentive regulation has largely contributed to these efforts.
relates to a minimum geographical coverage of a community, is more appropriate. An important question then is to what extent developing countries can afford in the short and medium terms a solution to universal provision of service that rests on network expansion as is the case in developed countries. The fact is that, in developing countries, mechanisms that circumvent the poor quality of networks to “link” rural areas are mushrooming at an impressive path. We identify some of the most widely used among these mechanisms, discuss the technologies they are based on, and explore their economic properties.

Even though they generally subscribe to the idea of liberalizing segments of their public utility sectors, developing countries typically lack experience with markets and competition. Hence, these countries face the simultaneous challenge of implementing policies aimed at reducing a market access gap by introducing new technologies, and developing proper market mechanisms and institutions aimed at reducing a market efficiency gap. The ability of governments to commit to and enforce these policies clearly is a key to the success of reforms of public utilities in developing countries.

This paper is organized as follows. The next section highlights the differences between universal service and universal access which mainly stem from the relative emphasis put on service provision and coverage in their fundamental objectives. Innovative options used by developing countries to address access to basic and more advanced telecommunications services in rural areas are discussed and compared from an economic efficiency standpoint to more traditional practices.

Section 3 discusses the economies of rural areas in developing countries for the purpose of identifying economic factors that hinder accessibility, on the one hand, and of assessing the relative performance of alternative technologies that have been deployed, on the other hand. An important implication that comes out of the discussion is that there is an urgent need for adapting the regulatory framework so as to facilitate the introduction of innovative technological solutions to the problem of rural areas coverage.
The issue of the relationship between telecommunications technologies deployment and the efficiency of economic institutions is discussed in section 4. We argue that developing countries need to simultaneously address the market efficiency gap and the market access gap. We also point out that the success of the reforms critically depends on these countries’ governments ability to commit to their successive stages and enforce them. We summarize our thoughts and give research directions that this preliminary investigation call for in the conclusion.

2 Universal Access

The first significant aspect that deserves particular attention when thinking about reforms of public utilities in developing countries relates to the content of universal service. While the 1997 World Trade Organization (WTO) agreement on “Basic Telecommunications Services” identifies a minimal set of principles that its members have to follow to implement an effective pro-competitive plan for universal service compliance, each country is free to define its specific goals in terms of telecommunications provision.2 These goals are typically set according to the country’s GDP per capita and teledensity.3 Current teledensity figures are strikingly extreme ranging from a high of more than 40 to 45% in developed countries to a low of 1% to 5% or even less in developing countries. The issue bears even more importance when attempting to predict the evolution of teledensity. For countries below the 1% threshold, it is merely impossible to predict the time required to reach higher levels (ITU, 1998). Beyond this threshold of 1%, it takes on average fifty years to reach a teledensity that reflects some reasonably high level of telecommunications development (of the 50% order).

These pronounced differences in teledensity have resulted in two types of policies. A first type concerns developed countries which have been mainly

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2This minimal set of principles includes transparency, non-discrimination, competitive neutrality, and no burdensome application.

3Teledensity is defined as the number of main telephone lines per 100 inhabitants.
upgrading their networks and expanding them to remote regions in order to provide service to the homes of the least accessible populations. These objectives are part of the so-called “universal service” policies which emphasize private or individual ownership of telecommunications means of access. In contrast, a second type of policies is followed by developing countries which have been seeking to install infrastructure in order to provide basic voice telephony to the population at large, and often for the very first time.\footnote{Currently, three billion people do not have access to basic telecommunications service in the developing world.} Under such circumstances, public and shared rather than private telecommunications means of access are of greater priority. This has resulted in “universal access” policies that emphasize “covering the territory” with means of access to telecommunications services rather than making them “available to every home” as stated in the historical objectives of universal service (Rey, 1984).

This difference in emphasis has translated into some goals in low-income countries that are simply hard to conceive in high-income economies. The ITU has considered as an achievable universal access goal for 2010 one public payphone per 1000 inhabitants and one telecenter (internet connection) for every 50,000 people.\footnote{For developed countries, the goal is one payphone per 500 inhabitants. Of a population of 143 million internet users worldwide, 90% resides in high-income countries while only 1% lives in Africa.} These goals vary with the size of rural communities, ranging from “a thirty-minute travelling distance to a phone” in South Africa to “a telephone within less than five kilometers” in Brazil, and a “one family, one telephone in urban areas and telephone service to every administered village in rural areas” in China (Navas-Sabater et al, 2002).

To reach these targets, developing countries have implemented various strategies all of them sharing the problems of money collection, vandalism and general maintenance associated with traditional telephone booths.\footnote{Anyimadu et al (2003).} A first proposed solution to these problems has been through the availability of phone cards. However, as users have to buy cards prior to using them,
this practice often makes the service less affordable. Moreover, this solution requires users to place their calls themselves which assumes some level of education that the population does not always possess.

An alternative solution is through the use of “village phones,” i.e., pay phones for community use which are operated by households for profit.\footnote{Village phones have been offered in Bangladesh, India, Morocco, South Africa, Peru, among other places.} While this strategy of offering basic telephone service has been widely used, so far it has had only a limited impact on rural areas. In Bangladesh where about 1,100 village mobile payphones have been franchised to private operators or households under a risk-sharing program, there are still close to 60,000 villages without telephone service. Similar situations prevail in India, South Africa, and in Morocco where only one third of the more than 6,000 payphones available throughout the country is in rural areas.\footnote{InfoDev(3) (2000).}

Options with a wider range of offered services exist, most notably Multi-purpose Community Telecenters (MTC) and Information and Communication Technologies (ICT) cooperatives.\footnote{The services offered typically include telephony, fax, e-mail, Internet access, and printing and photocopying capabilities. Public services, such as tele-education, tele-health care and government/community-on line services have also been offered together with some postal, banking, and Small and Medium-Sized Entreprises (SMEs) support services.} In Brazil and Vietnam, MCT projects have been launched but mainly in large cities. In India, Uganda, and Surinam, “regional information centers” that offer telematic services have been created in rural areas. In Bolivia and Poland, ICT based on community-owned networks provide connections to areas that otherwise would not be served. Although their ownership/management structure is still subject to some debate, there seems to be a consensus around a private business conception of telecenters combined with a public funding mechanism of the start-up costs (Wellenius, 2003).

Universal service obligations (USO) and universal access obligations (UAO) that operators have to comply with contain noticeable differences. In develop
oped countries, USO define the content of the “basket” of services to be offered to individual households. In the U.S., the 1996 Telecommunications Act defines the set of USO services to include access to services that clearly go beyond basic telephony.10 Moreover, the FCC explicitly recognizes the need to update periodically USO in order to take into account advances in telecommunications and information technologies. This same approach based on an evolving level of services that are to be offered by operators under USO has been followed by the EU.11

The situation is quite different in developing countries where UAO set standards of geographical coverage. In Peru, the Organismo Supervisor de Inversión Privada de Telecomunicaciones (OSIPTEL) has specified three goals: public payphones in rural villages with less than 3000 inhabitants (5000 villages with a total of 3.9 million inhabitants) and in localities with insufficient service (1600 localities representing a total population of 1.8 million inhabitants), and internet access in all of the country’s district capitals (911 of them with a total population of 1.5 million inhabitants).12 In Chile, 6000 rural localities with a total population of 2.2 million inhabitants were provided first-time community telephone service between 1995 and 2000.13 In Botswana, the government has adopted a Rural Telecommunications Program with the objective of providing telephony to all villages of 500 inhabitants or more.14 Other countries including Cuba, Ethiopia, Guinea, In-

10This set includes access to a telephone network with the ability to place and receive calls, access to touch tone capability, single-party service, access to emergency systems including, where available, 911 and enhanced 911, access to operator services, access to inter-exchange services, access to directory assistance, and access to limited long distance calling for those low-income users who qualify.
11In its most recent version of the Voice Directive, the EU has included advanced services such as voice telephony with fax and modem capabilities, operator assistance, emergency, and directory inquiry services.
13Wellenius (2002).
14Under this program, 160000 access lines are to be installed by Botswana Telecommunications Corporation (BTC) and 500 public phones by each mobile operator (Navas-Sabater et al, 2002).
dia, Iran, Kenya, Kyrgyzstan, Lesotho, Madagascar, Maldives, Mozambique, Pakistan, Philippines, Thailand, Togo, and Zambia have launched similar programs that give a high priority to rural territory coverage. The extent to which these programs take into account the specific economic characteristics of rural areas will clearly be determinant for their success.

3 Technologies deployment in rural areas

Rural areas in developing countries have some economic characteristics that render difficult the provision of telecommunications services of acceptable quality at affordable prices at no loss for operators. Chief among them are low disposable income and high cost per line for both fixed and wireless technologies in these areas. While worldwide consumers spend on average 2 to 3% of their disposable income on telecommunications services, the range is 1 to 5% in countries with low levels of GDP per capita (ITU, 2002). As aggregate income tends to be lower in rural areas than in urban areas, revenue per subscriber might not support network expansion.\textsuperscript{15} A solution to this “ineffective” demand problem is to make subscribers jointly contribute to marginal cost as done in universal access plans that have users share access devices.

Two main reasons explain the high cost of network installation and maintenance in rural areas of developing countries. A first reason that is also true for developed countries is that typically there are weak economies of density in these areas. A second reason is the poor quality or even lack of the infrastructure required for the installation and maintenance of telecommunications networks. Rural transportation networks are often small and not well maintained in developing countries. In fact, many rural communities may not be accessible at all by road and there is rarely technical personnel on site which makes maintenance interventions costly. Moreover, some ru-

\textsuperscript{15} Despite the fact that rural subscribers usually have higher consumer surplus per call, the total consumer surplus may be below marginal cost of network expansion.
ral areas are not connected to national power grids, and hence the operator has to supply its own energy. This is clearly onerous for the operator as, in addition to the cost of purchasing and installing the power system, it is also responsible for the lifetime maintenance costs of the system. The incentives for an operator to use telecommunications access devices with minimal power needs and compatibility with renewable energy resources such as solar energy are high.\textsuperscript{16} For the case of wireless technologies and Very Small Aperture Terminals (VSAT), lack of appropriate infrastructure has been estimated to double or even triple the cost of providing service in rural areas.\textsuperscript{17}

The generalization of wireless technologies has speed up the progression of universal accessibility especially in low density rural areas where the incremental cost of wired access lines is high. In addition to density, distance to the telephone exchange network is the other factor that matters. Wireless systems offer lower costs than wired systems beyond about a 5 km radius from the exchange network.\textsuperscript{18} Other advantages of wireless over wired technologies include the relatively low fixed costs, short deployment time, and a lower network exposure to vandalism. The number of subscribers to cellular systems is growing in developing countries twice as much as in developed countries. For the past five years, sub-saharian countries are experiencing the fastest growth with about a 150\% growth rate per year.

Alternative technologies including Wireless Local Loop (WLL), VSAT,

\textsuperscript{16}An end-user terminal’s energy need can be supplied with a solar panel that produces about 75 DC watts in full sun, costs about $300 to $400, and has a lifetime of 20 years. Depending on the range of services offered, more than one solar panel may be required. A two-way radio typically consumes 40 to 50 watts, a laptop computer 20 to 40 watts, and a desktop computer 350 to 500 watts. For larger power requirements, hybrid power systems that combine both renewable energies and fossil fuel may be used. Those systems provide 1.5 kwatts at a cost that ranges from $215,000 to $470,000 (ITU, 2000).

\textsuperscript{17}These estimations account for those cases where there is a need for repeaters towers for antennas and power systems (Navas-Sabater et al, 2002).

\textsuperscript{18}With cellular systems, the cost per radio connection can go from $500 to $1500 but depends very much on the cell density and on the available infrastructure. Coverage can go up to 40 km radius (Dymond et al, 1997).
and Multiple Access Systems, applied as stand-alone technologies or combined, are also enabling a large number of countries to connect their rural areas. The cost of VSAT can be as low as $3000 to $4000 for providing two or three village phones and fax lines but may vary significantly depending on available infrastructure. When combining VSAT with WLL, the concerned market includes distant rural communities with up to 50 subscribers served at a cost of $1000 per line, with a coverage that goes up to 100 km (Dymond et al, 1997). Countries that have made large investments in VSAT technologies include Chile, Colombia, Ethiopia, Guatemala, Kazakhstan, Peru, South Africa, and Thailand. In fact, wireless offers are continuously evolving and one can expect new niche markets to be reached in the near future.

Given that in most of the rural areas where these wireless technologies apply wired service was not affordable or even not available, neither the capacity nor the quality of these wireless technologies seems to be a problem at least in the short run. However, although developing countries usually use analogue systems only as second-best solutions, if one considers the state-of-the-art technology, wireless capacity with data rates that can go up to 2 Mbps still lags behind wire-line possibilities with rates up to 10Gbps.\textsuperscript{19} Wireless technologies also raise a problem of quality. In mobile systems, quality is affected by traffic and coverage and fidelity indicators, while in satellite systems the availability of the signal depends on interference noise and atmospheric and rain absorption, among other factors.\textsuperscript{20}

\textsuperscript{19} In cellular systems such as GSM 400/900/1800, 9.6 to 14.4 kbps data rates can be increased to 115 kbps when combined with General Packet Radio Service (GPRS) and to 384 kbps when combined with Enhance Data for GSM Evolution (EDGE). The Universal Mobile Telecommunications System (UMTS) or third generation cellular will allow up to 2 Mbps. Asymmetric VSATs are limited on the uplink as users have to share resources so that only 256 kbps can be attained per user. On the downlink, up to 2 Mbps can be reached. As impressive as they can be, these figures are far below the possibilities offered by wire connections with 200Mbps for coaxial cables and 10Gbps for fibre cable.

\textsuperscript{20} Concerning the coverage indicator, the provision of high speed data services remains constrained by the distance from the mobile to the base station with the maximum data rate falling the farther away the terminal is from the base station. The fidelity indicator
For both mobile and satellite technologies, lower frequencies are better suited than higher frequencies in rural areas.\textsuperscript{21} For example, GSM 400 stations cover the same area as GSM 1800 and GSM 900 with, respectively, a fifth and a half of the number of sites, a typical cell in the 400 MHz band covering a territory within a 40 km radius when using 2-watt mobiles.\textsuperscript{22} For satellite, the 1 GHz frequency dominates higher frequencies in terms of the cost/coverage ratio (ITU, 2000). It is worth noting that the quality of the signal is completely independent of the frequency range, as the latter does not affect the assigned bandwidth. Bandwidth is assigned to different services by the regulator who, therefore, determines quality. Since service providers in rural areas often lack sufficient data to estimate demand, flexible systems allowing the network to be built out as needed at the lowest incremental cost are available. An example is provided by scalable radio networks that allow for capacity to be modified from a few hundreds to a few thousands users without substantially affecting hardware and software configurations.

In order to reduce the economic impact of inadequate maintenance and low computer literacy in rural areas, developing countries have been favoring simplified access device configuration and operation.\textsuperscript{23} Other strategies that affect costs such as remote network management and long life cycles are also considered in rural areas. To the extent that systems can be controlled from centralized facilities allowing for economies of scope, the number of physical trips to the installation sites is reduced and thus, the life time operation and maintenance costs are minimized. Moreover, as equipment in rural areas cannot sustain rapid turnover, it is chosen under the constraint that repairing services and spare parts cannot be provided for long periods of time.

As the above review shows, the economics of rural areas in developing is affected by noise, radio channel characteristics, the type of modulation and the speed of the vehicle.

\textsuperscript{21}Higher frequencies are more appropriate in urban areas.
\textsuperscript{22}Similar comparisons can be made between CDMA 450 MHz and higher.
\textsuperscript{23}Computer resource managers involved in an UNESCO pilot project in Zimbabwe identified PC hardware configuration as the most difficult task they faced due to the absence of local expertise (ITU, 2000).
countries is the driving force behind the proliferation process of technological solutions to the problem of access to telecommunications services in these areas. To what extent this process is going to respond to the fundamental goals of universal access will critically depend on the adequacy of the markets and regulatory institutions that these countries have put in place to accompany this process.

4 Markets and institutions

Two broad policies have been identified by The World Bank as policies that should be pursued in order to achieve universal access.24 The first policy is the so-called “market efficiency gap” reduction strategy which aims at minimizing the difference between what the markets currently achieve and what they would achieve if entry barriers were removed. Thus, this strategy does not involve “direct” public intervention and concerns activities that can be deployed under suitable liberalization measures. These activities can be thought as constituting the commercially viable part of universal access. The second policy is the “market access gap” reduction strategy the objective of which is to minimize the number of people that remain beyond the limits of what markets would normally serve. Under this strategy, direct public intervention is necessary to deploy some activities that otherwise wouldn’t be offered by the market. Hence, such activities can be regarded as falling into the non commercially viable part of universal access.

4.1 Commercially viable universal access

When attempting to reduce their market efficiency gap, developing countries are often restricted to a limited set of measures, mainly due to the lack of government commitment and the difficulties in creating independent regula-

tory bodies.\textsuperscript{25} The typical measures used are the rebalancing of tariffs, the privatization of the incumbent, and the introduction of competition coupled with regulation. It is probably too early to assess the real impact of these measures on the telecommunications industry, but examining some experiences, in particular, those of some pioneering Latin American countries is very informative.

Available data seems to suggest a positive correlation between tariff rebalancing and network expansion as reflected in access demand. The current situation in developing countries is such that low penetration is often not so much a problem of prices that are not affordable but rather prices that are set too low to give operators incentives to meet demand. Using data on a panel of 23 Latin American countries from 1986 to 1995, Banerjee et al (2000) find that a 10\% increase in the average residential price reduces unmet demand by approximately 4.1\%. Increases in the percentage of households equipped with telecommunications access devices following tariff rebalancing plans have also been observed in Malaysia, Hungary, Morocco, and Uruguay during the 90s.

Due to a structurally constrained supply in developing countries, privatization of the incumbent can also be expected to enhance network expansion. Higher prices allowed by tariff rebalancing initiatives, which typically precede privatization plans, and availability of private capital gives the operator incentives to expand its market. After controlling for tariff rebalancing, Banerjee et al (2000) find that privatizing reduces unmet demand by approximately 28\%. A similar result is found by Gutierrez (2003) in 22 Latin American countries during the period 1980-1997 with a reduction of unmet demand in the order of 10 to 18\%.

The success of privatization programs depends heavily though on the extent to which governments commit not to expropriate the property of assets that are largely sunk and not to interfere with the regulatory process.\textsuperscript{25}

\textsuperscript{25}Lack of human and financial resources has also been a typical problem faced by developing countries.
In Ghana, the government unilaterally abrogated a 1996 management contract over the privatized incumbent Ghana Telecom (GT) preventing Telecom Malaysia from holding a majority of the board and refusing to sell an additional 15% of GT, while the Ministry of Communications exerted influence on the regulatory agency (Haggarty et al, 2002). In the Philippines, during the 70s and 80s the privatization process and the regulatory reforms lead to quite negative outcomes. Although disputes were brought to court, the regulatory rules had not been explicitly stated, the enforcing agencies had no clear mandates, and the judiciary system was weakened by the influence of the president. This resulted in a decrease of the network expansion rate during these periods. In contrast, in Chile where the commitment problems had been resolved, networks expanded substantially (Galal et al, 2002).

The impact of privatization on efficiency is also affected by the degree to which the regulator is independent. Indeed, while Banerjee et al (2000) and Gutierrez (2003) find that privatization increased labor efficiency in Latin American countries, a negative relationship is found by Wallsten (2001) in data on 30 African countries covering the period 1984-1997, where efficiency is measured in terms of connection capacity and main lines per employee. When regulatory independence is controlled for, Wallsten (2001) reverses this relationship between privatization and efficiency. Gutierrez (2003) also finds that in countries where government interference has been restrained, labor efficiency has increased. Baudrier (2001) provides an attempt to measure the effects of hold up problems by directly analyzing the impact of regulatory independence on basic telecommunications infrastructure, though the results are not conclusive.26

Although by 1999 73% of basic telecommunications services is still under monopoly provision, significant liberalization of the industry has occurred

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26Note, however, that the creation of an independent regulatory body may not be such an easy task even in relatively well governed and not particularly poor countries such as Botswana. Shortage of skilled people might be an obstacle to the separation of politics and economic regulation (Stern, 2000).
in Latin America, Eastern Europe, Africa, and Asia. Empirical studies indicate that the introduction of competition in developing countries has resulted in greater efficiency and network expansion. See Wallsten, 2001, Gutierrez, 2003, and Ross, 1999 for countries where the GDP per capita is less than $10,000. Two effects of liberalization are worth noting. First, liberalization measures destroys traditional cross subsidy mechanisms that can be used to expand networks to high cost areas. Second, while (yardstick) competition is expected to decrease firms’ rents due asymmetric information on technology, in the case of developing countries, it is not so clear that the regulator will be able to bridge the informational gap.

Another aspect concerning to market liberalization is the need to regulate (equal) access in order to prevent favoritism and promote effective competition. This clearly depends on the capacity of the regulator to enforce the access rules and tariffs. In Ghana, the incumbent firm GT had little incentives to ease interconnection for other operators. As a result, in 2001, after three years of operation, the second network operator Westel had only about 2,600 subscribers and the mobile operator Mobitel claimed that applied interconnection charges could force it to exit the market (Haggarty et al, 2002).

Just as with privatization, the process of liberalization can be substantially affected by government commitment and interference. For example, in Senegal, a second cellular license was issued in the 9Os to Sentela a subsidiary of the U.S. company Millicom International. When a new government took over in 2000, the price paid by Sentel was considered too low and the license was unilaterally withdrawn without any renegotiation. The creation of the regulatory agency had been deliberately delayed and the “Direction de la Réglementation” that was acting as a regulator had no effective power (Azam et al, 2002).

Concessions have also been used as an alternative mechanism to sales of licenses that, while allowing for ex ante competition, circumvent the

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27 InfoDev(1)(2000)
transfer of property rights to private investors.\textsuperscript{28} These concession contracts between the government or the incumbent (public) operator and private investors have taken various forms, including Built-Operate-Transfer (BOT), Built-Transfer-Operate (BTO), and Built-Operate-Own (BOO) arrangements, among others.\textsuperscript{29} In some cases, investors do not built or own facilities but just share revenues with the incumbent public operator in return for providing financing (China and Indonesia) or management (Vietnam).\textsuperscript{30} While BOT and BTO risk-revenue sharing agreements have had initially some relative success, they currently seem to be posing incentive problems.\textsuperscript{31}

In Thailand, during the 80s and the 90s, thirty concessions were granted to private investors and between 1990 and 1995 this country had a higher network expansion than average in South East Asia. Currently, the trend is towards below average. The situation is similar in Lebanon and Indonesia.\textsuperscript{32}

4.2 Non commercially viable universal access

Policies that are implemented by developing countries to reduce their market access gap are to some extent of the same type of those used in developed countries. However, as discussed in section 2, developing countries have focused on territory coverage and community rather than individual household access to service. This difference in emphasis as well as the specific characteristics of rural economies in developing countries have been reflected in the types of technologies deployed.\textsuperscript{33} Markets and regulatory institutions have a major role to play in the deployment of these innovative access technologies even in a priori non profitable territories.

\textsuperscript{28}In some cases, transfer of property rights to private investors is prohibited by law.
\textsuperscript{29}BTO schemes have been used in Thailand and Phillipines, BOT in Lebanon, India, and Indonesia, and BOO in Malaysia and Solomon Islands.
\textsuperscript{30}InfoDev(3) (2000).
\textsuperscript{31}The nature of these problems depends on the specific context, but the operator may use its bargaining power to choose the most profitable consumers, among other things.
\textsuperscript{32}\textcopyright{} (2003)
\textsuperscript{33}See section 3.
In Botswana, the introduction of two private mobile operators since 1998 has allowed populations of remote and low density areas to have access to telecommunications services via multiple access radio and VSAT technologies. In 1998, the public operator contracted a firm to build the infrastructure needed for fixed line voice messaging through a virtual telephony system.\textsuperscript{34} In Ghana, a rural license was issued in 1994 to Capital Telecom which provided 10,000 lines using WLL technology in 1997. In Uganda, privatization of the incumbent operator ended in 2000 with a development plan that included the provision of mobile and WLL services, and the deployment of tele-shops and multipurpose community centers to meet increasing demand.

Regulatory procedures also affect the rate of deployment of innovative access technologies.\textsuperscript{35} The radio spectrum allocation and assignment procedures often need to be redefined so as to allow for innovative offers that use wireless technologies. Proactive regulation speeds up deployment and reduces technical coordination problems that may arise among spectrum users. India and Indonesia are among the developing countries that have followed a proactive approach to the allocation of spectrum in order to stimulate innovation. Coordination in standards among operators is also an important issue in developing countries where particularly diversified access technologies are expected to proliferate.\textsuperscript{36}

Unbundling of the incumbent’s network capabilities is also a factor that enhances the technological feasibility and economic viability of offers based on cellular and satellite mobile communications technologies. In Mexico, specific interconnection regulatory rules facilitate the operations of cellular and value added services operators. In India, regulation was issued in 1999 that states that no service provider would be charged for any interconnection facility it

\textsuperscript{34}Virtual telephony allows a subscriber to have a telephone number and a voice mailbox enabling him to receive messages and access them from any phone.

\textsuperscript{35}Useful reviews of regulatory measures that enhance innovation are Tyler (1993), InfoDev(1) (2000), Info Dev(2) (2000), and ITU (2000).

\textsuperscript{36}Standardization raises a tradeoff between the benefits of competition in equipment supply and network externalities and the disadvantages of inertia in innovation.
does not require. This has enabled entrants to combine new technologies with existing networks. Unbundled access to the local loop has been mandated in other low-income countries such as Albania, Guatemala, Kyrgyzstan, and Pakistan.

Providing access to telecommunications services in rural areas comes at a high social cost anywhere, let alone in low-income countries. These costs are typically financed with public funds collected through taxation or with financial obligations imposed on operators. The financial mechanisms that are most commonly used are the Universal Service Fund (USF) and the mandatory UAO.37 The relative merits of these two types of mechanisms in the context of developing countries is still subject to investigation. Moreover, the specific characteristics of these countries might even restore some mechanisms such as the historical cross-subsidies that have practically disappeared in developed economies.

An increasing number of developing countries have set USFs (Brazil, Chile, Colombia, Dominican Republic, Guatemala, Malaysia, Morocco, Nepal, and Peru) or are in their planning phase (Bolivia, Egypt, and Uganda).38 In some of these countries, taxing operators’ revenues does not guarantee sufficient funds to cover the cost of network expansion.39 For example, for a country like Nepal which has an extremely low teledensity of 1.15, it would take about 109 years to finance a $124 million universal access cost with a tax rate of 1% on operators’ revenues (Navas-Sabater et al, 2002). Another problem that USFs face in developing countries is that once the funds are collected, the risk that they be diverted to other public expenditures or even privately used is high. In Ghana and Côte d’Ivoire, funds for rural development have been planned but have experienced problems to be operational.

Auctions have been used for universal access subsidies but their outcome

37Recall that UAO stands for universal access obligations.
38A particularly interesting experience is that of Malaysia where the fund compensates operators based on their investments in uneconomic areas (Navas-Sabater et al, 2002).
39Other sources of funding are license fees (Guatemala and Colombia) and government (Chile).
is uncertain in developing countries where lack of competitive bidding and expertise are exacerbated.\(^ {40}\) The adverse effects of the lack of competition is sometimes alleviated by twinning profitable and unprofitable areas in simultaneous multiple round auctions. In Ghana, Capital Telecom was the only bidder for providing services to rural areas in the south of the country and has only installed one site with a few hundred customers (Haggarty et al, 2002). Lack of expertise has induced too loose screening rules and bidding criteria. Experiences in Chile, Colombia, Guatemala, and Peru have shown that often winners are in partnership with, or owned by, equipment suppliers that do not always have the required customer service and marketing experience. Moreover, in some cases (Chile and Peru), economic uncertainty and lack of expertise have resulted in such an aggressive bidding that the (very low) subsidies turned out to have no significant impact on the operator’s obligations.\(^ {41}\)

Mandatory universal access obligations are the other technique used to finance universal access. Service provision target levels are typically imposed on newly privatized operators or operators who acquired a new license. Satisfactory results can be expected if certain important conditions are met. First and most importantly, the ability of the government to enforce these obligations through the legal and judicial system is critical. In India, by 2004, the six operators that were issued licenses in 1997 and 1998 covered only 13% (12,655 villages) of what they had committed to.\(^ {42}\) Although licenses agreements were subject to cancellation in case of non-compliance with the commitments, operators have only been imposed some fine for the delay.

A second important point concerning UAO is the burden that these obligations are likely to impose on operators. Too harsh an obligation may just not be feasible. In Malaysia, the incumbent has officially made a request to share with four other operators its obligation to reach a teledensity of 50%. If

\(^{40}\)Nett (1998) offers a useful review of universal service auctions.\(^ {41}\)Chile has changed the bidding criteria, in particular, it requires bidders to specify a delivery time together with the subsidy.\(^ {42}\)Borgohain et al (2004).
the costs of serving uneconomic areas are passed on to subscribers, resulting prices may no longer be affordable. In some cases, “exclusivity periods” have been granted to the operators that are under UAO. Clearly, the drawback of this practice is to severely limit competition during these periods. Argentina, Botswana, Chile, Malaysia, Peru, Singapore, and Venezuela are among the countries that have suffered from the adverse effects of this plan. To alleviate these affects, some countries such as Malaysia and Singapore have used renegotiation to introduce competition at an earlier stage against a financial compensation.

A third concern is that lack of experience and expertise might lead to the specification of targets that ex post are not legally enforceable. In the Philippines, roll out targets did not specify the areas to be covered resulting in the government’s objective of one rural line per ten urban lines not being achieved. In India, some operators have fulfilled the requirement of 10% rural network development by just technically covering the outskirts of cities where inhabitants of villages can still use the service but at high charges. Lack of expertise may also result in a serious mismatch between targets and expected demand. In the Philippines, because lines where installed either where households did not want them or couldn’t afford them, only 44% of the lines were finally used. In Uganda, unused lines more than doubled the waiting list in 1999. In Bolivia, operators were obliged to install a percentage of the lines that are actually demanded.

5 Conclusion

In their general thrust, the arguments that support public utility reforms in developing and developed countries are similar and those conducted in the telecommunications industry provide a good illustration. However, the actual policies designed to carry these reforms are far from being similar. For the case of policies aimed at expanding service to rural areas, our examination of some representative experiences has shown that they differ markedly from those implemented in developed countries in their fundamental objectives, the technological strategies they rest on, and the market organizations and regulatory institutions created to accompany these policies.

The objectives of territory coverage rather than household service penetration and community rather than individual access are both realistic and necessary for developing countries that although severely constrained by financial resources are conscious of the need to bring their rural populations the benefits of the new information and communication technologies. These broad objectives have translated into some strategies of technology deployment reflecting the specific characteristics of the developing countries’ rural areas. Indeed, the economics of these areas has prompted the proliferation of highly innovative and diversified access technologies. For this process of innovation to be sustained and efficient, however, the development of proper market and regulatory institutions seems crucial.

Government authorities are called to play a major role which is twofold. A first step of great importance consists in removing any barriers to the supply of activities that are deemed profitable. Relatedly, regulatory rules need to be given great flexibility in order to allow for technological diversification and hence to help relaxing operators’ profitability constraint. An unavoidable second step for the government is to more directly intervene so that activities that are not economically viable from a private incentives perspective but necessary from a social welfare point of view are supplied. Funds dedicated to the financing of these activities (USFs) and obligations imposed on operators to engage in them (USO) are the typical mechanisms used by governments.
However, the degree to which developing countries are able to use these powerful policy tools for the benefit of the largest parts of their populations critically depends on their capacity to circumvent the inefficiency of their financial systems and the weak ability of their governments to commit to and enforce announced policies.

Normative regulatory economics provides us with a theoretical framework allowing to analyze many of the questions that arise in developing countries embarked in large reforms of their public utilities. This overview of some experiences has convinced us of the pertinence of the approach but also of the need to incorporate some of the fundamental characteristics of developing countries. A developing-country-approach to regulation is expected to see the day light and empirical work on these countries seems both necessary and promising.
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