Telecommunications Technologies: Deployment in Developing Countries

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Communications & Strategies

June 2005

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Role of Markets and Institutions (*)

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Abstract: This paper examines some policies pursued 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 quite a challenging 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
Key words: Telecommunications, Developing Countries, Universal Access

Over the last two decades academic and industry observers of network industries development dynamics worldwide have witnessed pervasive efforts to construct a normative theoretical framework that can provide useful practical guidance for public utility reforms [1]. The reflection initiated in this paper takes its roots in our conviction that, when it comes to developing countries, there is a strong need to amend this intellectual corpus so as to account for the specific characteristics of their markets and institutions [2]. The main goal of this paper is to illustrate this point by revisiting some of the prominent questions surrounding the concept of universal service that has historically been developed in the context of advanced economies. More specifically, we

(*) We thank A. Chandhuri and two anonymous referees for useful comments. Remaining errors are ours.

1 The literature that has formalized and analyzed issues raised by incentive regulation has largely contributed to these efforts.

2 LAFFONT (2005) is a major step in this direction.

review some representative developing countries' experiences in the definition and implementation of universal access policies with the purpose of investigating the impact of the structuring of markets and institutions on the performance of these 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 is clearly a need to bring academic work closer to this rich "institutional" literature. As indicated above, however, for this endeavor to bear any fruits, it is important that the specific characteristics of developing countries be given due attention. The features of these countries' economies provide us with enough incentives to explore two directions in which we believe that thinking about public utility reforms in the developing world is of particular interest. These directions are discussed in turn.

While the concept of universal service in developed countries defines a minimum level of service that individual households must be provided with, for developing countries, the notion of universal access, which relates to minimum geographical coverage of a community, seems more appropriate. An important question is consequently to what extent developing countries can, in the short and medium term, afford 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 pace. We identify some of the most widely used mechanisms, discuss the technologies they depend on and explore their economic properties.

Although they generally subscribe to the idea of liberalizing some 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 crucial to the success of public utilities reforms 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 with more traditional practices from an economic efficiency standpoint.

The third section 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. An important implication that emerges from this discussion is that there is an urgent need to adapt 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 taken up in the following section. 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 and enforce their successive stages. We summarize our thoughts and point to some research directions that this preliminary investigation calls for in the conclusion. An appendix summarizes the advantages and disadvantages of various mechanisms for improving access in developing countries.

■ Universal access

The first significant aspect that deserves particular attention when considering public utilities reforms 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 [3]. These goals are typically set according to the country's GDP per capita and teledensity [4]. Current teledensity figures are strikingly extreme, ranging from

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

[4] Teledensity is defined as the number of main telephone lines per 100 inhabitants

a high of over 40% to 45% in developed countries to a low of 1% to 5% or even less in developing countries. The issue assumes even greater importance when attempting to predict the evolution of teledensity. For countries below the 1% threshold, it is simply 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 around 50%).

These pronounced differences in teledensity have resulted in two types of policies. A first type concerns developed countries, which have been mainly 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. A second type of policies concerns developing countries that 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 [5]. 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 [6]. For 2010 the ITU has set one public payphone per 1,000 inhabitants and one telecenter (Internet connection) for every 50,000 people as an achievable universal access goal [7]. These goals vary with the size of rural communities, ranging from "a thirty-minute traveling 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).

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[5] Currently, three billion people do not have access to basic telecommunications services in the developing world.

[6] For a recent review on universal service obligations in developing countries, see CHISARI *et al* (2003), CLARK & WALLSTEN (2002) and ESTACHE *et al* (2004).

[7] For developed countries, the goal is one payphone per 500 inhabitants. Of a population of 143 million internet users worldwide, 90% reside in high-income countries while only 1% live in Africa.

To achieve these targets, developing countries have implemented various strategies, all of which share the problems of money collection, vandalism and general maintenance associated with traditional telephone booths (ANYIMADU *et al*, 2003). An initial solution to these problems has been proposed 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 [8]. While this strategy of offering basic telephone service has been widely used, it has had only a limited impact on rural areas to-date. 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 almost 60,000 villages without telephone services. Similar situations prevail in India, South Africa, and Morocco where only one third of the over 6,000 payphones available throughout the country are in rural areas (InfoDev(3), 2000).

Alternative options with a wider range of services offered exist, most notably Multipurpose Community Telecenters (MTC) and Information and Communication Technologies (ICT) cooperatives [9]. 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).

Theres are notable differences between the universal service obligations (USO) and universal access obligations (UAO) that operators have to

[8] Village telephones have been used in Bangladesh, India, Morocco, South Africa, Peru, among other places.

[9] 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.

comply with. In developed countries, USOs define the content of the "basket" of services to be offered to individual households. In the United States, the 1996 Telecommunications Act defines the set of USO services to include access to services that clearly go beyond basic telephony [10]. Moreover, the Federal Communications Commision has explicitly recognized the need to periodically update USOs to reflect advances in telecommunications and information technologies advances. This same approach based on an evolving level of services that are to be offered by operators under USO has been followed by the European Union [11].

The situation is quite different in developing countries where the UAO sets standards of geographical coverage. In Peru, the Organismo Supervisor de Inversión Privada de Telecomunicaciones (OSIPTEL) has specified three goals. These goals are public payphones in rural villages with under 3,000 inhabitants (5,000 villages with a total of 3.9 million inhabitants) and in localities with insufficient service (1,600 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) (FITEL, 1996). In Chile, 6,000 rural localities with a total population of 2.2 million inhabitants were provided first-time community telephone service between 1995 and 2000 (WELLENIUS, 2002). In Botswana, the government has adopted a Rural Telecommunications Program with the objective of providing telephony to all villages with 500+ inhabitants [12]. Other countries including Cuba, Ethiopia, Guinea, India, Iran, Kenya, Kyrgyzstan, Lesotho, Madagascar, Maldives, Mozambique, Pakistan, Philippines, Thailand, Togo, and Zambia have launched similar programs that make rural territory coverage a high priority. The extent to which these programs take into account the specific economic characteristics of rural areas will clearly determine their success.

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10 This 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.

11 In its most recent version of the Voice Directive, the EU included advanced services such as voice telephony with fax and modem capabilities, operator assistance, emergency, and directory inquiry services.

12 Under this program, 160,000 access lines are to be installed by Botswana Telecommunications Corporation (BTC) and 500 public phones by each mobile operator (NAVAS-SABATER *et al*, 2002).

■ Technology deployment in rural areas

Rural areas in developing countries have some economic characteristics that make it difficult to provide telecommunications services of an acceptable quality at affordable prices without generating losses for operators. Chief among these services 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 [13]. A possible 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, which also applies to developed countries, is that there are typically weak economies of density in these areas.

A second reason is the poor quality or lack of infrastructure required to install and maintain 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 andtechnical staff on site is rare, making maintenance interventions costly. Moreover, some rural areas are not connected to national power grids, and hence operators have to supply their 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 requirements and compatibility with renewable energy resources such as solar energy are high [14]. In the case of cellular technologies and Very Small Aperture Terminals (VSAT), lack of appropriate

[13] 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.

[14] An end-user terminal's energy can be supplied with a solar panel that produces about 75 DC watts in full sun, costs about USD 300 to USD 400, and has a lifetime of 20 years. 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 USD 215,000 to USD 470,000 (ITU, 2000).

infrastructure has been estimated to double or even triple the cost of providing this service in rural areas [15].

The generalization of wireless technologies has speeded up the progression of universal accessibility, especially in low density rural areas where the incremental cost of wired access lines is quite high. Besides density, distance to the telephone exchange network is the other important factor. Wireless systems offer lower costs than wired systems beyond about a 5 km radius from the exchange network [16]. 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 fast as in developed countries. Over the past five years, sub-saharian countries have experienced the fastest growth with annual rates of up to 150% per year.

Other technologies including Wireless Local Loop (WLL), VSAT, 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 USD 3,000 to USD 4,000 to provide two or three village telephones and fax lines, but may vary significantly depending on available infrastructure. When combining VSAT with WLL, distant rural communities with up to 50 subscribers can be served at a cost of USD 1,000 per line, with coverage that ranges up to 100 km (DYMOND *et al*, 1997). Countries that have made large investments in VSAT technologies include Chile, Colombia, Ethiopia, Guatemala, Karakhstan, 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. If one considers state-of-the-art technology, while still lagging behind, wireless capacity with data rates up to 70 Mbps is becoming increasingly competitive with respect to wireline

15 These estimations account for those cases where there is a need for repeaters, towers for antennas and power systems (NAVAS-SABATER *et al*, 2002).

16 With cellular systems, the cost per radio connection can range from USD 500 to USD 1500, but depends very much on the cell density and on the available infrastructure. Coverage can extend to 40 km radius (DYMOND & KAYANI, 1997).

possibilities [17]. The comparison is even more pertinent for developing countries where analogue wireless systems are typically used as second-best solutions. This is not to say, however, that wireless technologies are exempt from problems, indeed quality is one of them. In mobile systems, quality is affected by traffic, 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.

For both terrestrial and satellite technologies, lower frequencies are better suited than higher frequencies in rural areas [18]. 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 [19]. 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.

Since bandwidth is assigned to different services by the regulator, in fine, it is therefore the latter who determines quality. In response to service providers' lack of sufficient data to estimate demand in rural areas, 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 hundred 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 [20]. Other

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17 A recent wireless technology, World Interoperability for Microwave Access (WiMAX), promises 70 Mbps in a 48-Km radius. With geostationary (GEO) and Low Earth Orbit (LEO) satellites a capacity up to 1 Gbps can be attained but this requires the use of all the bandwidth of the satellite. Thus, financial constraints typically limit capacities to much lower rates. As impressive as they can be, these figures are far below the possibilities offered by wire connections with 500 Mbps for coaxial cables and 1000 Gbps for fiber cable.

18 Higher frequencies are more appropriate in urban areas.

19 Similar comparisons can be made between Code Division Multiple Access (CDMA) 450 MHz and higher.

20 Computer resource managers involved in a 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).

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 countries is the driving force behind the proliferation of technological solutions to the problem of access to telecommunications services in those 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 of innovation in the use of telecommunications technologies.

■ 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 (NAVAS-SABATER *et al*, 2002). The first policy is the so-called "market efficiency gap" reduction strategy which aims to minimise the difference between what the markets currently achieve and what they would be able to achieve if entry barriers were removed. Thus, this strategy does not require "direct" government intervention and concerns activities that can be deployed under suitable liberalization measures. These activities can be thought of as constituting the commercially viable part of universal access [21]. The second policy is the "market access gap" reduction strategy, which aims to minimize the number of people that remain beyond the limits of what markets would normally serve. Under this strategy, direct government intervention is necessary to deploy some activities that otherwise wouldn't be offered by the

[21] It should be recognized that the assessment of commercial viability may still be a tough task in developing countries. In particular, waiting lists can be misleading due to artificially low prices and unexpressed demand.

market. Hence, such activities can be regarded as falling into the non-commercially viable part of universal access [22].

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 regulatory bodies [23]. 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, particularly 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 unsatisfied demand by approximately 4.1%. Increases in the percentage of households equipped with telecommunications access devices following tariff rebalancing plans were also observed in Malaysia, Hungary, Morocco, and Uruguay during the 1990s.

Due to a structurally constrained supply in developing countries, privatization of the incumbent can also be expected to enhance network expansion [24]. 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

22 Note that even if barriers are removed, the boundaries between these two gaps are expected to change due to technological progress among others.

23 Lack of human and financial resources has also been a typical problem facing developing countries.

24 For a recent review of international experiences with privatization, see BORTOLOTTI & SINISCALCO (2004).

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 of around 10-18%.

The success of privatization programs depends heavily 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. 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 1970s and 1980s the privatization process and the regulatory reforms lead to quite negative outcomes. Although disputes were taken 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 in the network expansion rate during these periods. By 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 has increased labour efficiency in Latin American countries, a negative relationship is found by WALLSTEN (2001) in data on thirty African and Latin American countries covering the period 1984-1997, where efficiency is measured in terms of connection capacity and main lines per employee. When regulatory independence is called for, WALLSTEN (2001) reverses this relationship between privatization and efficiency. GUTIERREZ (2003) also finds that in countries where government interference was restrained, labor efficiency 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, but the results are not conclusive [25].

Although by 1999 about 73% of basic telecommunications services were still under monopoly provision, significant liberalization of the industry had

[25] Note, 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. A shortage of skilled people might be an obstacle to the separation of politics and economic regulation (STERN, 2000).

occurred in Latin America, Eastern Europe, Africa, and Asia (InfoDev(1), 2000). Empirical studies indicate that the introduction of competition in developing countries has resulted in greater efficiency and network expansion [26]. Two effects of liberalization are worth noting. Firstly, liberalization measures may destroy traditional cross-subsidy mechanisms that can be used to expand networks to high cost areas. Secondly, while (yardstick) competition is expected to decrease firms' rents due to 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 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 access rules and tariffs. In Ghana, the incumbent firm GT had little incentive 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 [27]. For example, in Senegal, a second cellular license was issued in the 199Os to Sentela, a subsidiary of the U.S. company Millicom International. However, 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 licenses sales that, while allowing for ex ante competition, circumvent the transfer of property rights to private investors [28]. These concession contracts between the government or the incumbent (public) operator and

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[26] See FINK *et al* (2002) for a study of a panel data on 86 developing countries across Africa, Asia, the Middle East, Latin America and the Caribbean over the period 1985-1999. Wallsten (2001) and Gutierrez (2003) focus on the experiences of a set of African and Latin American countries while Ross (1999) examines countries with GDP per capita less than $10.000.

[27] For an empirical exploration of the relationship between institutional quality and access to telecommunications infrastructure, see HORRALL (2002).

[28] In some cases, transfer of property rights to private investors is prohibited by law.

private investors have taken various forms, including Built-Operate-Transfer (BOT), Built-Transfer-Operate (BTO), and Built-Operate-Own (BOO) arrangements, among others [29]. In some cases, investors do not build or own facilities, but just share revenues with the incumbent public operator in return for providing financing (China and Indonesia) or management (Vietnam) (InfoDev(3), 2000). While BOT and BTO risk-revenue sharing agreements initially met with relative success, they currently seem to be posing incentive problems [30]. In Thailand, during the 1980s and 1990s, thirty concessions were granted to private investors and between 1990 and 1995 this country had higher network expansion than average in South East Asia. Currently, the trend is towards below average. The situation is similar in Lebanon and Indonesia.

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 as those used in developed countries. However, as discussed before, 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, has been reflected in the types of technologies deployed [31]. 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.

In Botswana, the introduction of two private mobile operators since 1998 has allowed populations in remote and low density areas to access 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 [32]. In Ghana, a rural license was issued in 1994 to Capital Telecom which provided 10.000 lines using WLL technology in 1997. In

29 BTO schemes have been used in Thailand and Philippines, BOT in Lebanon, India, and Indonesia, and BOO in Malaysia and Solomon Islands.

30 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.

31 See above.

32 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.

Uganda, privatization of the incumbent operator ended in 2000 with a development plan that included the provision of cellular and WLL services, and the deployment of teleshops and multipurpose community centers to meet increasing demand.

Binding financial resources and weak accountability militate for keeping minimal regulatory intervention. However, the use of regulatory procedures can positively affect the rate of deployment of innovative access technologies [33]. 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 [34]. 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 of standards among operators is also an important issue in developing countries, where particularly diversified access technologies are expected to proliferate [35].

Unbundling of the incumbent's network elements is also a factor that enhances the technological feasibility and economic viability of offers based on cellular and satellite mobile communications technologies [36]. In Mexico, specific interconnection regulatory rules have facilitated 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 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, Kyrgistan, 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

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33 Useful reviews of regulatory measures that enhance innovation are TYLER (1993), InfoDev.a (2000), Info Dev.b (2000), and ITU (2000).

34 Wireless Fidelity (Wi-Fi) and WiMAX wireless technologies allow the use of unlicensed frequency bands which may have a positive impact on rural areas given that technical problems due to interference are likely to be small due to the presence of a limited number of competitors.

35 Standardization creates a tradeoff between the benefits of competition in equipment supply and network externalities and the disadvantages of inertia in innovation.

36 Note that unbundling reduces the incentives for facility-based entry and hence may negatively affect network expansion.

financial obligations imposed on operators. The most commonly adopted financial mechanisms 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 are still subject to investigation. In particular, given the specific characteristics of these countries, one wonders whether or not restoring some traditional mechanisms, such as the historical cross-subsidies that have practically disappeared in developed economies, is desirable.

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 USD 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 in getting operational.

Auctions have also been used to determine universal access subsidies to be granted to operators, but their outcome is uncertain in developing countries where lack of competitive bidding and expertise are exacerbated [40]. The adverse effects of the lack of competition are 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 exceesively loose screening rules and bidding criteria. Experiences in Chile, Colombia, Guatemala, and Peru have shown that winners are often in partnership with, or owned by, equipment suppliers that

37 UAO stands for universal access obligations.

38 A particularly interesting experience is that of Malaysia where the fund compensates operators based on their investments in uneconomic areas (NAVAS-SABATER *et al*, 2002).

39 Other sources of funding are license fees (Guatemala and Colombia) and government (Chile). Revenues from emerging data services could also partly relieve financial constraints.

40 Nett (1998) offers a useful review of universal service auctions.

do not always have the necessary customer service and marketing experience. Moreover, in some cases (Chile and Peru), economic uncertainty and a lack of expertise have resulted in such aggressive bidding that the (very low) subsidies turned out to have no significant impact on the operator's obligations [41].

Mandatory universal access obligation schemes constitute the other significant technique used to finance universal access. Service provision target levels are typically imposed on newly privatized or licensed operators. Satisfactory results can be expected if certain important conditions are met. Firstly and most importantly, the government's ability 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 the area they had committed to (BORGOHAIN *et al*, 2004). Although licenses agreements were subject to cancellation in case of non compliance with the commitments, operators have only been made to pay fines for the delay.

A second important point concerning UAO relates to the burden 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 its obligation to reach a teledensity of 50% with four other operators. If 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 that it severely limits competition during these periods [42]. Argentina, Botswana, Chile, Malaysia, Peru, Singapore, and Venezuela are among the countries that have suffered from the adverse effects of this type of plan (GUTIERREZ, 1999). To alleviate these effects a little, some countries such as Malaysia and Singapore have used renegotiation to introduce competition at an earlier stage for financial compensation.

A third concern is that lack of experience and expertise might lead to the specification of targets that are not legally enforceable ex post. In the Philippines, roll out targets did not specify the areas to be covered resulting in a failure to achieve the government's objective of one rural line for ten

41 Chile has since changed its bidding criteria, in particular, by requiring that bidders specify a delivery time together with the subsidy bid.

42 WALLSTEN (2000) finds that such a practice may lead to a reduction in mainline growth rates of up to 40%.

urban lines. 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 (BORGOHAIN *et al*, 2004). Lack of expertise may also result in a serious mismatch between targets and expected demand. In the Philippines, because lines were installed either where households did not want them or couldn't afford them, only 44% of lines installed were actually used. In Uganda, unused lines more than doubled the waiting list in 1999. In Bolivia, operators were obliged to install a given percentage of the lines that are actually demanded.

■ 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 throughout the world provide a good illustration. However, the actual policies designed to carry these reforms are far from similar. In 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, on the one hand, and community rather than individual access, on the other hand, are both realistic and necessary for developing countries which, although severely constrained by financial resources, are conscious of the need to bring their rural populations the benefits of new information and communication technologies. These broad objectives have translated into some technology deployment strategies 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, which can provide substantial social benefits and opportunities. For this process of innovation to be sustained and efficient, however, the development of proper market and regulatory institutions seems crucial.

Government authorities are bound 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 directly intervene so that activities, that are not economically viable from a private incentives perspective, but desirable from a collective standpoint, 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 to make this supply happen. However, the degree to which developing countries are able to use these policy instruments 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 powerful theoretical framework for analyzing many of the questions that arise in developing countries embarked on major reforms of their public utilities. Particularly important in the case at hand is its contribution to our understanding of the incentives to deploy new low-cost technologies in terms of spectrum allocation, interconnection agreements and compatibility between standards. Moreover, it allowed us to highlight the critical role of independent regulatory bodies and regulatory expertise in mitigating the common market failures encountered in these countries.

This overview of some experiences has convinced us of the pertinence of the approach, but also of the need to explicitly incorporate some of the fundamental specific characteristics of these countries. Reforms such as the use of price caps, interconnection agreements, cost allocation mechanisms, expansionary targets among others need to be addressed in terms of their impact on infrastructure and affordability under the institutional and financial constraints discussed in this paper. A developing-country-approach to regulatory reforms is expected to see the light of day and empirical work on these countries seems both necessary and promising.

Appendix

Mechanisms to improve access in developing countries

Market efficiency gap mechanisms	*Disavantages*	*Advantages*
Tariff rebalancing	- Increases residential and rural prices	- Reduces unmet demand
Privatization	- Lack of commitment - Lack of independent regulator	- Reduces unmet demand
Competition	- Lack of commitment - Lack of interconnection agreements - Incompatible standards - Need for spectrum allocation	- Reduces unmet demand - Introduces low-cost technologies
BOT/BTO	- Distorts incentives	- Encourages capital and managerial skills
Market access gap mechanisms		
Universal Service Funds	- Lack of financial resources and high cost of public funds - Lack of expertise in calculating and allocating subsidies - Bad governance - Uncertain outcomes with auctions	- Targeted - Addresses ineffective demand
Mandatory Service Obligations	- Imposes burden - Lack of expertise in specifying targets - Lack of enforcement - Used sometimes to limit competition and tariff rebalancing	- Addresses effective demand - More effective when lumping low- and high- cost areas, and with technology neutral targets

References

ANYIMADU A. & M. FALCH (2003): "Telecenters as a Way of Achieving Universal Access - The Case of Ghana", in *Telecommunications Policy*, 27: 21-39.

AZAM J.P., DIA M. & T. N'GUESSAN (2002): "Telecommunications Sector Reforms in Senegal", The World Bank Policy Research Working Paper 2894.

BANERJEE A. & A. ROS (2000): "Telecommunications Privatization and Tariff Rebalancing: Evidence From Latin America", in *Telecommunications Policy*, 24: 233-252.

BAUDRIER A. (2001): "Independent Regulation and Telecommunications Performance in Developing Countries", ISNIE Conference on Institutions and Governance, Berkeley, CA, USA.

BORGOHAIN B., MOHAN R. & R.R.N. PRASAD (2004): "Universal Service Obligations in the Telecommunication Sector of India: Effectiveness, Regulatory and Funding Issues", The Energy and Resources Institute, India.

BORTOLOTTI B. & D. SINISCALCO (2004): *The Challenges of Privatization - An International Analysis*, Oxford University Press.

CHISARI O., ESTACHE A. & WADDAMS-PRICE C. (2003): "Access by the Poor in Latin America's Utility Reform: Subsidies and Services Obligations", in: Ugaz C. & Waddams-Price C. (Eds): *Utility Privatization and Regulation: A Fair Deal for Consumers?*, Edward Elgar, Northampton, MAS, USA.

CLARK G. & WALLSTEN S. (2002): "Universal(ly) bad Service: Providing Infrastructure Services to Rural and Poor Urban Consumers", The World Bank, Policy Research Working Paper 2868.

DYMOND A. & KAYANI R. (1997): "Options for Rural Telecommunications Development", The World Bank Technical Paper 359.

ESTACHE A., LAFFONT J.J. & ZHANG X. (2004): "Universal Service Obligations in Developing Countries", The World Bank, Policy Research Working Paper Series 3421.

FINK C., MATTOO A. & R. RATHINDRAN (2002): "An Assessment of Telecommunications Reform in Developing Countries", The World Bank Policy Research Working Paper 2909.

Fondo de Inversión en Telecomunicaciones (FITEL) (1996): "Universal Service and the Development of Rural telephony in Peru", Coopers and Lybrand L.L.P. Consulting Policy Paper.

GALAL A. & B. NAURIYAL (1995): "Regulating Telecommunications in Developing Countries", The World Bank Policy Research Working Paper 1520.

GUTIERREZ L.:
- (1999): "An Index of Telecommunication Regulatory Frameworks in the Context of Privatization and Competition Reform", PhD Dissertation, University of Florida, Gainesville, FL, USA.
- (2003): "The Effect of the Endogenous Regulation on Telecommunications Expansion and Efficiency in Latin America", in *Journal of Regulatory Economics*, 23: 257-286.

HAGGARTY L., SHIRLEY M. & S.J. WALLSTEN (2002): "Telecommunication Reform in Ghana", The World Bank Policy Research Working Paper 2983.

HORRALL J. (2002): "Institutions, Political Regimes and Access to Telecommunications Infrastructure in Africa", mimeo, Public Utility Research Center, University of Florida, Gainesville, FL, USA.

International Telecommunication Union (ITU) (1998): "Universal Access," World Telecommunication Development Report 1998.

International Telecommunications Union (ITU):
- (2000): "New Technologies for Rural Applications", Final Report of ITU-D Focus Group 7.
- (2002): "Minimum Subsidy Competitive Auction Mechanisms for Funding Public Telecommunications Access in Rural Areas and Tariff/Interconnection Regulation for The Promotion of Universal Service/Access", Model Universal Service/Access, Part II. Global Symposium for Regulators.

InfoDev(1) (2000): "Overview of Telecommunications Regulation", Telecommunications Regulation Handbook, Module 1, The World Bank.

Infodev(2) (2000): "Interconnection", Telecommunications Regulation Handbook, Module 3, The World Bank.

Infodev(3) (2000): "Licensing Telecommunications", Telecommunications Regulation Handbook, Module 4, The World Bank.

LAFFONT J.J. (2005): *Regulation and Development*, Cambridge University Press.

NETT L. (1998): "Auctions: An Alternative Approach to Allocate Universal Service Obligations", in *Telecommunications Policy*, 22: 661-669.

REY R.F. (Ed.) (1993): *Engineering and Operations in The Bell System*, AT&T Bell Laboratories.

ROSS A.J. (1999): "Does Network and Competition Matter? The Effects of Telecommunications Reform on Network Expansion and Efficiency", in *Journal of Regulatory Economics*, 15: 62-92.

STERN J. (2000): "Electricity and Telecommunications Regulatory Institutions in Small and Developing Countries", Utility Policies, 9: 131-157.

TYLER M. & LETWIN W., (1995): "Universal Service and Innovation in Telecommunication Services: Fostering Linked Goals through Regulatory Policy", in *Telecommunications Policy*, 19: 3-20.

WALLSTEN S. J.:

- (2000): "Telecommunications Privatization in Developing Countries: The Real Effects of Exclusivity Periods", Stanford Institute for Economic Policy Research Paper 99-21.
- (2001): "An Econometric Analysis of Competition, Privatization, and Regulation in Africa and Latin America", in *The Journal of Industrial Economics*, 49: 1-11.

WELLENIUS B.:

- (2002): "Closing the Gap in Access to Rural Communications: Chile 1995-2000", The World Bank Discussion Paper 430.
- (2003): "Sustainable Telecenters", The World Bank Discussion Paper 251.