Working Paper Series

19/2007

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Telecommunications in Small Economies: the Impact of Liberalization and Alternative Technologies on Universal Service

ABSTRACT

The paper identifies a lack of research in the field of telecommunications in the context of small economies. The central research question of the paper is whether there exist significant differences between small and large economies with relation to the effects of liberalization and alternative technologies on Universal Service that would necessitate the consideration of smallness in the formulation of optimum policy. It examines this question following an econometric approach using data for more than 140 economies for the period 1980-2004. Research findings support that, for small economies, smallness constitutes a significant factor leveraging the outcomes of competition and alternative technologies on the fixed network and prices. Suggestions for policy development are provided.

Key words:

Small economies; Universal Service; Alternative Technologies; Liberalization; Cyprus; European Union

SECTION 1 – INTRODUCTION

Existing research on telecommunications has produced limited evidence regarding the effects of competition on Universal Service. Moreover, recent literature on telecommunications has examined the impact of alternative technologies on Universal Service but has also produced ambiguous evidence on the nature of the relationship. This evidence is based on studies which have concentrated mainly on large industrial economies or large developing economies. Whilst the literature on small economies postulates that optimal national policy should differ with size the telecommunications literature has placed nominal emphasis upon it.

This paper examines the effects of competition and alternative technologies on Universal Service when smallness becomes influential. An econometric model assesses these effects. Smallness is depicted by a composite index consisted of the measures of population, GDP and arable area. The effects of liberalization are modeled by distinguishing between competition in the distinct markets of fixed voice, mobile telephony and the Internet. Alternative technologies are represented by development indicators in mobile telephony and the Internet.

Research findings support the hypothesis that, for small economies, smallness constitutes a significant factor leveraging the outcomes of competition and alternative technologies on the fixed network and prices. Competition effects on Universal Service vary between the three telecommunications markets. Policy implications suggest that small economies require endogenous policy that addresses their distinctive characteristics. For their characteristics, small economies are more apt to encounter a natural monopoly in the fixed voice. Incumbent providers in small economies may find it practical to serve demand in fixed voice in neighboring economies that may allow them to exploit economies of scale. Technologies that exhibit a relationship of substitution should be combined in one market and be ruled by the same policy. Finally, technological evolution and market convergence call for a redefinition of Universal Service.

The structure of the paper has as follows. Section 2 presents a literature review on the concept of Universal Service and elaborates on existing empirical studies which examine the impact of competition and alternative technologies on Universal Service. The concept of smallness is then introduced and its implications on liberalization are discussed. Section 3 concerns the empirical part of the paper where the research methodology is outlined and the econometric model assessing the effects on Universal Service is discussed. Section 4 elaborates on the econometric analysis and builds on the research findings to suggest policy implications.

SECTION 2 – LITERATURE REVIEW

This section acknowledges the gap in telecommunications policy research relating to small economies. The first part discusses the evolving notion of Universal Service in fixed voice, a central concern for telecommunications policy. A second part presents empirical studies of the effects of competition on Universal Service and is followed by a discussion regarding the role of mobile telephony in Universal Service. A fourth part brings up the issue of the size of the economy and unfolds the generic leverage that size may have on the liberalization of an economy. The section completes with an attempt to create a linkage between the liberalization of telecommunications and smallness by associating them with the issue of Universal Service.

2.1 UNIVERSAL SERVICE IN THE FIXED TELEPHONY

Universal Service aims to establish the right of a consumer to connect to the telecommunications network at a price that does not exclude significant consumer groups (Bergman et al., 1998). It is therefore a dual component notion and its fulfillment should involve the measurement of both telephone density and the level of prices (Barros and Seabra, 1999).

In most cases the incumbent firm is mandated to provide service to meet the Universal Service Objective (USO). USO is pursued through a variety of approaches. They mainly concentrate on extending the service to unserved populations in urban and rural areas without discrimination and making telecommunications services affordable for low-income citizens (Bergman et al., 1998). The requirement for telecommunications firms to offer geographically uniform retail tariffs when the cost of network provision varies in different regions, results in offering retail tariffs that are distinct to their underlying costs (Armstrong, 2001). Therefore, if liberalization eliminates profits from existing profitable markets then the incumbent may be unable to subsidize the unprofitable operations. For these problems, it is often presumed that competition and USO do not mix.

Recent literature on the study of USO stresses that the notion requires a new definition. The new definition should address the changing nature of the services available through the telecoms networks and the ambiguous delineation of what is considered as “basic service”. Also, it should be resilient to adjust to technological advancements and facilitate the providing firm to achieve the minimum efficient scale of operation (MES). According to Hudson (2001) USO should have a set of moving targets. The definition of basic service needs to take into consideration changes in technology and user needs[1]. Thus, goals should be stated not in terms of a specific technology or service provider but in terms of functions and capabilities, such as the ability to transmit voice and data. This view can open to regulators new alternatives for policy design through a multi-network perspective, one that considers the total sum of capabilities enabling a citizen’s access to a national telecommunications network (Fuentes-Bautista, 2001).

Rapid technological change also dictates that the definitions of basic and advanced services will change over time (Hudson, 2001). Advanced services are currently interpreted as Internet access. In the future, it is likely that advanced services will be redefined, perhaps to include access to new generations of services available through the Internet or its successors. In rural areas, both terrestrial wireless and satellites offer greater capacity without the cost of building out fiber and cable networks. These technological trends have significant implications, since distance is no longer a barrier to accessing Universal Service; costs of providing services are declining; and new competitors can offer multiple technological solutions.

Moreover, technological convergence and blurring market barriers have altered the structure of telecommunications as well as traditional definitions of USO (Fuentes-Bautista, 2001). The number of fixed phone lines per hundred inhabitants, the index traditionally used to weigh the concept, is considered an “imperfect measure of Universal Service” (ITU, 1998 p. 20). This index does not reflect the direction and segmentation of a network’s expansion, nor does it account for other access methods such as mobile telephony, satellite and digital channels, which are currently used to access national and global networks.

The role of alternative access technologies to fixed voice gains rising importance in Universal Service fulfillment. This is more prevalent in the case of the developing world. Some developing countries have badly lagged more developed countries in the availability of fixed network capacity. The development of mobile telephony has offered these countries the option to leapfrog existing fixed networks and gain access to communications that they previously could not (Banerjee and Ros, 2004a).

2.2 EMPIRICAL STUDIES ON THE EFFECT OF COMPETITION ON USO

There is a widely held presumption that competition has a negative effect on telephone density (Barros and Seabra, 1999). This presumption derives from the abolition of cross-subsidies that is expected to come with liberalization. Namely, incumbent providers subsidize the network development in rural and less dense areas, where costs of service are high, at the expense of more profitable areas and services. Competition destroys cross-subsidies to a great extent resulting in some areas left with very high costs of provision that culminate in socially unreasonable or unaffordable prices (Gasmi et al., 2000). On the other side, competition is believed to drive service prices downwards. Competitive action drives telecommunications providers to acquire more efficient technologies, increase capital productivity and minimize their costs of provision (Armstrong, 2001). Empirical studies attempting to capture these effects show vague results. This is demonstrated in Table 1.

Insert Table 1 Here

2.3 THE ROLE OF MOBILE TELEPHONY IN USO

Mobile service adoption has grown at astonishing rates as the quality of the service and the performance of mobile providers steadily improved since its inception in the early 1980s. In 2002, the number of mobile subscribers worldwide surpassed the number of fixed mainlines for the first time (Banerjee and Ros, 2004a). Yet, the potential that mobile telephony can play a significant role in USO has been given minor attention by the economics and telecommunications literature (Hamilton, 2003).

While on average almost one out of three people in the world is a mobile subscriber, there are major regional differences (ITU, 2006). In 2004, Europe's mobile penetration rate stood at 71%, almost twice the penetration rate of North America (43%), and nearly four times the penetration rate of Asia (19%). Europe had almost eight times the penetration rate of Africa, where less than one out of ten people subscribe to a mobile service.

According to a recent EU-commissioned survey, about 12% of EU households are using only mobile services and do not subscribe to fixed line services. This figure ranges from 4% in Germany and Sweden to 16% and 29% respectively in France and in Finland (Taubman and Vagliasindi, 2005). In addition, transition countries witnessed important trends in the mobile segment of the market. First, mobile penetration rates have been growing at exponential rates, whereas fixed line penetration rates have at best stagnated. Second, in many countries, mobile penetration rates have overturned fixed line penetration rates. This is the case not only for most of the EU countries but also for countries of South Eastern Europe and Russia.

It is therefore naive not to realize the significant leverage that mobile telephony can have on USO. In developed economies, mobile telephony is believed to function as complementary to fixed line and in developing countries as a substitute (Hamilton, 2003; Rodini et al., 2002; Taubman and Vagliasindi, 2005). Yet, empirical research has not managed to provide concrete support on this postulation as yet (Barros and Cadima, 2000). Table 2 presents empirical studies which have assessed the relationship between the two technologies. It illustrates that existing research findings have been ambiguous.

Insert Table 2 Here

2.4 Liberalization and the Smallness of Economy

2.4.1 Small economies – an overview

Selwyn (1980) suggested that categorizing into small and large economies should help in understanding specific country problems; in forecasting likely social or economic trends in a country; and in shedding light on appropriate policies for particular countries. The definition of small economy is arbitrary in the sense that there is no specific line of distinction between a small from a large one. The literature on small economies attempts to conceptualize smallness in terms of measurable variables; notably, population, economic activity and geographic area, whether combined or individually (Armstrong and Read, 1998). Population is the most commonly used size measure mainly because it is easily accessible as well as proving a crude proxy for two economic variables; the size of the domestic market and the local labor force (Armstrong and Read, 1995). Earlier studies on small economies used a threshold of 10 and 15 million. Over time this threshold started attenuating as smaller nations emerged and in the 70's international institutions adopted a one million threshold (Armstrong and Read, 1998). The latter authors use an upper limit of three million for their discussion on smallness.

Ambiguity in the definition of smallness based solely on population becomes more obvious in the examples of countries used in different studies[2]. For instance, Briguglio and Buttigieg (2004) discuss the case of Malta; Spiller and Cardilli (1997) study the notion of smallness in Australia, Chile, Guatemala, and New Zealand; Stewart (2004) uses Bahamas, Belize, Jamaica, St Lucia, St Vincent, and Trinidad and Tobago; and Gal (2003b) makes a reference to the Faroe Islands, Jersey, Malta, Cyprus, New Zealand, Israel, and Australia. Evidently, the size of these countries varies from a few thousands to several millions which imply that solely population is not a representative indicator of smallness. It is therefore suggested that smallness be measured by a collection of variables that involves a combination of measures of size such as population dispersion, land area, GDP, and degree of openness to trade (Briguglio and Buttigieg, 2004; Gal, 2003a; Armstrong and Read, 1998).

In terms of characteristics of a small economy there appears a general consent among various studies (Armstrong and Read, 1998; Briguglio and Buttigieg, 2004; Gal, 2003a; Stewart, 2004). A small economy's capacity to support many competitors is limited and it depicts high concentration in many of its industries. Concentration of an industry is determined by the size of firms operating in it and the main driving factor of concentration is the size of minimum efficient scale of production. Furthermore, small economies are characterized by high entry barriers. The main entry barrier is created by scale economies[3], by the need to produce at levels that cater to a large portion of demand in order to achieve minimum costs. This is also associated with another major issue, the problem of sub-optimal levels of operation.

Small economies are likely to have small markets which in turn limit competition possibilities, due to the ease of market dominance by firms. Smallness also renders the exploitation of advantages deriving from economies of scale difficult as manifested by higher prices. In the context of utilities, small economies tend to be characterized by natural monopolies. To add, state aid is inevitable in small economies where governments aim to sustain comparative advantage in the respective market. Armstrong and Read (1995) identify a number of advantages arising from smallness (i.e. greater social homogeneity and cohesion, greater social flexibility and openness to change rendering them more responsive to exogenous change) which nevertheless are expected to be outweighed by the disadvantages. These advantages are primarily intangible and therefore impossible to quantify.

These salient characteristics have important policy implications as they require small economies to devise appropriate endogenous policies that offset at least some of the adverse effects of their small size (Gal, 2003b). However, most small economies do not scrutinize their special economic traits in designing and applying their antitrust laws. Rather, they adopt or rely on the statutes and established case law of large economies, mostly of the European Union. This approach has many recognizable advantages such as a ready basis for the law, a large body of comprehensive case law and commentary, and network externalities. Adopting the competition laws of larger jurisdictions is also sometimes predicated on the existence of the hegemonic power of a large jurisdiction with the ability to impress its will, and its competition policy, on smaller and weaker jurisdictions. The main pitfall of such an approach is that insufficient weight is given to the unique characteristics of small economies (Kaminarides et al., 1989).

2.4.2 Smallness and Efficiency

Armstrong and Read (1995) stress that a concrete economic definition of small size should address the influence of sub-optimality upon the structure of domestic output. This methodological issue involves the effect of smallness on economies of scale and scope, efficiency, and competitiveness. The measure of sub-optimality is manifested by the minimum efficient scale of operations which determine the level of economic activity that can effectively be pursued within any country.

According to Gal (2003a) smallness affects the three main contributors to social welfare which comprise allocative, productive, and dynamic efficiency. Whereas competition policy in small economies should be based on the support and promotion of efficiency, policy makers, agencies and courts often overlook considerations of economic size. This is further exacerbated by the recent trend towards the harmonization and convergence of competition policies on a universal scale.

A major handicap resulting from small size is the need of firms in many markets to produce at a level that caters to a large portion of demand to achieve economies of scale, since they are the main determinant of minimum efficient scale (MES) of operation (Scherer et al., 1975). While in large economies MES tend to be too small relative to most markets to warrant high levels of concentration, in small economies the number of MES that firms in many markets can support is much smaller, and accordingly industrial concentration is likely to be much higher. This appears to be a major explanation to the reduced number of sustainable competitors in small economies' industries (Jalan, 1982).

In the context of small economies, Gal (2003b) suggests that social goals should be given little or no independent weight in formulating competition policy. Small economies should strive to achieve economic efficiency as their main goal because they cannot afford a competition policy that is prepared to sacrifice economic efficiency for broader policy objectives. Structural remedies, such as the dissolution of monopolistic or oligopolistic structures by reducing concentration, may on one level help reduce the feasibility of market power, collusion and interdependent behavior. On another level, they usually involve a trade-off between enhancing competition and exploiting potential cost efficiencies that flow from MES of production, when applied in small economies (Gal, 2003b). Posner (1976) examined the practice of breaking up large firms as a panacea to reducing concentration levels in any industry. The author's critique of the hitherto competition policy is that divestiture decisions are incorrectly justified as a means for alleviating the problem of economies of scale considered to be a barrier of entry. Economies of scale (by themselves) do not create a barrier to entry (Vernon et al., 2000). They merely dictate the level of output that the new entrant must achieve in order to minimize costs. Moreover, the costs of a de-concentration policy probably outweigh the benefits which are conjectural (Posner, 1976).

The implication that industrial concentration has for competition policy is that small economies cannot afford to transplant simplistic competition policies applied in large economies. Thus, concentration measures alone are not a good guide for competition policy for small economies. Rather, measures of levels of concentration should be balanced with productive efficiency considerations dictated by market size. Indeed, small economies need to give careful consideration to the optimal combination of competition (through deconcentration or restrictions on incumbents) versus regulatory invention (such as continuous regulation of incumbent prices).

2.4.3 Smallness and (Natural) Monopoly

A contrasting recommendation to conventional competition policy is that attainment or maintenance of a monopoly position per se should not be prohibited (Lien and Peng, 2001). Accordingly, the regulator should distinguish between monopolies based on superior efficiency and those that are not. Posner (1976) raised the question of whether it is socially desirable to promote small business which might turn out to be pursued at the expense of the consumer. Competition policy is an inappropriate method of trying to promote the interests of small business as a whole. In specific industries there are situations where a single firm may have much lower costs of provision of a product than more than one firm providing the same product. The costs of the single firm may be so low that the profit-maximizing monopoly price is actually below the competitive price. In such market conditions, Posner (1976) suggests that society's economic welfare would be greater if the monopoly were permitted. This becomes more vital in the case of small economies where the impact of natural monopoly might be much stronger than in large economies especially in leveraging other vertically interconnected markets (Gal, 2003a).

This contention pro the incumbent monopolist extends further to the issue of structural separation of the dominant firm (Gal, 2003b). If the dominant firm has to be divided into two or more viable firms, this should be without jeopardizing scale or scope economies. When a small economy can support only one firm, divestiture may create a concentrated market structure – duopoly or oligopoly – that is also prone to monopolistic exploitation. Instead, the joint ownership of natural monopoly's facilities by all competing firms could be an alternative. Under this structural solution, production or service is unified and centralized to achieve scale economies, but ownership is decentralized among multiple owners who compete with one another. According to Vernon et al. (2000) a small economy should adopt a test, based on economic analysis, which ensures that the monopolist's conduct actually reduces welfare before it is prohibited. Given the difficulties involved in proving in each case that a certain type of conduct has amounted to abuse dominance, several small economies have included in their competition laws nonexclusive lists of practices from large economies that are presumed to constitute abuses of power if engaged in by a dominant firm.

The preceding discussion illustrates that research on the effects of liberalization and alternative technologies on USO has not been exhaustive. There is high potential that the distinction between small and large economies shed light on pertinent issues. The central empirical research question of this paper is whether there exists a significant difference between small and large economies with relation to the effects of liberalization and alternative technologies on USO so that it can be considered in the formulation of optimum policy. It attempts to examine this question following an econometric approach. The research methodology and econometric analysis are unfolded in the following section.

SECTION 3 – RESEARCH METHODOLOGY

The econometric model aims to assess the impact of competition and alternative technologies on Universal Service in the context of small economies. It is a multiple regression model that employs panel data estimation techniques and a Fixed Effects transformation. Following the duality in the definition of Universal Service the model tests for the effects both on network expansion and price levels.

As regards the network variable Gutierrez and Berg (2000) used the number of main lines per 100 inhabitants whereas Jha and Majumdar (1999)) used the actual number of mainlines. In addition, Wallsten (2001) used the number of payphones and connection capacity of the network. A further suggestion by Hamilton (2003) is that the total number of installed mainlines plus the number of mainlines remaining on the waiting list be used instead. This indicator is meant to capture the demand side of fixed voice rather than merely the supply side.

Longitudinal price data are characterized by Wallsten (2001) as the most problematic to analyze. Notwithstanding their accuracy, they may be incomparable across countries and they often encompass extensive subsidies. Nonetheless, Wallsten (2001) used the price of 3 minute local calls; Ros (1999) and Ros and Banerjee (2000) used data for the cost of initial connection to the network and monthly subscriptions for both household and business customers in addition to the price of a 3 minute local call; and Barros and Seabra (1999) used business and residential tariffs in the form of call baskets.

The set of available independent variables of the model encompasses notions for the measurement of mobile telephony development; Internet development; the liberalization status of an economy; and the size of an economy. Mobile telephony development is usually measured by the number of cellular subscribers in a country or per capita rate (Hamilton, 2003; Gutierrez and Berg, 2000). Pertaining to the development of the Internet the ITU uses the number of Internet subscribers per 100 inhabitants, international bandwidth in Mbits per capita, ISDN and DSL subscribers as a percentage of total internet subscribers, inter alia (ITU, 2006).

The extent of telecommunications liberalization has been viewed from various perspectives. For example, Jha and Majumdar (1999) employed an index taken from the 1993 OECD Telecommunications Outlook which ranks countries according to the degree of infrastructure liberalization. Wallsten (2001) used the number of mobile operators as a proxy for competition in the market. Instead, Barros and Seabra (1999) employed a dummy variable which drew a distinction between monopoly and non-monopoly markets.

The last dependent variable is the size of an economy. Measures of the size of economies have provided unclear distinction between large and small economies. Selwyn (1980) noted that if we are concerned with constraints resulting from a narrow range of resources, we may identify size with physical area. If we are concerned with manpower limitations of the small clientele for public and other services, we will measure size in terms of population. The rationale is that different studies employ different measures for smallness.

For this study an index for smallness suggested by Jalan (1982) is adopted which combines population, income and geographical measures. The index is calculated using the following formula:

$$L_i = \frac{100}{3} \times \left(\frac{P_i}{P_{\max}} + \frac{A_i}{A_{\max}} + \frac{Y_i}{Y_{\max}} \right)$$

where:

L_i, is the country size index for an individual country;

P_i, A_i and Y_i are population, arable area and GDP of each country respectively;

$P_{\max}$, $A_{\max}$ and $Y_{\max}$ represent the highest values of population, arable area and GDP respectively.

Applying this formula on 214 countries and jurisdictions from data from the United Nations' Human Development Report of 2005 produced the country size index. For many countries, the index value is very small. Particularly, the mean and the median values of the index for the whole sample are only 2.81 and 0.53 (on a scale from 0 to 100). There is also a discontinuity at the end of the series of country size indices and there are three countries (USA, China and India) whose index values are exceptionally high. In view of the skew distribution and the predominance of small values, the median value of the index is selected as the cut-off point to divide countries into small and large adopted from Jalan (1982). A set of 112 countries and jurisdictions fall within the range of the cut-off point which have less than 9.2 million population (Guinea), less than USD$86.17[4] billion GDP (Singapore), and less than 19.3 thousand km² of arable land (Central African Republic). An illustrative list of small economies is given in Appendix I.

3.1. Data and Variable Description

Telecommunications related data were primarily obtained from the ITU's telecommunications indicators database. They consist of time-series, cross-sectional data for 214[5] countries and jurisdictions for a number of telecommunications and other indicators. 112 of these countries fall into the category of small economies and data for the period 1980-2004 were considered "appropriate", in terms of completeness for the purpose of this study. Economic, geographical, and demographic data were obtained from the United Nations' Human Development Report of 2005 and the World Bank's World Development Indicators.

As regards the econometric model, the two dependent variables depict the fixed network expansion and prices. The former is teledensity, expressed as the number of fixed lines per 100 inhabitants. Whereas the assessment of the demand side of fixed voice – the joint indicator of both teledensity and unmet mainlines per 100 inhabitants - would be more suitable, lack of data limit the analysis to the met demand. Yet, teledensity is considered a sufficient indicator for the measurement of the penetration level of fixed voice.

The number of international outgoing calls is used as a proxy for the measurement of the level of prices. Limitations in using price data identified by previous studies (i.e. Banerjee and Ros, 2004a; Wallsten, 2001) called for the search for an alternative variable. The rationale behind the selection of this variable is that a decrease on the level of fixed voice prices would be expected to cause an increase in the volume of international calls. In addition, since consumers make international calls through a fixed line, changes on this variable tend to be associated with price changes for the fixed voice. The selection of this proxy variable is not flawless. Less developed countries typically suffer from capacity constraints, also involving international routes. Therefore, an increase in outgoing traffic in a single year may simply be due to capacity expansion and not necessarily to price reductions. Moreover, a decrease in prices for international calls may not be correlated with a decrease in the overall level of fixed prices. Namely, some countries may still have an unbalanced price structure (e.g. high international calls subsidizing local calls). Nevertheless, availability of data for long periods allows us to view changes in the volume of outgoing international calls in the long-term, overcoming, thus, the hurdle of temporary effects.

The independent variables used consist of variables depicting the status of competition, the development of mobile telephony, the development of the Internet, and the size of the economy. In order to assess the distinct impact of competition in all three telecommunications technologies three dummy variables are employed which demonstrate whether an economy has liberalized any of its fixed voice, mobile telephony and the Internet market. Information on the opening of the respective markets was obtained from the ITU's World Telecommunication Regulatory Database. These variables allow a distinction between the effects of competition in different technologies, a factor that has not been taken into consideration in previous empirical studies.

Development of mobile telephony is expressed by the number of mobile subscribers per 100 inhabitants. Internet development is gauged by the number of ISDN lines per capita. The latter variable was preferred to the number of Internet subscribers per capita because of data availability and the fact that it is a better proxy to Internet technology development.[6] Lagged variables are also used in the models in order to address the question whether the impact of alternative technologies represents a permanent change in teledensity or prices in the event year.

Regarding the variable for smallness, the methodology employed above produces a composite index which draws a distinction between small and large economies. This methodology also specifies the maximum population, GDP, and arable area that describe a small economy. From the composite index, a dummy variable is created which distinguishes between small economies and large economies.

The model also includes three variables which assess the individual effects of population, GDP, and arable area. Instead of using the original variables, new variables have been developed which attempt to capture the effects of the original variables as the latter fluctuate between the upper and lower borderlines of small or large economies. The logic behind these variables is that they assess the advantage or disadvantage created if a small (or large) economy were larger relative to other small (or large) economies.

For example, with regard to *pop_small*, the new variable that accounts for fluctuations in population for small economies only, it ranges between 0 and 1 and takes a higher value when population is closer to the lower borderline for small economies and a lower value when population approaches the highest borderline for small economies. Namely, Tuvalu which has the lowest population in the group of small economies with 10396 people takes a value of 0.998 whereas Guinea which accounts for the upper line in small economies with population of 9201759 people takes a value of 0. Similarly for the group of large economies, Chad takes a value close to 1 and China close to 0 as they comprise the lowest and upper borderlines, respectively (see Appendix II for the calculation of the new variable).

A number of control variables are included in the model. Namely, these are GDP per capita lagged one year; the percentage of population living in urban areas; the logarithm of investment in telecommunications as a percentage of GDP; and the logarithm of openness of the economy. Openness of the economy is expressed as total imports plus total exports divided by GDP (Rodrik, 1998). Economic variables are converted to real values of 2000. A time trend variable is included as an indicator of temporal effects. Li and Xu (2004) use such a variable to capture effects of technological changes. In support of capturing time effects, yearly dummies are also added in order to allow modeling possible idiosyncratic temporal effects much more intelligently and control for unobserved time-varying effects. Table 3 describes all variables used in the regression models.

Insert Table 3 Here

Summary statistics are exhibited in Table 4. The mean values of the indicators illustrate that small economies compared to large economies have smaller arable area relative to total geographic area; have more open economies; invest more in telecommunications as a percentage to GDP; their population is somewhat more concentrated in cities; and they are less affluent. They also encounter higher volumes of outgoing international calls and thus lower prices in fixed telephony than large economies; yet, they face lower levels of penetration in both fixed and mobile telephony and have fewer ISDN channels per capita. Whereas these statistics do not represent causal relationships or yearly trends with size they give a crude approximation of the general situation between small and large economies.

Insert Table 4 Here

Table 5 presents a timeline of liberalization in the three distinct markets of fixed and mobile telephony and the Internet by drawing a distinction between small and large economies. Generally, liberalization in large economies has taken place earlier than small economies and large economies appear to be more apt to liberalize their telecommunications industry. Until 2004, almost 70% of large economies have introduced competition in their fixed voice, 92% in mobile and 92% in the Internet, whereas, small economies are more reluctant by accumulating 41% in the fixed voice, 64% in the mobile, and 72% in the Internet. For both categories of economies, the fixed telephony market has the lowest percentage of liberalization whereas the Internet has the highest.

Insert Table 5 Here

3.2 The Effect on Fixed Teledensity

For the assessment of the effects on teledensity two regression models employing a Fixed Effect transformation are assessed. The first one concentrates on the effect that competition has on teledensity in small economies. The second model also incorporates the effect of alternative technologies on teledensity. Beginning with the first model, it has the following form:

$$y_{it} = a_i + \beta x_{it} + \gamma d_{it} + u_i + \varepsilon_{it}$$

where i(= 1,2,…,141) is the subscript for the cross-sectional dimension (country) and t(= 1,2,…,25) is the subscript for the time-series dimension (year). y_{it} is a T x 1 vector representing mainlines per 100 inhabitants; a_i is a 1 x 1 scalar constant; β is a series of coefficients corresponding to x_{it} series of exogenous variables, γ is a series of coefficients corresponding to d_{it} dummy variables; u_i is a T x 1 vector of the effects of omitted time-invariant country-specific variables; and ε_{it} is a random disturbance variable assumed to be distributed identically and independently with zero mean and finite, constant variance. Treating the country-specific effects as fixed parameters leads to the Fixed Effects form of panel data model estimation, while treating them as a random variable with known distribution leads to the Random Effects form of panel data model. In order to identify the most appropriate form of model as regards the error structure, the two models were subjected to the Hausman test, the best-known test for discriminating between the two competing models (Baltagi, 2005). The test produced a chi^2 statistic of 348.75, suggesting the use of a Fixed Effects model.

A limitation of the Fixed Effects transformation is that it inherently suppresses time-invariant effects. Therefore, it would be impossible to include the *smallness* variable per se. Instead, *smallness* is included in the model by interacting it with year dummies. The combined variable captures the time trend in fixed teledensity by also considering the effect of *smallness*. t-statistics are estimated using robust standard errors that account for time-series autocorrelation within each country. Furthermore, according to Baltagi (2005) robust estimation of the standard errors often results in the greatest precision resulting in the smallest standard errors. Table 4 illustrates the estimates for the generic model as they are produced by STATA 9[7]. Although the full panel comprises 5350 observations (= 214 countries × 25 years), only a fraction is ultimately usable. That is a result of STATA omitting incomplete data rows. This results in the creation of an unbalanced panel which nevertheless is handled by the software's estimation techniques.

The within-R^2 signifies a generally good fit of the specified model to the data explaining 67% of the variance of fixed teledensity. The F-statistic accounts for the joint significance of the coefficients and proves high enough to reject the null hypothesis of insignificance in all coefficients. The value of -0.069 at the lowest section of the Competition model represents the correlation between the idiosyncratic error (e_{it}) and the regressors. The low value gives support to the assumption of strict exogeneity of the regressors and also advocates the use of the Fixed Effects model. Under the assumption of strict exogeneity the Fixed Effects estimator is unbiased (Wooldridge, 2002).

Regarding the regressors' coefficients, they are all statistically significant at conventional levels apart from *pop_large*, *lib_internet_small* and fourteen out of twenty four s*mallness_year(t)* variables. *lag_real_gdp_cap*, *urban_cap* and *logopenness* are positively related with teledensity whilst *log_investment* has a negative relationship with teledensity. The former result suggests that an increase in the economy's income results to an increase in the supply of mainlines in the following year. However, a 1% increase in teledensity would require almost an 888USD increase in real GDP per capita. This is an extraordinary amount considering that there are developing economies with much lower GDP per capita than 888USD. Density of urban population is associated with an increase in teledensity. This is an expected outcome as population concentration in the cities facilitates the reduction of average cost of installation for additional lines, favoring network expansion. The positive effect portrayed in the *logopenness*'s coefficient suggests that more open economies exhibit higher teledensity.

On the other hand, the negative effect of *log_investment* implies that investing in the sector causes attenuation in fixed teledensity. Since this variable controls for the effect of total investment and not the effect of investment in the fixed relative to alternative technologies it is not possible to gauge the effect of the allocation of investment to different technologies on fixed teledensity. A risky assumption that investment be provided for the development of newer (thus, alternative) technologies, would suggest that development in alternative technologies has a negative effect on fixed teledensity.

As regards the effect of smallness on teledensity, this is captured by *gdp_small* and *pop_small* interaction variables and *smallness_year(t)* dummies[8]. *gdp_small* has a negative effect on teledensity. That is, the closest a small economy gets to the lower bound of GDP for small economies the lower teledensity this economy has[9].

pop_small has a positive relationship with teledensity. Similarly, according to the definition of *pop_small* when actual population of a country increases the variable's value attenuates. The positive relationship with teledensity suggests that small economies with population approaching the higher bounds of small economies are expected to have lower teledensity than small economies with less population. The *smallness_year(t)* dummy variables exhibit positive relationship with teledensity. Since the variable constitutes an interaction of time trend with smallness it suggests that in general, small economies have higher levels of teledensity than large economies. The statistically significant coefficients of *smallness_year(t)* remain stable across time averaging at around 4 showing that fixed teledensity in small economies appears to be higher by 4%. This finding implies the existence of different dynamics in the industry of telecommunications between small and large economies.

With regard to the respective size variables for large economies, only *gdp_large* is statistically significant and has a positive effect on teledensity. This is converse to small economies and suggests that wealthy large economies have lower fixed teledensity than less wealthy large economies.

Pertaining to the effects of competition in small economies, it appears that liberalization in different markets is associated with a distinct effect on teledensity. *lib_fixed_small*, the variable that assesses the liberalization in small economies in the fixed market has a strong negative effect on the mainline network, since on average, small economies which have opened their fixed markets encounter a decline of 1.88% in teledensity. Notwithstanding the increase in competitiveness in the market that would be expected to increase mainlines, abolition of cross-subsidies, also brought about with competition, appears to have an overwhelmingly negative impact on teledensity. Competition in the mobile market has a positive effect on teledensity. It appears that competition in the mobile market increases the competitiveness in the overall telecommunications industry. As a result, small economies liberalized in mobile telephony have 0.84% higher fixed teledensity than small economies that maintain a monopoly. This is nonetheless not enough to outweigh the negative effect of liberalization in the fixed market. Liberalization in the Internet has a positive effect on fixed teledensity; yet, the coefficient is not statistically significant. Last, the yearly trend variable, *t*, suggests a general yearly increase in teledensity of 0.38%.

Insert Table 6 Here

In a subsequent step the Competition Model was augmented with variables which assess the impact of the development of alternative technologies on teledensity. These are represented in Table 6 under the Augmented Model heading by *mobile*, *isdn_cap* and their respective lagged variables. Inclusion of these variables increases the model's goodness of fit. In addition, there is a loss of 321 observations as a result of incomplete data, especially in the earlier years of introduction of alternative technologies. Overall, the Augmented Model maintains the same relationships between the regressors and the dependent variable, though the general size of the coefficients changes. This is expected as in the Competition Model the impact of alternative technologies was captured by the existing variables.

Two major changes emerge upon the inclusion of the new variables. First, the coefficient of *log_investment* loses its significance. Second, the coefficients of *smallness_year(t)* dummies become all negative with an average value of (-14) all statistically significant at the 0.01 level. On the one hand, *smallness_year(t)* captures the effects of technological change on teledensity over time. On the other hand, inclusion of variables controlling for the development in alternative technologies reveals a different relationship between small and large economies. Namely, fixed teledensity turns out to be around 14% lower in small economies once alternative technologies are considered. A possible explanation is that in the Competition Model the omitted effect of alternative technologies was captured by variables included in the model and mainly the interaction variable *smallness_year(t)*.

The effects of the development in mobile voice and the Internet are akin. The coefficient of *mobile* is positive whereas the coefficient of its lagged variable is negative. These results portray a relationship of complementarity between fixed and mobile telephony at the event year as both technologies show a growing trend. This reinforces the claim that growth of mobile telephony has been mainly a demand-creating effect for general telecommunications services (i.e. Barros and Cadima, 2000). A relationship of substitution though is observed between mobile and fixed telephony where the development of the former in the current year affects negatively the development of the latter in the following year. The joint effect of the two coefficients turns out to favor complementarity to substitution over the period. Similar relationships are developed between *isdn_cap* and its lagged variable with teledensity. Positive effects on the event year depict complementarity whereas the negative relationship with teledensity on the following year suggests substitution effects. The difference with the impact of mobile telephony is that the joint effect of *isdn_cap* and *lagisdn_cap* favors substitution to complementarity. It is not possible to distinguish whether the effects of alternative technologies can be explained by parallel movements in demand in response to mutual relative price changes or by technological reasons.

3.3 THE EFFECT ON FIXED PRICES

Two semi-logarithmic regression models employing a Fixed Effect transformation are assessed. The first one concentrates on the effect that competition has on fixed voice prices in small economies. The second model incorporates also the effect of alternative technologies on prices. Beginning with the first model, it has the same form as the teledensity model; albeit, the dependent variable is *log_calls*, the proxy for the level of prices for fixed voice. Caution should be placed on the interpretation of relationships with the dependent variable. On the one level, positive relationships with the dependent variable would suggest a negative relationship with prices and vice versa. On another level, the actual effect of dummy variables on the dependent in a semi-logarithmic expression is $e^{\gamma} - 1$, where γ is the coefficient of the respective dummy variable (Halvorsen and Palmquist, 1980) produced by STATA and given in Table 7. For example, the actual effect of *lib_fixed_small* with coefficient 0.1543 on fixed prices is $e^{0.1543} - 1 = 1.668$. Interpretation should be analogous.

Tests similar to the teledensity model were employed to support the selection of a Fixed Effects transformation in the model. The t-statistics were estimated using robust standard errors to account for time-series autocorrelation within each country, increase precision in the coefficients, and generate an unbiased Fixed Effects estimator. The within-R^2 signifies a very good fit of the specified model to the data explaining 80% of the variance of prices. The F-statistic is high enough to allow for the rejection of the null hypothesis for joint insignificance in all coefficients. The value of 0.35 representing the correlation between the idiosyncratic error (e_{it}) and the regressors supports the assumption of strict exogeneity of the regressors and also advocates the use of the Fixed Effects model.

Regarding the regressors' coefficients, they are all statistically significant at conventional levels apart from *lag_real_gdp_cap, log_investment*, and six out of twenty four *smallness_year(t)* coefficients. *urban_cap* has a positive effect on the dependent variable, which suggests that concentration of population in the urban areas has a downward effect on prices. The positive effect of *logopenness* implies that more open economies tend to have lower fixed voice prices.

GDP has a negative impact on prices in small economies, depicted by the negative coefficient of *gdp_small.* This suggests that for the more-affluent small economies, prices tend to be lower[10]. In contrast, GDP in large economies appears to have a converse effect on prices, illustrated by the positive coefficient of *gdp_large*. Namely, in less-affluent large economies fixed voice prices appear to be lower. This relationship of GDP with size leads to the conclusion that economies with GDP close to the upper bounds of GDP levels for small economies (or otherwise, close to the lower bounds of GDP levels for large economies) most likely have the lowest prices in fixed voice. As regards the impact of actual population, it has a negative effect on prices but the effect for small economies is more than threefold illustrated by the coefficients of *pop_small* and *pop_large*. Furthermore, the *smallness_year(t)* variables show a positive relationship with *logcalls*, therefore an inverse relationship with prices. The coefficients across time do not exhibit any substantial fluctuation averaging at 0.9. They imply that in general, small economies have lower prices than large economies.

Pertaining to the variables assessing the effects of competition there is statistically significant evidence that liberalization in small economies affects price. Yet, a decline in prices is observed only in small economies that have liberalized their fixed and mobile markets whereas liberalization in the Internet exhibits an increase in prices. The effect of liberalization of the fixed market on prices can be related to increased competitiveness which drives prices downwards. The liberalization in the mobile market also increases overall competitiveness in the industry. By promoting an alternative means of voice communication it is expected to culminate in a pressure on prices. Increase in prices caused by competition in the Internet market may reflect the additional costs for newer technology, upgrades and maintenance of the existing physical network that incumbents are incurred in order to increase bandwidth, and provide better interconnection with local and international networks.

Insert Table 7 Here

The respective Augmented Model for prices incorporates the effects of alternative technologies in the former model. Inclusion of these variables increases the model's goodness of fit but there is a loss of 383 observations. Overall, the Augmented Model maintains the same relationships between the regressors and the dependent variable. The coefficient of *log_investment* continues to be insignificant; *lib_mobile_small* and *pop_small* lose their statistical significance; and two of the newly included variables, *mobile* and *lagmobile,* manifest no statistically significant coefficients. Nonetheless, the two variables that gauge the effect of development in the Internet market are statistically significant. *isdn_cap*, the effect in the current year, has a negative coefficient implying a positive impact on prices. *lagisdn_cap*, the effect in the following year, has a positive coefficient, therefore a negative impact on prices. Since the incumbents incur costs for the installation of hardware and software necessary for the increase in bandwidth and connectivity; costs of service and therefore prices increase. Nevertheless, economies of scale taking place upon the utilization of the network for Internet services allow for reductions in prices.

The remaining smallness related variables; namely, *gdp_small*, *gdp_large*, *pop_large*, and *smallness_year(t)* maintain equivalent results consistent with the Competition Model. This also applies to the effects of the competition variables. Analysis shows that the impact of the introduction of competition in fixed telephony in a small economy on prices is negative. Liberalization causes prices to attenuate in the form of price rebalancing or downward pressure on high monopoly prices. In addition, liberalization in the Internet market in small economies has a positive effect on prices. Interpretation for this is similar to that of the effects of development in the Internet in the current year. Small economies in average manifest lower prices than large economies implied by the positive values of the *smallness_year(t)* variables. This suggests the existence of other factors that keep prices low and outweigh the small size of the market.

It is important to notice the different behavior of the two Competition Models that assess the effects on fixed teledensity and prices when the alternative technologies' variables are included. Inclusion of these variables in the Competition Model for teledensity causes the *smallness_year(t)* coefficients to become negative whereas inclusion in the Competition Model for prices merely reduces the size of *smallness_year(t)*. Omitting the alternative technologies' effect shows that small economies on average have higher teledensity than large economies. Including the effect of alternative technologies changes this relationship to the converse. Apparently, the role of alternative technologies on the two parameters of Universal Service is fundamental. Yet, it appears that on the one hand alternative technologies in small economies have a much greater effect on fixed voice penetration than the level of fixed voice prices. On the other hand, alternative technologies turn out to play a more important role in small economies than large economies.

SECTION 4 – DISCUSSION AND POLICY IMPLICATIONS

The paper follows an econometric approach to examine whether the size of the economy is an important determinant of the effects of competition and alternative technologies on Universal Service. It employs a Fixed Effects model using data for more than 140 economies for the period 1980-2004. Research findings provide significant evidence that smallness is a fundamental concept for policy and economic research.

Small economies as defined for the purposes of this paper encompass economies with maximum population of 9.2 million; GDP of less than USD$86.17 billion; and no more than 19.3 thousand km^2 of arable area. The econometric analysis has shown that smallness has a significant leverage on the examined relationships which implies that different policy models should be developed for economies that meet these thresholds. For example, the optimum policy for small economies favors the preservation of a single provider in the fixed voice. In addition, it appears that Universal Service in small economies can benefit from the combination of fixed voice and mobile telephony into a single market that will be ruled by the same competition and regulatory policy. Research findings and policy implications are elaborated below.

Teledensity in small economies appears to be lower than in large economies. Lower levels of teledensity do not necessarily reflect poorer provision of service. On the one hand, the teledensity indicator simply captures access to fixed voice and not the actual level of access to voice telephony which is complemented by alternative technologies. Particularly for small economies, alternative technologies are more likely to have a considerable contribution to voice telephony relative to fixed voice, as they feature lower costs of supply and easier network expansion. On the other hand, competition in fixed voice appears to deter network expansion in small economies. This negative effect outweighs the positive effect that alternative technologies have on fixed teledensity that is a result of increasing competitiveness in the sector. As it is most likely, smallness restrains fixed voice firms from operating at MES and therefore they concentrate on the most profitable areas. This strategy decreases the profit margins in these areas for incumbents from which they normally subsidize network expansion in less profitable areas.

As regards the level of prices, small economies appear to have lower prices than large economies. This is mainly a result of competition in fixed voice.

Competition in the mobile market and respective development in mobile telephony do not affect fixed voice prices. On the other hand, competition in the Internet market and development of the Internet market increase fixed prices.

The behavior of smallness's size components advocates that smallness has a significant leverage on the effects of competition and alternative technologies on Universal Service. Namely, GDP and population demonstrate varying relationships with or magnitude of effect on Universal Service, between small and large economies. To illustrate, GDP shows a positive relationship with teledensity for small economies and negative for large economies. Moreover, GDP in small economies has a negative impact on prices in contrast to large economies where GDP has a positive impact. It appears that wealthier small economies enjoy better Universal Service in the fixed voice (higher teledensity and lower prices) than less wealthy small economies. This is exactly the opposite in large economies where less wealthy large economies are depicted by higher teledensity and lower prices. Universal Service is most likely to achieve its optimum condition in economies whose size, in terms of GDP, approaches the borderline that distinguishes between small and large economies. Of course, it does not imply that wealthier large economies lack access to fixed telephony. Most possibly, wealthier large economies are in an advanced stage of incorporating alternative technologies for communication that complements – but is not gauged by the existing definition of – Universal Service.

On another level, population has a strong negative effect on teledensity for small economies whereas it has no statistically significant effect for large economies. As regards its relationship with price, population is associated with decreases in prices for both economies (in the Augmented Model the coefficient for small economies becomes statistically insignificant). Population's relationship with prices of both small and large economies advocates the underlying effect of existence of strong economies of scale in telecommunications. Their exploitation allows firms to achieve efficient levels of operation that enable them to reduce prices.

Regarding the effects of liberalization in small economies, competition in the three markets of fixed voice, mobile telephony, and the Internet leads to varying effects on Universal Service. Liberalization in the fixed voice exhibits a negative effect on teledensity probably as a result of the discontinuation of cross-subsidizations, which increases the per capita cost of installing new lines. New entrants' cream-skimming strategies may reduce the profit margin for incumbents which are normally responsible for the provision of Universal Service. In addition, in small economies the fixed voice market seems to exhibit large economies of scale that inhibit competition. Yet, competition in fixed voice also has a negative effect on prices in small economies. This is anticipated from increased competitiveness in the market.

Competition in mobile telephony in small economies has a positive effect on fixed teledensity. Increased competitiveness in the industry induced by competition in mobile telephony, most likely motivates fixed voice providers to look into unserved and potentially less profitable areas. Fixed voice providers face, not only customer switching to competitors, but customer switching to alternatives technologies, as well. Competitiveness induced by competition in mobile telephony does not appear to have an effect on fixed voice prices.

With relation to competition in the Internet market in small economies, it does not have an effect on teledensity. Yet, it increases fixed voice prices. This is probably a result of additional investments which are necessary to enhance bandwidth capacity and connectivity. These investments increase the cost of the physical network, which is consequently transferred onto consumers.

The effects of alternative technologies on teledensity are analogous to the effects that competition in the respective markets has. Mobile telephony and the Internet exhibit both relationships of substitution and complementarity with fixed voice. That is, all three technologies show positive growth over time. However, over time, alternative technologies demonstrate an effect of substitution on fixed voice. Development of mobile telephony and the Internet in the current year appears to have a negative effect on development of fixed voice in the subsequent year. These findings suggest that presently all three technology markets develop. Parallel development increases network effects which benefit consumers. In addition, utilization of the fixed network by both fixed voice and the Internet reinforces a relationship of complementarity between them. However, the relationship of substitution illustrates that alternative technologies eventually absorb users from the fixed voice for their capacity to offer voice communication in a more technologically attractive manner and at lower prices.

The optimum policy in small economies seems to favor the preservation of a single provider in the fixed voice where economies of scale are large and the MES is rather difficult to achieve by more than one operator. The effects of smallness on competition in the fixed voice are manifested through the impact that the latter has on Universal Service. The act of liberalization in the market directs competing firms towards the most profitable (crudely, the most populated) areas. Moreover, the general profitability of the market is weakened by competition in alternative technology markets. Consumers switch to competitors and alternative technologies. Eventually, network expansion becomes a secondary task, subsidies are harder to produce and incumbent providers are less apt to operate efficiently.

Existence of natural monopoly in the fixed voice in small economies should not be ruled out by policy makers. Liberalization of the market can only harm economic and social welfare and constitutes an inappropriate policy for the promotion of Universal Service. Instead, policy for the fixed voice should facilitate the efficient operation of the incumbent. Liberalization in the market may take place only in the event that the minimum efficient scale of operation for the incumbent is small relative to the total market size so that it allows the efficient operation of additional providers.

On the part of the incumbent provider, it should aim to exploit the economies of scale necessary to minimize its long-term average costs. This implies that, conditional on the available technology, if the total market size is not sufficient to meet MES, the firm should seek for demand by functionally merging with neighboring incumbent telecommunications providers. Collaboration with neighboring providers can facilitate the minimization of average cost, which consequently can be expressed in reductions in prices. Serving a fraction of a neighboring economy's fixed telephony may enable the host provider to meet Universal Service requirements and the "parasite provider" to achieve MES. Apparently, such parasitic models of fixed telephony may not be applicable for water-surrounded economies. Yet, economies in the regions of the former Soviet Union and the Gulf may exhibit suitable conditions for collaborative provision of service.

An important implication that derives from the theoretical and empirical analysis in this paper concerns the relationships that evolve between telecommunications technologies that lead to the blurring of telecommunications markets. Existing policies which base their provisions on the nature of technology become obsolete upon the convergence of technologies. Particularly, in small economies, policy should be oriented on consumer needs met by technology and not on the technology as such. A postulate by Stigler (1975) that an industry should encompass products and services which in the long term tend to manifest a relationship of substitution, should also pervade regulation. If consumers of a product A can easily switch to a product B or vice versa, then these products should be combined in the same industry and therefore be ruled by the same competition and regulatory policy. This may be applicable in the distinct markets of fixed and mobile telephony, which exhibit an imminent relationship of substitution.

Emerging relationships between fixed telephony and alternative technologies call for a redefinition for Universal Service. Access to voice telephony is a more appropriate indicator than access to fixed voice that is currently used to gauge Universal Service. This will allow alternative technologies to contribute to Universal Service. Respectively, Universal Service prices could refer to the cost of a basket of minutes of voice telephony that represents all technologies which facilitate voice telephony. In areas where Universal Service is more efficiently implemented by fixed telephony this could be signified in the number of minutes for fixed voice which minimize the cost of the basket. Currently, only fixed voice providers contribute to the Universal Service fund. This financial burden, in addition to decreasing profit margins in the fixed voice, renders fixed voice firms incapable of minimizing their costs. Hence, a redefinition of the Universal Service will allocate this burden to alternative providers, as well.

To conclude, economies of scale are fundamental for the efficient operation of telecommunications firms. Structural competition policies, such as divestiture of the incumbent operator and condemnation of merger agreements on the grounds of their subsequent increase in market concentration should be avoided as they may sacrifice efficiency. Currently, international telecommunications regulation is following the US and the EU models, which are strict with regard to concentration issues. This regulation is becoming less suitable for small economies. It is therefore necessary for small economies to devise appropriate policies which would address their distinctive scale characteristics.

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Table 1: Empirical studies assessing the effect of competition on Universal Service

Study	Research questions	Research findings	Regions involved	Nature of analysis
Mueller (1993)	The expansion rate of telephone access in USA before and after liberalization.	During monopoly annual growth rate of telephone connections was 5%. Following liberalization annual rate increased to 40%.	USA	Descriptive
Gillet (1994)	The impact of competition on USO after the divestiture of AT&T.	Telephone penetration increased by 2.4% between 1984 and 1992. Growth rates were higher among the lower income groups and in regions characterized by low teledensity	USA	Descriptive
Wallsten (2001)	The impact of competition, privatization, and regulation in Africa and Latin America.	Competition increases mainline penetration and reduces prices for local calls.	30 countries in Africa and Latin America	Econometric
Barros and Seabra (1999)	The effects of liberalization on USO.	There is no definite conclusion as to whether competition is harmful to mainline penetration. Also, there is no clear downward pressure on prices from competition.	24 OECD countries	Econometric
Ros (2000)	The effect of competition and ownership of the incumbent firm on network expansion and efficiency.	As regards competition, the author can not relate it with either a positive or a negative effect on fixed telephony penetration.	110 countries	Econometric
Li and Xu (2004)	The impact of privatization and competition in the telecommunications sector.	Competition does not have any detectable effects on fixed line penetration. Competition also appears to increase real cost of local phone calls (this finding was statistically insignificant).	160 countries	Econometric

Table 2: Empirical studies assessing the effect of mobile telephony on Universal Service

Study	**Research questions**	**Research findings**	**Regions involved**	**Nature of analysis**
Taubman and Vagliasindi (2005)	The impact of usage of mobile telephony by businesses on fixed lines penetration.	There is evidence of some substitution effects at the country level. Complementary effects dominate at the enterprise level.	26 Eastern European countries (6000 companies)	Econometric
Sung and Lee (2002)	The relationship between mobile and fixed voice telephony.	Results show that increase in the number of mobile telephones results in a reduction in new fixed connections and increase in fixed disconnections. This indicates that mobile telephony is becoming a substitute for fixed telephony.	Korea	Econometric
Hamilton (2003)	The relationship between mobile and fixed voice telephony.	Mobile telephones act as a competitive force encouraging fixed-line providers to improve access. It is possible that mobile and main lines are sometimes substitutes and at other times complements in consumption.	23 African countries	Econometric
Gruber and Verboven (2001)	Development of a diffusion model for mobile services.	Research findings advocate the existence of a form of complementarity between fixed and mobile network services†.	140 countries	Econometric
Banerjee and Ros (2004b)	The relationship between mobile and fixed voice telephony.	Mobile and fixed telephony have generally developed apace in the more affluent countries. Relatively less affluent countries have favored the leapfrogging of fixed by mobile telephony.	61 countries	Cluster analysis
Barros and Cadima (2000)	Examination of a bidirectional relationship between fixed and mobile telephony.	There is only a unidirectional relationship of a negative effect of mobile telephony on fixed telephony. Though, there is positive correlation between the two technologies as long as the two penetration rates are still rising.	Portugal	Econometric

Notes:
†The authors defined this form of complementarity as "technological complementarity" referring to the parallel growth of mobile and fixed telephony for technological reasons. This is in contrast to "economic complementarity" which is portrayed by parallel movements in demand in response to mutual relative price changes. This distinction was also raised by Banerjee and Ros (2004b).

Table 3: Description of variables used in the regression models.

Variable	Description
Dependent Variables	
teledensity	Teledensity measured as the number of fixed mainlines per 100 inhabitants
logcalls	The logarithm of the volume of outgoing international calls
Independent Variables	
lag_real_gdp_cap	Real GDP per capita in USD of 2000
t	Time trend variable
urban_cap	Percentage of urban population
log_investment	The logarithm of investment in the telecommunications sector as a percentage of GDP in USD in real prices of 2000
mobile	Mobile teledensity measured as the number of mobile telephony subscribers per 100 inhabitants
lagmobile	Mobile subscribers per 100 inhabitants lagged one year
isdn_cap	ISDN channels per capita
lagisdn_cap	ISDN channels per capita lagged one year
logopenness	Logarithm of openness of the economy
pop_small	Population interaction variable for small economies
arable_small	Arable area interaction variable for small economies
gdp_small	GDP interaction variable for small economies
pop_large	Population interaction variable for large economies
arable_large	Arable area interaction variable for large economies
gdp_large	GDP interaction variable for large economies
lib_fixed	Dummy variable that equals 1 if the fixed voice market has more than one provider
lib_mobile	Dummy variable that equals 1 if the mobile telephony market has more than one provider
lib_internet	Dummy variable that equals 1 if the Internet market has more than one provider
lib_fixed_small	Interaction variable between smallness and lib_fixed
lib_mobile_small	Interaction variable between smallness and lib_mobile
lib_internet_small	Interaction variable between smallness and lib_internet
smallness_year(t)	A vector of 24 dummy variables consisting of the interaction between yearly dummies and smallness dummy. t represents 1981-2004. t for 1980 is omitted from the model as it is the base year

Notes:
All variables related to competition in the distinct markets, namely, lib_fixed, lib_mobile, lib_internet, lib_fixed_small, lib_mobile_small, and lib_internet_small were initially included in the econometric model. However, due to multicollinearity either group of variables was dropped. In addition, substituting lib_fixed, lib_mobile, and lib_internet for lib_fixed_small, lib_mobile_small, and lib_internet_small was indifferent as it produced the same relationships with the dependent variable and exhibited respective statistical significance. Hence, the set of competition variables accounting for smallness was preferred as it would allow making inferences regarding the effects of competition related to the size of the economy.

Table 4: Summary statistics for basic indicators for the year of 2004

	Mean		**Std. Dev.**		**Min**		**Max**	
Variable/Economies	Small	Large	Small	Large	Small	Large	Small	Large
Arable to total area	10.86	16.70	11.88	13.17	0.00*	1.03	54.45	55.69
Openness	0.0000956	0.000074	0.0000562	0.0000596	0.00000975	0.000018	0.0003424	0.0003679
Investment in telecoms as percentage to GDP	0.00000152	0.00000101	0.00000156	0.00000180	0.00000001	0.00000001	0.00000744	0.00001660
ISDN channels per capita	4.59	5.82	9.74	9.07	0.00***	0.00****	41.82	39.53
Mobile density	30.40	33.37	29.91	35.20	0.00**	0.12	119.38	114.14
Outgoing international calls per capita	0.0001432	0.0000475	0.0003258	0.0000919	0.0000005	0.0000002	0.0022311	0.0006392
Population	2338722	62700000	2492606	172000000	10396	3443341	9201759	1290000000
Real GDP per capita	6478.34	7144.43	11011.05	10686.01	94.92	97.08	72936.65	38131.58
Teledensity	20.68	21.11	20.78	21.83	0.20	0.15	99.37	76.57
Urban pop. to total	21.17	21.04	10.68	9.41	3.07	0.55	60.41	39.55

Notes:
* Gibraltar Greenland, Jersey, Macau, Nauru, Tuvalu have 0 arable area
** Eritrea and Tuvalu have 0% in Mobile density
***Belize, Eritrea, Gabon, Georgia, Micronesia (Fed. States of) have 0 ISDN channels per capita
****Benin, Cambodia, Cuba have 0 ISDN channels per capita

Table 5: Chronological progress in the liberalization of telecommunications in the Fixed and Mobile telephony and the Internet

		Liberalized Large Economies In:							**Liberalized Small Economies In:**					
Year	Total # Large Economies	Fixed #	%	Mobile #	%	Internet #	%	Total # Small Economies	Fixed #	%	Mobile #	%	Internet #	%
2004	98	68	69.39	90	91.84	90	91.84	94	38	40.43	60	63.83	67	71.28
2003	98	66	67.35	90	91.84	90	91.84	94	38	40.43	60	63.83	67	71.28
2002	98	64	65.31	90	91.84	90	91.84	94	28	29.79	56	59.57	63	67.02
2001	98	62	63.27	87	88.78	87	88.78	94	24	25.53	51	54.26	60	63.83
2000	98	58	59.18	84	85.71	86	87.76	94	20	21.28	48	51.06	59	62.77
1999	98	54	55.10	75	76.53	77	78.57	94	15	15.96	38	40.43	47	50.00
1998	98	35	35.71	67	68.37	73	74.49	95	7	7.37	30	31.58	39	41.05
1997	98	21	21.43	54	55.10	54	55.10	95	7	7.37	25	26.32	25	26.32
1996	98	19	19.39	40	40.82	40	40.82	95	6	6.32	18	18.95	17	17.89
1995	98	14	14.29	34	34.69	36	36.73	95	5	5.26	11	11.58	11	11.58
1994	98	14	14.29	6	6.12	7	7.14	95	5	5.26	1	1.05	1	1.05
1993	98	14	14.29	5	5.10	6	6.12	95	5	5.26	1	1.05	1	1.05
1992	98	14	14.29	5	5.10	6	6.12	95	5	5.26	1	1.05	1	1.05
1991	98	14	14.29	5	5.10	6	6.12	95	5	5.26	1	1.05	1	1.05
1990	98	14	14.29	5	5.10	6	6.12	95	5	5.26	1	1.05	1	1.05

Source: Data obtained from ITU's World Telecommunication Regulatory Database

Table 6: Regression results for the Competition model and Augmented model assessing the impact on teledensity

Dependent variable: teledensity		**Competition Model**			**Augmented model**	
	Coefficient	Robust Stand. Error	t	Coefficient	Robust Stand. Error	t
lag_real_gdp_cap	.0011261***	.0000736	15.30	0.0009993***	0.0001011	9.88
t	.3777305***	.0238408	15.84	0.3662501***	0.0276401	13.25
urban_cap	.0257988***	.0082447	3.13	0.0423172***	0.0169974	2.49
log_investment	-.1507792***	.0568555	-2.65	-0.0423103	0.0583629	-0.72
mobile	-	-	-	1.93913***	.5161452	3.76
lagmobile	-	-	-	-1.893587***	.5154593	-3.67
isdn_cap	-	-	-	.7551247***	.2059719	3.67
lagisdn_cap	-	-	-	-.9846746***	.2167971	-4.54
logopenness	2.564051***	.3320229	7.72	2.148382***	.3457467	6.21
pop_small	21.60179***	1.956426	11.04	23.76021***	2.13276	11.14
gdp_small	-5.188359***	1.410308	-3.68	-5.074571***	1.528192	-3.32
gdp_large	2.462547***	.6734626	3.66	1.548848**	.681107	2.27
pop_large	-.3300241	.3161458	-1.04	.0144833	.306705	0.05
lib_fixed_small	-1.881202***	.501254	-3.75	-1.295567**	.6161914	-2.10
lib_mobile_small	.844869**	.4785767	1.77	.8718427*	.4971102	1.75
lib_internet_small	.5912096	.4986232	1.19	-.0695044	.5051917	-0.14
smallness_year(t)		all positive values†			all negative values†	
	Number of obs = 2333			Number of obs = 2012		
	Total number of countries = 148			Total number of countries = 148		
	Small economies = 61			Small economies = 61		
	R-sq: within = 0.6701			R-sq: within = 0.7066		
	F(35,2150) = 76.75			F(39,1825) = 87.50		
	corr(u_i, Xb) = -0.0690			corr(u_i, Xb) = 0.3851		

Notes:
*** Statistically significant at the 0.01 level
** Statistically significant at the 0.05 level
* Statistically significant at the 0.1 level
† smallness_year(t): interaction variable between the smallness dummy variable and yearly dummies. For the competition model ten out of twenty four coefficients are statistically significant at the 0.05 and 0.1 levels, all with positive values. For the augmented model the coefficients are all statistically significant at the 0.01 level, all taking negative values.
arable_small and arable_large are dropped from both models because of multicollinearity.

Table 7: Regression results for the Competition model and Augmented model assessing the impact on fixed voice prices

Dependent variable: logcalls		**Competition Model**			**Augmented model**	
	Coefficient	Robust Stand. Error	t	Coefficient	Robust Stand. Error	T
lag_real_gdp_cap	-0.0000018	0.00000618	-0.29	.0000367***	0.00000976	3.76
t	.11631***	.0028641	40.61	.1220827***	.0033202	36.77
urban_cap	.0071154***	.0007545	9.43	.0065861***	.0012668	5.20
log_investment	-.0005265	.0098288	-0.05	.003452	.0101167	0.34
mobile	-	-	-	.017549	.034892	0.50
lagmobile	-	-	-	-.0201518	.0349745	-0.58
isdn_cap	-	-	-	-.0321963***	.007741	-4.16
lagisdn_cap	-	-	-	.0195641**	.0079612	2.46
logopenness	.08094*	.0446985	1.81	.0901006***	.0508647	1.77
pop_small	-.7005938**	.284644	-2.46	-.4776864	.3299231	-1.45
gdp_small	-1.224985***	.1800959	-6.80	-1.128061***	.2198781	-5.13
gdp_large	.1330146***	.0506463	2.63	.1172625**	.0530607	2.21
pop_large	-.2042462***	.0673751	-3.03	-.2583808***	.0619541	-4.17
lib_fixed_small	.1543733***	.0563402	2.74	.1648395**	.0697703	2.36
lib_mobile_small	.097734**	.046012	2.12	.0723621	.0594268	1.22
lib_internet_small	-.2308458***	.0442548	-5.22	-.1846953***	.0536687	-3.44
smallness_year(t)		all positive values†			all positive values†	
	Number of obs = 2282			Number of obs = 1875		
	Total number of countries = 146			Total number of countries = 146		
	Small economies: 60			Small economies: 60		
	R-sq: within = 0.8095			R-sq: within = 0.8134		
	F(35,2101) = 191.16			F(39,1744) = 265.08		
	corr(u_i, Xb) = 0.3594			corr(u_i, Xb) = 0.5189		
	Prob > F = 0.0000			Prob > F = 0.0000		

Notes:
*** Statistically significant at the 0.01 level
** Statistically significant at the 0.05 level
* Statistically significant at the 0.05 level
† smallness_year(t): interaction variable between the smallness dummy variable and yearly dummies. For the competition model eighteen out of twenty four coefficients are statistically significant at the 0.05 and 0.1 level, all with positive values. For the augmented model fourteen out of twenty four coefficients are statistically significant at the 0.1 and 0.05 levels, all taking positive values.
arable_small and arable_large are dropped from both models because of multicollinearity.

Appendix I: An illustration of economy categorization based on GDP, arable area and population combined index.

	Country	**GDP (USD billions)**	**Arable area (sq. km)**	**Population**	**Index values**
Ten highest index values from total number of countries	United States	8785.00	1760180	295409638	74.33
	China	1419.00	1426210	1285227228	65.73
	India	698.50	1617150	1087123789	61.47
	Russia	485.00	1234650	143899225	28.95
	Brazil	611.70	589800	183912538	18.26
	Japan	3630.00	44180	127923488	17.93
	Canada	856.60	457440	31957882	12.74
	Germany	2164.00	117910	82645291	12.59
	Australia	496.70	483000	19942410	11.55
	France	1605.00	184490	62052222	11.19
Ten highest index values from small economies	Nicaragua	5.57	19250	5376140	0.53
	Dominican Rep.	18.81	10960	8767870	0.51
	Slovak Republic	21.38	14330	5401480	0.49
	Croatia	25.25	14620	4539732	0.49
	Turkmenistan	2.74	18500	4766009	0.48
	Central African Rep.	1.44	19300	3985971	0.47
	Moldova	1.81	18430	4217911	0.47
	Rwanda	3.23	11160	8882365	0.45
	Singapore	86.17	10	4272572	0.44
	Latvia	7.55	18320	2318469	0.44
Ten lowest index values from small economies	Micronesia (Fed. States of)	0.17	40	109691	<0.01
	Seychelles	0.51	10	79910	<0.01
	Grenada	0.31	20	102254	<0.01
	Dominica	0.18	50	78534	<0.01
	Saint Kitts and Nevis	0.27	70	42189	<0.01
	Kiribati	0.05	20	97409	<0.01
	Marshall Islands	0.06	30	59721	<0.01
	Palau	0.10	40	19853	<0.01
	Nauru	0.03	0	13386	<0.01
	Tuvalu	0.02	0	10396	<0.01

Source: Data were obtained from the United Nations' Human Development Report of 2005
Index value = 100/3 (P/Pmax +A/Amax + Y/Ymax),
P, A and Y are population, arable area and GDP of each country, respectively;
Pmax, Amax and Ymax represent the highest values of population, arable area and GDP respectively.

Appendix II: Calculation of variables which account for the sensitivity of size.

Step 1:

A set of three dummy variables is created that take the value of 1 if the economy has population less than 9.2 million; GDP less than 86.17 billion USD; and arable area less than 19.3 thousand km² and the value of 0, otherwise. These variables are named $Pop1_{it}$, $GDP1_{it}$ and $Arable1_{it}$.

Step 2:

A set of three variables is created which takes values that derive from the following equations:

$$Pop2_{it} = \left(\frac{population\_\max - population_{it}}{population\_\max} \right)$$

$$Arable2_{it} = \left(\frac{arable\_\max - arable_{it}}{arable\_\max} \right)$$

$$GDP2_{it} = \left(\frac{GDP\_\max - GDP_{it}}{GDP\_\max} \right)$$

Where:

$population\_\max$, $arable\_\max$, $GDP\_\max$, are the maximum values that small economies are identified with;

$population_{it}$, $arable_{it}$, and GDP_{it} are the respective values for country i at time t.

i: 1,2,3,…,214

t: 1980, 1981,…,2004

Step 3:

The variables included in the model consist of the interaction variables between the two sets of variables, namely:

pop_small $= Pop1_{it} \times Pop2_{it}$;

gdp_small $= GDP1_{it} \times GDP2_{it}$;

arable_small $= Arable1_{it} \times Arable2_{it}$.

For the construction of the three variables that account for large economies (pop_large, gdp_large, arable_large) the procedure is similar. In Step 1, the dummy variables take the opposite values. In Step 2, $population\_\max$, $arable\_\max$, and $GDP\_\max$ are the maximum values that large economies are identified with. In Step 3, the final variables used in the model are the product of the respective variables of Step 1 and 2.

Notes:

[1] Basic services for USO pertain to someone's access to a mainline that can support the use of fax and low speed data transmission.
[2] It is noteworthy that a review of the literature on small economies shows that the study of size has merely concentrated on the manufacturing sector and on tradable goods.
[3] The postulation that economies of scale consists a barrier to entry per se has accepted considerable criticism, see Posner (1976) and Vernon et al. (2000) for a discussion. It is however considered an important element for the sustainment of competition.
[4] GDP is based on constant prices of 2000.
[5] There were countries which lacked a considerable amount of data for different variables used in the models. Therefore, different models involve a different number of countries.
[6] A possible limitation of this variable is that it may tend to have a positive relationship with teledensity since a subscription to the ISDN Internet network requires the installation of an additional line to the fixed network.
[7] Stata reports an "intercept" which can cause confusion in light of the earlier claim that the fixed effect transformation eliminates all time-constant variables, including an overall intercept. Reporting an overall intercept in FE estimation arises from viewing the a_i as parameter to estimate. Typically, the intercept reported is the average across i of the estimate of a_i. An interpretation thus of the intercept would be unnecessary.
[8] *arable_small* and *arable_large* are dropped from the model because of multicollinearity
[9] According to the definition of *gdp_small* when actual real GDP of a country increases *gdp_small*'s values attenuate.
[10] Again the sequence of steps for interpretation of this coefficient is as follows: the values of *gdp_small* variable increase when actual GDP decreases; since an increase in *gdp_small* has a negative effect on *log_calls* it implies that a decrease in actual GDP has a negative effect on *log_calls* and the reverse. That is an increase in actual GDP is associated with an increase in *log_calls* and therefore a decrease in prices.