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THE IMPACTS OF REGULATORY REFORM ON THE GLOBAL TELECOMMUNICATIONS SECTOR

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ABSTRACT: This paper empirically explores the impacts of different types of regulatory agencies, privatisation, foreign ownership, and competition on the performance of the telecommunications sector of 80 countries during the period of 1990 to 1995. A general conclusion that can be drawn from the estimation results is that the implications of deregulation and the type of regulatory agency for the telecommunications sector of a country differ notably between OECD countries and non-OECD countries. The policy approaches that may work well in the telecommunications markets of the wealthy OECD countries may not lead to the desired results in the less mature telecommunications sectors of non-OECD countries. Our estimation results further suggest that *who* regulates the market at the national level in both OECD and non-OECD countries is of fundamental importance.

KEY WORDS: Telecommunications sector, regulatory reform, technology policy

TIIVISTELMÄ: Tutkimus selvittää empiirisen aineistoanalyysin avulla erilaisten sääntelyviranomaisten, yksityistämisen, ulkomaalaisomistuksen ja kilpailun vaikutuksia 80 maan telekommunikaatiosektorin toimintaan vuosina 1980-1995. Empiiristen estimointien tuloksista voidaan vetää yleinen johtopäätös siitä, että sääntelyn purkamisen ja erityyppisten sääntelyviranomaisten vaikutus maiden telekommunikaatiosektoreihin vaihtelee huomattavasti OECD-maiden ja OECD:n ulkopuolisten maiden välillä. Teknologiapoliittiset toimenpiteet, jotka saattavat toimia hyvin rikkaiden OECD maiden telekommunikaatiomarkkinoilla eivät välttämättä johda toivottuihin tuloksiin OECD:n ulkopuolisten maiden vähemmän kehittyneillä telekommunikaatiosektoreilla. Estimointitulokset viittaavat siihen, että sekä OECD-maissa että OECD:n ulkopuolisissa maissa on olennaisen tärkeää *kuka* säätelee niiden telekommunikaatiomarkkinoita kansallisella tasolla.

AVAINSANAT: Telekommunikaatiosektori, sääntely, teknologiapolitiikka

Heli Koski

The impacts of regulatory reform on the global telecommunications sector

SUMMARY

This paper empirically explores the impacts of different types of regulatory agencies, privatisation, foreign ownership, and competition on the performance of the telecommunications sector of 80 countries during the period of 1990 to 1995. A general conclusion that can be drawn from the estimation results is that the implications of deregulation and the type of regulatory agency for the telecommunications sector of a country differ notably between OECD countries and non-OECD countries. The policy approaches that may work well in the telecommunications markets of the wealthy OECD countries may not lead to the desired results in the less mature telecommunications sectors of non-OECD countries.

In OECD countries, opening up the market to competition seems to increase the penetration rates of telecommunications services, decrease telecommunications service prices to some extent and improve the quality of telecommunication services. Non-OECD countries have, on average, benefited from privatisation in that it has resulted in lower prices and higher quality of telecommunications services. On the other hand, it seems that privatisation and liberalisation of the telecommunications markets are not sufficient policy means to build comprehensive telecommunications networks in non-OECD countries.

Our estimation results further suggest that who regulates the market at the national level in both OECD and non-OECD countries is of fundamental importance.

Telecommunications service prices in particular seem to highly depend on the type of national regulatory agency, i.e. whether or not the telecommunications market is regulated by an independent regulatory agency. Among OECD countries we find a clear difference in the pricing patterns between markets that are regulated by an independent regulatory agency or by a ministry. Among non-OECD countries, it seems highly important, as a first step, that regulation is separated from operation in the telecommunications markets.

1. Introduction

The view that economic and social development of economies depends critically on their access to the telecommunications networks is widely accepted (see, e.g., Saunders et al., 1994; Wellenius and Stern, 1994). For this reason, in order to facilitate economic growth, national technology policies have focused on improving the performance of the telecommunications sectors world-wide. The expected positive relationship between economic development and telecommunications utilisation - in addition to the drastic technological progress that occurred in the telecommunications sector during the past decades - has also been a driving factor leading to the substantial regulatory and organisational changes during the past decade. A global trend in the re-organisation of the telecommunications sector has been towards liberalisation and deregulation of the telecommunications markets, but the national policy strategies for the telecommunications sector have been highly country-specific.

The regulation of telecommunications markets seems necessary, at least during the period of transition, when many markets are legally open to competition but incumbent monopoly operators still have substantial market power. The earlier experiences of certain countries (e.g. UK), which opened up their telecommunications markets to competition, suggest that this period of transition from a monopolistic market environment to effective competition in the telecommunications sector may be long (see, e.g., Amstrong, 1997). Consequently, the regulatory framework and implemented telecommunications policy during that time are highly important as they critically affect the development of the information infrastructure and more generally, the performance of the telecommunications sector.

One of the critical reasons for the variety of telecommunications policy approaches is that the economic benefits of privatisation and liberalisation of the

telecommunications markets have been uncertain and various countries have not been convinced that their net socio-economic benefits for society are positive. This has led to diverging degrees of privatisation and liberalisation - in terms of the allowance of competition and foreign ownership - of the national telecommunications markets. Also, the type of regulator of the telecommunications market has varied among the countries: some countries have relied on self-regulated telecommunications operators, whereas others have separated regulatory and operational tasks in their telecommunications market such that the market is regulated either by (or under) the ministry or independent regulatory party. The literature provides a multitude of examples regarding the pricing procedures and regulatory and market structures in the telecommunications sectors of various countries. However, there exist no systematic empirical cross-country studies[1] exploring the relationship between the different regulatory and market structures and the performance of the telecommunications sector.

This paper considers four key institutional arrangements that may decisively affect the performance of the telecommunications sector of a country: (i) privatisation of the telecommunications operator(s), (ii) the allowance of foreign ownership in the telecommunications sector, (iii) deregulation of market access or the allowance of competition, and (iv) the type of regulatory agency. It empirically explores the impacts of different types of regulatory agencies, privatisation, foreign ownership, and competition on the performance of the telecommunications sector - measured by the penetration rates of telephones and the prices and quality of telecommunications

[1]We may note here the studies of Wolak (1996) and Colombino (1998) that empirically explore the impacts of tariff restructuring in the competitive telecommunications markets on consumer welfare, respectively, in the U.S. and in Italy. Also, the empirical investigation of Majumdar (1997) considers the impacts of incentive regulation on the efficiency of the U.S. telecommunications sector.

services - of 80 countries during the period of 1990 to 1995. Our database includes 23 OECD countries and 57 non-OECD countries.

Our estimation results imply that the impacts of regulatory reform clearly differ between OECD and non-OECD countries. In OECD countries, opening up the market to competition seems to increase the penetration rates of mobile telephones, decrease telecommunications service prices to some extent (local calls) and improve the quality of telecommunication services (shorter waiting list for connection to a fixed telephone network). Non-OECD countries have, on an average, benefited from privatisation in that it has resulted in lower prices and higher quality of telecommunications services. On the other hand, it seems that privatisation and liberalisation of the telecommunications markets are not sufficient policy means to build comprehensive telecommunications networks in non-OECD countries. These results indicate that technology policy means that work well in the network markets of rich countries may not be as efficient in the markets of poor countries.

Our estimation results further suggest that who regulates the market is of fundament importance. Telecommunications service prices in particular seem to critically depend on the type of regulatory agency. Among OECD countries, we find a clear difference in the pricing patterns between markets that are regulated by an independent regulatory agency or by a ministry. Among non-OECD countries, it seems highly important, as a first step, that regulation is separated from operation in the telecommunications markets.

The paper is organised as follows. Section 2 discusses the regulatory and institutional reform that the telecommunications markets have witnessed world-wide. It discusses the policy means used in the telecommunications sectors of various countries and their expected impacts on the penetration rates, prices and quality of

telecommunications services. Section 3 introduces the database and describes the variables used in our empirical investigation. It also presents the estimated econometric models. Section 4 presents the results of our empirical exploration. Section 5 summarises the estimation results and concisely discusses their implications for practical technology policy in the telecommunications sector.

2. Regulatory and institutional reforms in the world telecommunication sector

Technology policy with regard to the national telecommunications markets has various common goals world-wide: e.g., universal telecommunications service provision, sufficiently low prices and adequate quality of telecommunications services for residential customers independent of their geographical location (see, e.g., OECD, 1990; Cave, 1997). Nonetheless, countries have implemented different policy strategies and approaches in their telecommunications sectors. This section will discuss the regulatory and institutional arrangements in the world telecommunications markets, their targets and expected impacts on the penetration rates of telephones and on the prices and quality of telecommunications services. We distinguish four critical components of national telecommunications policy reform: privatisation, the allowance of foreign ownership, opening up markets to competition and the type of regulatory agency employed. This section provides a theoretical framework for our empirical analysis concerning the impacts of regulatory reform in the world telecommunications markets during the first half of the 1990s.

At the beginning of the 1990s, most OECD countries were implementing some type of policy or institutional reform in their telecommunication sector. Also, at least fifteen developing countries were restructuring their telecommunications sector and

various developing countries were preparing a major telecommunications policy reform by 1992 (Saunders et al, 1994). Nevertheless, most of the operators in the world telecommunications markets between 1990 and 1995 were still monopolies, or if the markets were opened legally to competition, they still had remarkable monopoly power arising from their incumbency in the telecommunications market. Regulation thus played a remarkable role in the telecommunications sectors world-wide.

The *privatisation* of British Telecom in 1984 was followed by the privatisation of the telecommunications sector of various other countries and by 1989, more than 50 percent of the main lines of the world were owned by private investors (see Saunders et al., 1994). The degree of privatisation of the markets for local, national and international telecommunications services, and the share of the telecommunication companies the government has sold to private investors has varied greatly among the countries. In many countries, the previously state-owned telecommunications operators have been partly sold to private parties while the government has kept a part of the shares of the company. The principal reasons for privatising the telecommunications sector of a country differs among developed and developing countries. In developing countries, privatisation has mainly emerged due to the need to raise capital for building sufficient telecommunication infrastructures or to satisfy the largely unmet demand for telecommunications services, whereas more developed countries have primarily sought efficiency gains by getting rid of the bureaucratic state-owned companies (see, e.g., Noam and Kramer, 1994).

Privatisation is thus - due to an increase in investments in the telecommunications sector - expected to be positively related, particularly in developing countries, to the coverage of basic telecommunications services in a country and to the quality of services. Also, an increase in efficiency achieved from transforming the bureaucratic

government organisation into a privately organised company is expected to result in lower prices in the telecommunications sector.

Privatisation changes the ownership structure of the telecommunications entity from public to private ownership but it does not necessarily eliminate all ownership restrictions. In many countries, where private investors are allowed to buy the shares of the telecommunications entity, foreign ownership is not, however, permitted or it is limited to a certain maximum portion of the telecommunications operator(s) that may be owned by foreign investors. The importance of globalisation of the telecommunication markets and the role of foreign investors in the national telecommunications markets have intensified since the end of the 1980s. The foreign direct investments of the telecommunications operators in national public telecommunications operators (PTOs) of the other countries have rapidly expanded, changing the ownership structures of various previously national telecommunications entities (see, e.g. OECD, 1995).

Since *the allowance of foreign ownership* may bring additional capital into the telecommunications market of a country, it is expected that it increases - particularly in developing countries where the development of the telecommunications infrastructure is often restricted by the shortage of capital – both t he penetration rates and quality of telecommunications services.[2] The impact of foreign ownership on the prices of telecommunications services seems ambiguous. On the one hand, the allowance of foreign ownership in the national telecommunications market is likely to increase competition, or its threat, and thus decrease the prices of telecommunications services. Moreover, foreign investors may - particularly when they are not merely

[2] Some developing countries are, however, seen as being so risky investment objects (e.g. for their political instability) that they cannot attract foreign investors in their markets and thus, in these countries, it may not make any practical difference whether or not foreign ownership is allowed.

financial investors but act as telecommunications operators themselves[3] - improve the poor organisation and management of the operating entities by their technical and organisational expertise in commercial telecommunications service provision and by their capital funds. Consequently, the costs of operation and expansion of the telecommunications infrastructure may decrease and lower the prices of telecommunications services. On the other hand, many developed countries have witnessed decreasing profit margins for basic telecommunications services (OECD, 1995), which may attract private telecommunications operators and other investors to invest in the telecommunications sector of countries where the profit margins and the returns of investments are higher. Then, particularly when competition is not allowed in the market, the presence of foreign investors may not have any impact on the prices of telecommunications services.

Economic theory suggests that the deregulation of entry to the market *or the allowance of competition* generally results in lower prices and higher quality of services or products as competition gives incentives for cost minimisation, forces prices to the marginal cost level and also facilitates competition in terms of quality. However, it should be kept in mind that service prices in the telecommunications markets have typically been unbalanced such that some services have been subsidised by other services and provided under their marginal cost level. Flat-rate charges for connection to fixed telephone lines and prices of local calls represent such a subsidised service category. Thus, we expect that the tariff re-balancing related to liberalisation of the telecommunications sector are positively related to the prices of fixed network connection and local calls.

[3] For instance, Cable and Wireless invests and operates in over 40 countries worldwide (Wellenius and Stern, 1994).

We do not expect that opening up telecommunications markets to competition affects remarkably the penetration rates of basic telephone services in OECD countries, since in most countries telecommunications operator(s) have had both before and after regulatory reform the responsibility to provide universal basic telephone service. Since the markets for mobile telephone services still have plenty of scope for profitable mobile network expansion, we expect opening up mobile telephone markets to competition to increase the quantity of communications services sold and decrease service prices. In non-OECD countries, competitors may expand their market by investing in the telecommunications infrastructure and thus the allowance of competition in non-OECD countries may also increase the penetration rate of fixed telephone lines.

The principal goals of telecommunications regulation are to prevent telecommunications operators from earning monopoly profits or to otherwise abuse their monopoly power, to ensure fair competition when markets are opened up to competition, and to ensure provision of universal basic telephone services. Economic regulation of telecommunications markets typically focuses on controlling the prices and quantity of services, monitoring the quality of provided telecommunications services and regulating entry to the telecommunications markets. Entry regulation determines the number of firms allowed in the telecommunications market of a country and sets rules for the private and foreign ownership of telecommunications operators.

At the beginning of the 1980's, the telecommunications market was regulated by the government-owned telecommunications monopoly in various OECD and non-OECD countries. Technological development, which challenged the reasonability of monopoly provision of telecommunications services, and increasing awareness of the

socio-economic importance of the telecommunications sector during the 1980's led – in addition to the more general liberalisation of the telecommunications markets - to the separation of operational and regulatory functions in the telecommunications sector of various countries. This separation was undertaken generally in either of the following ways: (i) by having a government department regulate the telecommunications company or (ii) by establishing an independent regulatory agency that regulates the telecommunications sector. We assume that the separation of regulatory and operational tasks in the telecommunications markets reduces the monopoly power of the telecommunications operator. Consequently, telecommunications markets are expected to witness higher penetration rates, lower prices and higher quality of telecommunications services when they are regulated either by the ministry or the independent regulatory party (instead of the operator itself).

The regulation of the telecommunications sector by a government department involves the problem that the regulatory authorities are part of the political process and their personal objectives may differ from the targets that would maximise the society's welfare.[4] The economic theory of regulation - which began from the approach of Stigler (1971) and was followed, e.g., by the studies of Peltzman (1976), Becker (1983), Laffont and Tirole (1991) and Laffont (1994) - suggest that governmental regulation may not be optimal from society's point of view. This may result because whether the regulatory authority can keep its position in the government office depends on the political support it receives from various interest

[4]For instance, Faulhaber (1995) raises a doubt on the policymakers' willingness to make welfare maximizing decisions from society's point of view. He points out that regulators are often reluctant to changes that alter the status-quo and possibly also reduce their own power. He suggests that in the US telecommunications market, this has meant a considerable delay in the competitive process. Consequently - as competitive markets offer a wider variety of communications products - consumers have suffered from the loss of benefits (or delay for achieving these benefits) due to the regulatory actions of telecommunications authorities.

groups. Thus, telecommunications regulation by a ministry may lead to politically biased regulatory decisions that maximise the political support of the regulatory authority instead of the welfare of a society.

The notion that telecommunications regulation by the government of a country may suffer from the self-interested behaviour of politically selected regulatory authorities has led to the establishment of an independent regulatory authority separated from political decision-making and run by the experts in various countries (e.g. OFTEL in the UK). Another reason why an independent regulatory agency is seen as preferable to government regulation is that it provides more credibility to the stability of regulatory principals in the future than government regulation which may alter according to the power relations of parties with different views (see Levy and Spiller, 1994).

The economic theory of regulation (the regulatory capture theory) suggests that particularly the producer groups – that are small in number - are likely to have sufficient resources to organise collective actions that affect governmental regulatory decision-making. Consequently, governmental regulation is assumed to support more the interests of producer groups than consumers. Since the number of telecommunications operators in the markets of various countries is in general small, this theory should hold particularly in the telecommunications sector. This means that the market outcomes – penetration rates, prices and quality of telecommunication services – are likely to be different from the ones that we observe when the telecommunications market is regulated by the ministry or by the operator itself. We assume – according to the regulatory capture theory – that both governmental regulation and self-regulation by telecommunications operators support the interests of the industry rather than general public interests. Consequently, we assume that the

presence of an independent regulatory agency in the telecommunications market is related to lower prices and higher quantity and quality of provided telecommunications services than that resulting from a self-regulating operator or governmental regulator.

The next section discusses our data and variables used in the econometric investigation. It also introduces the estimated econometric models.

3. Data and econometric model

This section will first introduce the database and define the dependent and independent variables (Section 3.1) and then present the econometric models (Section 3.2) employed in our empirical estimations.

3.1 Database

Our database - World Telecommunications Indicators, ITU - comprises information regarding 202 OECD and non-OECD economies during the years 1980-1995. We will use data from 80 countries - 23 OECD countries and 57 non-OECD countries - during the period of 1990 to 1995 (see Annex 1 for the list of countries). We selected this specific time period for our study since by the early 1990s various OECD and non-OECD countries have substantially restructured their telecommunications sectors. This has enabled an empirical exploration of the impacts of these reforms on the telecommunications sectors of the countries. The selection of countries for our study was based on the available information on the regulatory and market structures of the telecommunications sector of the countries of the ITU database. The ITU database provides information on the penetration rates, prices and quality of telecommunication

services. We used the book of Wellenius and Stern (1994) and the OECD publication (1995) for gathering information concerning privatisation, the allowance of foreign ownership, the degree of competition and the type of regulatory agency of a country. We will next introduce the dependent and independent variables of the estimated models.

Dependent variables: Our study considers three main categories of dependent variables: the penetration rates, prices and quality of provided telecommunications services. We use the following variables describing the penetration rates of fixed and mobile telecommunications services:

- **TELEP** = log of the number of main telephone lines[5] per 100 inhabitants.
- **CELLU** = log of the number of cellular mobile telephone subscribers per population.

We have data on the prices of local calls (only from OECD countries) and on the connection and monthly subscription prices of telecommunication services. The dependent variables with regard to telecommunications service prices are defined as follows:

- **PLOC** = the cost of a three minute local call (US $).
- **RESSP/BUSSP** = log of residential/business telephone connection charge (US $), the one-time payment for signing up for a new telephone line.
- **RESMP/BUSMP** = log of residential/business monthly subscription charge (US $), the fixed charge for subscribing to the Public Switched Telephone network.

Unfortunately, there is not much data available with regard to the quality of services in different countries[6]. We use the following variable as an indicator of telecommunication service quality:

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[5] Main telephone lines refer to telephone lines connecting a customer's equipment (e.g., telephone set, facsimile machine) to the Public Switched Telephone Network (ITU).

[6] We do have data with regard to the number of faults per main lines, but since the definition of a fault varies among countries (ITU, 1995), these data are not comparable between the countries.

• **WAIT** = waiting list for main lines = the total number of applications for a connection to a fixed telephone line that have to be held over owing to a lack of technical availability.

Independent variables: Our independent variables include variables describing the privatisation (STATE OWN, OWNC, OWNL) and liberalisation (FOR OWN, FOWNC, FOWNL, COMP, COMPC, COMPL) of the telecommunications markets and the type of regulatory authority (REGU1, REGU2). The expected impacts of these variables are discussed in detail in the previous section. Table 1 summarises this discussion by presenting an overview of the expected signs of the estimated coefficients of the explanatory variables.

- TABLE 1 ABOUT HERE -

Most of our dependent variables concern the operation of local telecommunications markets. These include the prices of local calls, connection charges, monthly subscription prices and also the waiting list for mainlines. In these cases, we use dummy variables that describe the privatisation and liberalisation of local telecommunications markets (OWNL, FOWNL, COMPL). Correspondingly, in explaining the diffusion of mobile phones (CELLU), we use regulatory dummies concerning the cellular phone markets (OWNC, FOWNC, COMPC). The dependent variable TELEP, the number of main telephone lines per 100 inhabitants, concerns telephone lines that are used not only for local telephone traffic but also for national and international telephone calls. Consequently, in explaining the penetration rates of main telephone lines, we use policy dummies that take into account the degree of privatisation and liberalisation of the telecommunications market as a whole,

comprising local, long-distance and international telecommunications markets. These dummy variables (STATE OWN, FOR OWN, COMP) are constructed as weighted averages of individual dummies concerning privatisation and liberalisation of the local, long-distance and international telecommunications markets of a country. The variables describing the degree of privatisation and liberalisation of the telecommunications markets of a country are defined as follows:

Privatisation:

• **STATE OWN** = (OWNL+OWNLD+OWNI)/3,

where OWNL/OWNLD/OWNI = 1 if the operating entity(s) providing local/long-distance/international telecommunications services is government-owned, 0 otherwise.

• **OWNC** = 1 if the operating entity(s) providing cellular is government-owned, 0 otherwise.

Allowance of foreign ownership:

• **FOR OWN** = (FOWNL+FOWNLD+FOWNI)/3,

where FOWNL/FOWNLD/FOWNI = 1 if foreign ownership is allowed in the provision of local/long-distance/international telecommunications services, 0 otherwise.

• **FOWNC** = 1, if foreign ownership is allowed in the provision of cellular services, 0 otherwise.

Opening up markets to competition:

• **COMP** = (COMPL+COMPLD+COMPI)/3,

where COMPL/COMPLD/COMPI = 1 if local/long-distance/international telecommunications services are open to competition, 0 otherwise.

• **COMPC** = 1 cellular services are open to competition, 0 otherwise.

The type of regulatory agency:

- **REGU1** = 1 if regulatory and operational activities of the telecommunications market are separated, 0 otherwise.
- **REGU2** = 1 if the telecommunications market is regulated by an independent regulatory agency, 0 otherwise.

In addition, several control variables are used as explanatory variables:

- **GDP** = log of the per capita gross domestic product of a country (US $);
- **POPC** = concentration of population = log of the population of the largest city of a country per population.
- **DMY91..DMY95** = 1 for the years 1991-1995, 0 otherwise.
- **CPI** = Consumer Price Index (1987=100).

Gross domestic product per capita (GDP) is used for describing the wealth of a country. Richer countries have greater financial resources to develop their telecommunications infrastructure: in rich countries, the penetration rates and quality of telecommunications services are likely to be higher than in poor ones. Also, richer countries have greater purchasing power and, consequently, they are likely to have higher demand, and thus also higher prices, for telecommunications services. Consequently, we assume that the variable GDP is positively related to all of our dependent variables.

Studies on the spatial diffusion of innovations and new technologies emphasise the importance of central areas in the diffusion process: spatial concentration is regarded ass favourable to economic development and to the diffusion of innovations (Davelaar and Nijkamp, 1997). In building up the telecommunications infrastructure, spatial concentration is particularly important since it allows the utilisation of scale economies and means lower costs to supply – and consequently lower prices of - telecommunications services in areas with dense populations. Since the provision of

telecommunications services in sparsely populated areas is typically subsidised by telecommunications service revenues from central areas, relatively large central areas may also facilitate the penetration of telecommunications networks to rural areas. The variable POPC is used as a proxy for population concentration. We assume that it is negatively related to telecommunications service prices and positively related to the penetration and quality - in terms of the length of the waiting list for a connection to the fixed telephone network - of telecommunications services.

Time dummies, DMY91..95, are used to capture changes in the macroeconomic environment of global telecommunications markets that may affect their performance (e.g. technological development). The consumer price index (CPI) variable is used as an explanatory variable in the price equations for capturing changes in the level of consumer prices in general.

Table 2 presents some descriptive statistics, means and standard deviations, for the independent and dependent variables of the estimated equations. It illustrates various clear differences among the developed and developing countries. Table 2 shows that the penetration rates of both non-wired and wired telephones are, on an average, higher in OECD countries and also that OECD countries are more homogenous in terms of their telephone penetration rates than they are in non-OECD countries. Moreover, the quality of service in terms of the length of the waiting list for a telecommunications network connection is lower in the non-OECD countries than in OECD countries. We do not have information regarding the prices of local calls in developing countries, but both residential and business connection and monthly subscription prices are, on an average, lower than in OECD countries.

- TABLE 2 ABOUT HERE -

Table 2 also illustrates that the stage of telecommunications policy reform during the time period of 1990-1995 has differed among the developed and developing countries. OECD countries have proceeded further in opening up their telecommunications markets to competition than non-OECD countries. They have also more often separated regulatory activities from operational activities and established independent regulatory agencies for regulating their telecommunications sectors than developing countries have done. The average differences among OECD and non-OECD countries in terms of privatisation and the allowance of foreign ownership in the telecommunications of a country are not as apparent.

Before discussing the estimation results, we will next introduce the estimated econometric models.

3.2 Econometric framework

It seems possible that there exists a substantial cross-country variation or heterogeneity among our sample of 80 OECD and non-OECD countries during the period of 1990-1995. Consequently, the ordinary least squares (OLS) estimations of the models may result in inconsistent estimators and lead to false inferences. For this reason, we estimate, in addition to the OLS models (see Model 1), the random effects models[7] (see Model 2) that assume that the country-specific constant terms are randomly distributed across the countries and estimate a separate random disturbance term, u_i, for each country. The estimated model can be written as follows:

[7] We were not able to estimate the fixed effects models since the explanatory variables include time dummies, i.e. variables which are perfectly collinear with the fixed effects for each country. Also,

$$Y_t = \alpha_1 + \beta_1 GDP_t + \beta_2 POP_t + \beta_3 STATEOWN_t + \beta_4 FOROWN_t$$

$$+ \beta_5 COMP_t + \beta_6 REGU1_t + \beta_7 REGU2_t + \beta_8 CPI_t \times I + \sum_{t=9}^{13} \beta_t DMY91..95 \quad \text{(Model 1)}$$

, where I is an indicator variable which takes the value 1 in price equations and 0 otherwise, $E[\varepsilon_{it}] = 0$ and $Var[\varepsilon_{it}] = \sigma_\varepsilon^2$.

$$Y_t = \alpha_1 + \beta_1 GDP_t + \beta_2 POP_t + \beta_3 STATEOWN_t + \beta_4 FOROWN_t$$

$$+ \beta_5 COMP_t + \beta_6 REGU1_t + \beta_7 REGU2_t + \beta_8 CPI_t \times I + \sum_{t=9}^{13} \beta_t DMY91..95 \quad \text{(Model 2)}$$

, where I is an indicator variable which takes the value 1 in price equations and 0 otherwise, $v_{it} = \varepsilon_{it} + u_i$, $E[v_{it}] = 0$, $E[v_{it}^2] = \sigma^2 = \sigma_\varepsilon^2 + \sigma_u^2$, $E[v_{it} v_{is}] = \sigma_u^2$ and $E[v_{it} v_{js}] = 0 \ \forall t, s$ if i≠j.

Y_t = dependent variable measuring the performance of the telecommunications sector at time t (i.e. $TELEP_t$/$CELLU_t$/$PLOC_t$/$RESSP_t$/$BUSSP_t$/$RESMP_t$/$BUSMP_t$/ $WAIT_t$).

We examine the impacts of ownership structure, opening up the markets to competition, and regulatory procedures on the performance of the telecommunication sectors by estimating the OLS models and the random effects models. The models are first estimated on the pooled data consisting of both OECD and non-OECD countries and then for the two separate groups consisting of OECD countries and non-OECD countries. The selection of the proper econometric models was based on the Lagrange multiplier test (LM-test)[8]. The LM-test was used for testing whether the estimated models reveal substantial heteroscedasticity among the countries, i.e. whether the random effects model is favoured to the OLS model (See Tables 3-7 for the results of the LM-tests). The Chow-test – an application of the F test – can be used for exploring

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because our data contains a relatively large number of countries (i.e. 80 countries), the use of the fixed effects models would have remarkably decreased the degrees of freedom in our empirical estimations.

[8] A hypothesis Lagrange multiplier test is based on the OLS residuals and it testes the following hypothesis: H_0: $\sigma_u^2 = 0$, H_1: $\sigma_u^2 \neq 0$. The LM test statistic is of the form (Breusch and Pagan, 1980):

$$LM = \frac{nT}{2(T-1)} \left[(\sum_i (\sum_t e_{it})^2 / \sum_i \sum_t e_{it}^2) - 1 \right]^2 .$$

whether or not the regression coefficients are different in some pre-selected subsets of data. We used the Chow-test for analysing whether the impacts of different market and regulatory conditions on the performance of the telecommunications sectors differ from one another among the OECD and non-OECD countries.

The next section analyses the results of the econometric estimations.

4. Results

This section will present the estimation results of the econometric models introduced in the previous section. It will discuss how different regulatory parties and privatisation and liberalisation of the telecommunications sector have affected the penetration rates, prices and quality of telecommunications services during the first half of the 1990s. A general observation can be made with regard to all of the estimated equations from the Chow test values. The Chow test values indicate that the coefficients on the independent variables are not stable over the samples of OECD and non-OECD countries (see Tables 3-7). This finding suggests that the impact of policy approaches countries have used in the regulatory reform of their telecommunications sectors have had different impacts on the telecommunications markets of OECD and non-OECD countries.

Next, we will discuss in detail the estimation results of equations with respect to the penetration rates, prices and quality of telecommunication services.

• Penetration rates of telecommunications services:

Table 3 presents the estimation results of the models in which the penetration rates of fixed telephone lines (TELEP) and mobile telephones (CELLU) are used as the

dependent variables. The LM-test favours the random effects model in explaining the penetration rates of fixed main telephone lines, whereas the OLS model seems suitable in all of the estimated models describing the diffusion of mobile phones. The R-squared test values vary between 0.64 and 0.87, indicating good explanatory power of the estimated models.

The estimated coefficients on the time dummies indicate that both OECD and non-OECD countries have statistically significantly increased their investments in telecommunications infrastructure – both in terms of the penetration rates of the fixed telephone lines and mobile telephones - during the period of 1992-1995. Our estimation results show that the penetration rates of both fixed telecommunications lines and cellular mobile phones are clearly higher in richer countries (in terms of the order of magnitude of GDP of a country) than they are in poorer. This concerns both the estimation results of the separate samples of OECD and non-OECD countries, and the estimation results of the pooled sample comprising all countries in our database. The concentration of the population in the largest cities does not seem to have any statistically significant impact on the penetration rates of fixed telephone lines. Instead, the diffusion of mobile phones in OECD countries is positively and statistically significantly related to the variable POPC. This finding supports the spatial diffusion theory of innovation in that it suggests that spatial concentration facilitate the diffusion of innovations and new technologies.

It seems that the penetration rate of fixed telephone lines during the period of 1990-1995 is not much affected by the considered regulatory and institutional arrangements. Among OECD countries, one potential reason for this result is that generally these countries have stressed the importance of universal fixed telephone service provision as their primary telecommunication policy objective irrespective of

the regulatory or institutional structure of their telecommunications market. Though the estimation results concerning the whole sample provide evidence that the allowance of foreign ownership increases the penetration rate of the fixed telecommunications network, the estimations concerning separate samples of non-OECD and OECD countries do not find this effect to be statistically significant.

The penetration rates of fixed telephone lines in non-OECD countries are lower than they are in OECD countries. Among non-OECD countries, the variation compared to the mean value of the variable TELEP is high (see Table 2) – unlike among OECD countries - suggesting remarkable differences in the penetration rates of main telecommunications lines between OECD countries. However, our explanatory variables with regard to the regulatory reform of the telecommunications sector do not succeed in explaining the differences in the penetration rates of telecommunication services in non-OECD countries. It seems that non-OECD countries that have privatised their telecommunications operators, opened up their telecommunications markets for competition and allowed foreign investments in their telecommunications sector have not succeeded in alluring significantly more investments in building up their telecommunications infrastructure than other non-OECD countries. The penetration rates of fixed telephone lines and the diffusion of mobile phones are not statistically significantly related to either the variable REGU1 or REGU2 in the case of non-OECD countries. In other words, the penetration rates of telecommunications services in non-OECD countries seem to also be independent from the type of telecommunications regulator, i.e. whether the market is regulated by the operator itself, by a ministry or by an independent regulatory party.

- TABLE 3 ABOUT HERE -

Differences in the exercised technology policy of OECD countries are related more notably to the diffusion of mobile phones than to the penetration rates of fixed telephone lines. Both allowing foreign ownership and competition in the market for cellular phones clearly facilitates the diffusion of cellular phones. It appears that competition in the mobile telephone markets is effective and that the new international players in, or the threat of their entry to, the national telecommunication markets positively influences the spread of mobile phones among the OECD countries.

We also find interesting evidence of the impact of different types of regulatory agencies on the penetration rates of cellular phones in OECD countries. The estimated coefficient of the variable REGU1 is negative and statistically significant, suggesting that when the market is regulated by the telecommunications operator itself the penetration rate of cellular mobile phones tends to be higher than it would otherwise be. A possible explanation for this result is related to fact that the operator regulating the telecommunications market is typically a monopoly in the market. Consequently, it may have a great incentive to build a complementary network (for mobile phones) to its fixed telecommunications network that provides it a new source of income. Also, the regulator-operator may anticipate that - due to the global trend of liberalisation of the telecommunications markets - it will soon lose its monopoly and regulatory status in the national market. It may then want to ensure that it will have a strong position not only in providing fixed telecommunications services but also in the markets for mobile telephone services in the future.

The presence of an independent agency regulating the telecommunications market of a country is distinctly positively related to the penetration rate of cellular

telephones. It seems that independent regulatory agencies tend to create a regulatory environment that facilitates the diffusion of mobile phones more than telecommunications regulation formulated under a ministry or by a self-regulated telecommunications operator, on average, does. The estimation results with regard to the variables REGU1 and REGU2 suggest that governmental regulation hinders the diffusion of mobile telephones. This finding may be related to the bureaucracy of the political regulatory institution that negatively impacts on the diffusion of new communications services.

• **Prices:**

Prices of local calls: Table 4 presents the estimates of the OLS model for the prices of local calls. Our data with respect to the prices of local calls is limited to OECD countries. The estimated coefficients on the time dummies suggest – though none of them appears to be statistically significant - that local prices have, on an average, increased during the period of 1990-1995. Neither GDP nor the variable describing the concentration of the population (POPC) is statistically significantly related to the prices of local calls. The estimated coefficient on the CPI variable is positive and statistically significant, indicating that higher prices of local calls are related to higher consumer prices in general.

The estimated coefficient on the variable describing state-ownership of the local telecommunications operator is, contrary to our expectation, negative but not statistically significant. These estimation results hint that privatised local telecommunications companies among OECD countries may not be remarkably more efficient than those that are state owned, or if they are, this difference in efficiency between privately and publicly owned telecommunications companies is nevertheless

not reflected in the prices of local calls. Similarly, we do not find any evidence of statistically significant differences in pricing of local telecommunications services when foreign ownership is allowed in the local telecommunications market and when it is not.

- TABLE 4 ABOUT HERE -

The prices of local calls are considerably lower in local telecommunications markets that have been opened up to competition than they are in monopoly markets. This estimation result does not support our assumption of tariff re-balancing related to competitive markets, but does support the traditional economic theory of the impacts of competition. The lack of actual competition in local telecommunications markets even when access to the market is free has concerned researchers in the telecommunications field. Our estimation results suggest that even if local telecommunications companies have generally maintained notable monopoly power, opening up local telecommunications markets to competition has clearly affected their pricing behaviour. The mere threat of competition seems to be quite effective in leading local telecommunication companies to decrease the prices of local calls.

It appears that the separation of regulatory and operational tasks in the telecommunications market has not had much impact on the local telecommunications prices among OECD countries. Countries that have established independent regulatory agencies, instead, seem to charge higher prices for local telecommunications services than other countries. Since the pricing of local calls in various countries has been cross-subsidised by long-distance telephone traffic, this finding may indicate that the independent regulatory agencies have adopted

telecommunications policy tools promoting more cost-based pricing of local telecommunications services than governmental regulators have done. This finding does not support the regulatory capture of producers, but it reflects to a greater extent the impact of consumers on governmental telecommunications regulation. Raising rates has, at large, been regarded as politically difficult and thus governmental regulators may have been more reluctant to implement rate restructuring in the local telecommunications markets than independent regulatory agencies. The estimated coefficient on the variable describing state ownership further supports this view: state ownership is negatively (though not statistically significantly) related to the prices of local calls.

Subscription prices: Table 5 gives the estimation results of the OLS models for residential and business subscription prices. The estimation results generally show a negative relationship between the time dummies and residential and business subscription prices, but in most cases the estimated coefficients are not statistically significant. The variable GDP is, as expected, positively and statistically significantly related to telecommunications service subscription prices in all of the estimated equations. The variable describing the concentration of the population (POPC) is, unexpectedly, positively and statistically significantly related to both residential and business subscription prices in the estimated equation among OECD countries.

Clearly, the state ownership of the local telecommunications operator is related to higher residential and business subscription prices in non-OECD countries, reflecting the more efficient organisation and operation of resources in the privatised telecommunications companies. In OECD countries, privatisation does not seem to lead to notably lower prices for network connection than state ownership does, but instead, the relationship between state ownership and subscription prices is negative,

though not statistically significant. This estimation result is similar to the one we had with regard to the pricing of local telecommunications services in OECD countries. We find no evidence that the allowance of foreign ownership in the local telecommunications market would affect either residential or business subscription prices of telecommunications services in the sampled countries. Neither does opening up local markets to competition seem to affect subscription prices in the telecommunications markets.

- TABLE 5 ABOUT HERE –

It appears that the type of agency regulating telecommunications markets during the first half of the 1990s has had a greater impact on the subscription prices of telecommunications services than opening up the market to competition and foreign investors has had. The data suggest that both residential and business customers in non-OECD countries have benefited from the separation of operational and regulatory tasks in their telecommunications sector. Residential subscription prices are clearly lower when the operator does not regulate the market itself, but the presence of an independent regulatory agency has not had any significant effect on residential subscription prices in non-OECD countries. It seems that the mere separation of operational and regulatory tasks does not remarkably affect business and residential subscription prices among OECD countries. The variable REGU1 is not statistically significantly related to either residential or subscription prices among OECD countries, whereas the variable REGU2 is negative and statistically significant in both cases. This means that the presence of an independent regulatory agency has distinctly different implications for telecommunications services prices than other types of

telecommunications regulators. Also, business customers in non-OECD countries seem to be charged lower subscription prices when the market is regulated by an independent regulatory party than they would otherwise be charged.

Monthly prices: Table 6 presents the estimation results of the OLS equations concerning monthly subscription prices. The estimated coefficients of the time dummies are mostly insignificant and, consequently, do not indicate any clear trend in monthly telecommunications service prices for residential and business customers during the period of 1990-1995 (see Table 6). The wealth of a country seems to be an important determinant of residential and monthly subscription prices only in the case of non-OECD countries: in richer non-OECD countries, customers have clearly higher monthly fixed fees for their access to telecommunications networks than in poorer non-OECD countries. The concentration of the population does not have any statistically significant impact on monthly subscription prices among our sampled countries.

- TABLE 6 ABOUT HERE -

We cannot find much evidence that privatisation and liberalisation of the telecommunications market would have affected monthly prices for telecommunications service subscribers. The differences in residential and monthly business prices between monopolistic and competitive markets and between privately and publicly owned local telecommunications companies are not statistically significant. Quite surprisingly, it seems that the allowance of foreign ownership increases the monthly business prices in non-OECD countries. One potential explanation for this is that foreign investors seek higher profit margins from the

provision of telecommunications services to business customers – who are more solvent customers than residential ones – in non-OECD countries.

Again, our data provide evidence of the important role of regulatory agencies in telecommunications markets: monthly residential and business prices are clearly lower in non-OECD countries when operational and regulatory tasks are separated in the telecommunications markets. Moreover, residential customers of non-OECD countries seem to benefit from the presence of an independent regulatory agency in that it further lowers their monthly prices for access to telecommunications services. In OECD countries, the relationship between monthly access prices and the type of regulatory agency seems quite different. First, though the estimated coefficients of the variable REGU1 are negative, they are not statistically significant: among OECD countries, we find no clear difference in monthly business and residential prices when the market is regulated by an operator itself or when it is regulated by some other party. Neither does the presence of an independent regulatory agency seem to affect monthly residential access prices in OECD countries. Instead, our database suggests that the presence of an independent regulatory agency is positively and statistically significantly related to the monthly prices charged on business customers. It does not seem clear that this result would be related to the more advanced stage of tariff re-balancing in the presence of an independent regulatory agency, since both residential and business subscription prices are negatively and statistically significantly related to the variable REGU2. Since we don't have data on the prices of long-distance and international calls we cannot further explore the relationship between tariff re-balancing and the types of regulatory agencies.

• Quality of telecommunications services:

We estimated the equations where the dependent variable described the waiting list for main lines, i.e. this variable is a proxy for unsatisfied demand for fixed telephone connections. The estimation results of the random effects models and OLS model (see Table 7) suggest neither a clear declining nor ascending trend in the number of the unmet applications for fixed telephone network connections during the period of 1990-1995. It seems that in richer countries – in terms of GDP per capita – new telephone lines were connected faster than in poorer countries among both non-OECD and OECD countries. The concentration of the population is negatively related to the variable WAIT. Among non-OECD countries, this variable is statistically significant, indicating that the excess demand for telecommunications services is served faster – probably due to economies of scale - in the non-OECD countries with larger metropolitan areas.

- TABLE 7 ABOUT HERE –

Interestingly - though our price data did not reflect any differences in the efficiency of privately and publicly owned local telecommunications companies – we find that the waiting lists for main lines tend to be considerably longer when the local telecommunications company is owned by the government. This result applies to both OECD and non-OECD countries. It supports the view that privatised telecommunications companies are more efficient in that they can respond faster to the additional demand for services than government-owned companies.

The allowance of foreign ownership does not seem to bring such an increase in capital to the telecommunications market – that was expected particularly in the case

of non-OECD countries – that the excess demand for telecommunications services would be satisfied faster than it would otherwise be. Furthermore, the estimated sign on the coefficient of the variable FOWNL is, unlike we expected, positive in the case of non-OECD countries. Even more confusing is the estimation result suggesting that the allowance of competition in the local telecommunications market of non-OECD countries would further increase the length of the waiting list for main lines. It should be noted that the explanatory power of the estimated model for non-OECD countries is relatively low - the R-squared value is 0.28 – meaning that our model is not able to explain very well the variation in the length of the waiting lists for main lines among non-OECD countries.

Among OECD countries, opening up local telecommunications markets to competition is negatively and statistically significantly related to the length of the waiting list for a fixed network connection. This result further supports our finding with regard to prices of local calls that the threat of competition has clear implications for the market behaviour of local telecommunications operators in OECD countries. Our data suggest that local operators in markets that are open to competition not only decrease their service prices but also improve the quality of their service by providing faster access to the telecommunications network than local telecommunications monopolies do.

The type of regulatory agency does not seem to play a remarkable role in affecting the quality of telecommunication services. Neither the estimated coefficient on REGU1 nor the estimated coefficient on REGU2 is statistically significant among our sampled countries.

The next section will present an outline of the estimation results and discuss their implications for practical technology policy in the telecommunications sector.

5. Summary and policy implications

Our data suggest that opening up telecommunications markets to competition and allowing foreign ownership in them has neither led to lower telecommunications service prices nor higher quality of telecommunication services in non-OECD countries. It is also noteworthy that the allowance of foreign ownership has not increased, on average, the level of investments in the telecommunications sectors of non-OECD countries such that it would have resulted in substantially higher penetration rates of telecommunications services. It seems that privatisation and the separation of regulatory and operational tasks have been more effective policy approaches in the telecommunications markets of non-OECD countries. The separation of regulation from operation in the telecommunications markets of non-OECD countries has been a critical step in preventing telecommunications operators from abusing their monopoly power. Both subscription and monthly telecommunications service prices are lower in non-OECD countries that do not allow the telecommunications operator itself to regulate the market.

We do not find much evidence of the impacts of the various ownership types on the telecommunication markets of OECD countries. The only dependent variable that relates statistically significantly to the allowance of foreign ownership is the penetration of cellular telephones: foreign investors tend to facilitate the diffusion of mobile telephones in OECD countries. In OECD countries, privately owned telecommunications companies seem to provide faster access to the telecommunications network to new subscribers than government-owned firms do. However, we do not find any evidence that privatisation of telecommunications

companies in OECD countries would have resulted in efficiency gains reflected in lower telecommunications service prices.

Instead, the type of regulatory agency seems to have a critically important impact on the telecommunications service prices in OECD countries. The telecommunications regulation that takes place under the ministry or by the operator itself does not seem to result in any clear differences in the prices of telecommunications services, whereas the presence of an independent regulatory agency seems to imply distinctly different pricing patterns of telecommunications services among OECD countries. It appears that the independent regulatory agencies exercise to some extent more cost-oriented pricing policy, which is reflected in higher prices of local calls. Telecommunications service subscription prices, instead, are lower in OECD countries that are regulated by independent regulatory agencies than they would otherwise be.

Our data from OECD countries support the view that opening up the market to competition is one of the most effective policy means that facilitates the diffusion of (new) telecommunications services, decline in prices and increase in the quality of telecommunications services. The penetration rates of cellular phones are clearly higher, the prices of local calls are lower and the waiting list for connection to the telecommunications network is clearly shorter in OECD countries that have opened their telecommunications markets to competition. However, we find evidence that neither telecommunications service subscription prices nor monthly telecommunications service prices are significantly different irrespective of whether or not the local telecommunications market is competitive. These results may be related to the lack of actual competition in the local telecommunications markets of OECD countries: the telecommunications operators' abuse of their market power and

lack of competition further reduces the incentives of incumbent local operators to increase their efficiency (which would be reflected in lower prices).

Our estimation results stress the importance of one common factor to the performance of the telecommunications markets of both OECD and non-OECD countries: the type of regulatory agency. Particularly, the pricing of telecommunications services seems to be highly dependent on whether the market is regulated by the operator itself, ministry or independent regulatory party. This result supports the regulatory capture theory in that the governmental regulator seems to support the interests of the telecommunications operator: its regulation leads to the same outcome with regard to telecommunications service prices as that resulting from the presence of an operator-regulator. Furthermore, we find clear differences in the pricing of access to telecommunications services between independent regulatory agencies and other regulatory parties in OECD countries. The estimation results among non-OECD countries provide weaker evidence for the regulatory capture theory. They imply that residential subscription prices and monthly access prices, in particular, to both residential and business customers are lower under governmental regulation than they are when the market is regulated by the operator itself.

We also find interesting evidence suggesting that the type of regulator is not significantly related to the quality of services in the telecommunications markets. This might indicate that telecommunications regulators are more concerned with other issues, such as telecommunications service prices, than with the quality of provided telecommunications services. However, the issue of telecommunications service quality is of substantial importance: if the telecommunications regulators emphasise the control of service prices only, telecommunications companies may be induced to behave strategically, such that it eventually leads to the deterioration of

telecommunications service quality. Since we only have data on one indicator of telecommunications service quality, we cannot make any far-reaching conclusions on the relationship between privatisation, liberalisation, the type of regulatory agency and the quality of provided telecommunications services in the markets. This fundamentally important issue would require further estimations based on a more extensive database on telecommunications service quality.

Another shortcoming of our database is the limited price information it contains. Although it contains data on the prices of local calls and subscription and monthly prices divided into the groups of residential and business prices, data concerning the prices of long-distance and international calls and the prices of cellular telephone calls are not available. Further empirical investigations with these additional data would shed more light on the pricing patterns of telecommunications companies and their relation to regulatory reform in the telecommunications sector. Particularly, they could be used for exploring the relationship between regulatory reform and tariff re-balancing in world telecommunications markets.

A general conclusion that can be drawn from the estimation results is that the implications of deregulation and the type of regulatory agency on the telecommunications sector of a country differ notably between OECD countries and non-OECD countries. The policy approaches that may work well in the telecommunications markets of the wealthy OECD countries may not lead to the desired results in the less mature telecommunications sectors of non-OECD countries. Liberalising the telecommunications markets by opening them up to competition and foreign investors has clearly facilitated the diffusion of mobile telephones in OECD countries. Our estimation results also suggest distinctly different impacts of various regulatory parties on the diffusion of mobile phones among OECD countries. It seems

that building a telecommunications infrastructure in non-OECD countries requires, on average, more than just privatisation and liberalisation of telecommunications markets. The regulatory reform of the telecommunications sector is not sufficient to build up a comprehensive (or universal) telecommunications infrastructure in a country that cannot attract sufficient capital to its markets due to reasons related to the poor or uncertain economic and political conditions of the country. In these countries, the first critical precondition is to provide investors with a sufficiently safe and reliable business environment in which to act.

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Annex 1. List of countries

Antigua and Barbuda
Argentina
Bahamas
Bangladesh
Barbados
Belize
Bolivia
Brazil
Brunei Darussalam
Bulgaria
Chile
China
Colombia
Cote d'Ivoire
Dominican Rep.
Estonia
Ghana
Grenada
Guyana
Honduras
Hongkong
Hungary
India
Indonesia
Jamaica
Jordan
Korea (Rep. of)
Kuwait
Lithuania
Madagascar
Malaysia
Malta
Morocco
Mozambique
Myanmar
Nepal
Nicaragua
Nigeria
Oman
Panama
Paraguay
Peru
Philippines
Poland
Puerto Rico
Romania
Saint Kitts and Nevis
Singapore
Sri Lanka
St. Vincent and the Grenadines
Taiwan, China
Tajikistan
Tanzania
Thailand
Trinidad and Tobago
Ukraine
Uruguay
Uzbekistan
Vanuatu
Venezuela
Australia
Austria
Belgium
Canada
Denmark
Finland
France
Germany
Greece
Ireland
Italy
Japan
Mexico
Netherlands
New Zealand
Norway
Portugal
Spain
Sweden
Switzerland
Turkey
United Kingdom
United States

Table 1. The expected effects of policy variables on the performance of the telecommunications sector of a country

Variable	Penetration of wired telephone		Penetration of cellular telephone		Prices of local calls and (flat-rate) subscription prices		Waiting list	
	Non-OECD	OECD	Non-OECD	OECD	Non-OECD	OECD	Non-OECD	OECD
STATE OWN	-	-/0	-	-	+	+	+	+
FOR OWN	+	+	+	+	-	0	-	-
COMP	+	0	+	+	+	+	-	-
REGU1	0	0	+	+	-	-	-	-
REGU2	0	0	+	+	-	-	-	-

Table 2. Descriptive statistics

Variable	All countries Mean (Std.Dev.)	Non-OECD countries Mean (Std.Dev.)	OECD countries Mean (Std.Dev.)
TELEP	2.05127 (2.33526)	1.35973 (2.44268)	3.73436 (0.46146)
CELLU	-5.21696 (2.19984)	-6.12405 (2.25034)	-3.92792 (1.30616)
PLOC	-2.16934 (0.46787)	N/A	-2.16934 (0.46787)
RESSP	4.46685 (1.29925)	4.21763 (1.42289)	4.94323 (0.84163)
BUSSP	4.68350 (1.31639)	4.47896 (1.47029)	5.05879 (0.85973)
RESMP	1.81199 (0.78054)	1.52251 (0.76724)	2.33714 (0.46961)
BUSMP	2.28103 (0.86750)	2.07433 (0.91038)	2.67689 (0.61016)
WAIT	8.37401 (6.09143)	10.95688 (2.38641)	3.07466 (7.74775)
FAULT	3.54247 (1.10539)	3.97417 (0.92371)	2.67909 (0.92028)
GDP	24.04817 (2.52363)	22.90917 (2.11964)	26.47471 (1.30835)
POP	15.88276 (2.15596)	15.45932 (2.35608)	16.78488 (1.24497)
STATE OWN	0.57475 (0.47601)	0.57918 (0.47301)	0.56530 (0.48430)
OWNL	0.56889 (0.49578)	0.58333 (0.49380)	0.53623 (0.50050)
OWNC	0.25725 (0.43791)	0.23457 (0.42504)	0.28947 (0.45552)
FOR OWN	0.43450 (0.48639)	0.40408 (0.47927)	0.49930 (0.49715)
FOWNL	0.42222 (0.49446)	0.38462 (0.48729)	0.50725 (0.50177)
FOWNC	0.72464 (0.44751)	0.74074 (0.43959)	0.70175 (0.45951)
COMP	0.13108 (0.32871)	0.067347 (0.24069)	0.26687 (0.43468)
COMPL	0.13556 (0.34270)	0.076923 0.26690	0.26812 (0.44459)
COMPC	0.48188 (0.50058)	0.42593 (0.49602)	0.56140 (0.49841)
REGU1	0.76389 (0.42528)	0.68980 (0.46352)	0.92174 (0.26976)
REGU2	0.14722 (0.35482)	0.10204 (0.30332)	0.24348 (0.43106)
LCPI	5.78818 (2.69847)	6.16866 (3.19443)	5.00052 (0.58299)

Table 3. The estimates of the random effects and the OLS models for the penetration rates of main lines per 100 persons and cellular phones

Variable	ALL LHS=telep	Non-OECD LHS=telep	OECD LHS=telep	ALL LHS=cellu	Non-OECD LHS=cellu	OECD LHS=cellu
Model	Random effect	Random effect	Random effect	OLS	OLS	OLS
Constant	-1.00442 (0.407149)	-0.858244 (0.565835)	-0.844484 (0.465167)	-16.8299 (0.606938)	-17.4740 (1.20132)	-15.3646 (1.19552)
GDP	0.340010 (0.041946)	0.272249 (0.054760)	0.462292 (0.049967)	1.22039 (0.059931)	1.27753 (0.132027)	1.14861 (0.115275)
POPC	-0.053845 (0.061232)	-0.012614 (0.84768)	-0.008974 (0.046983)	0.123804 (0.082761)	0.007528 (0.164623)	0.332275 (0.117125)
STATE OWN/ OWNC=C	-0.013109 (0.088202)	-0.091248 (0.196851)	-0.002435 (0.049864)	0.271191^{C} (0.279944)	0.007152^{C} (0.562650)	0.309814^{C} (0.266306)
FOR OWN/ FOWNC=C	0.278551 (0.112651)	0.177515 (0.209493)	0.036649 (0.088760)	0.755358^{C} (0.222392)	0.764060^{C} (0.423365)	0.820254^{C} (0.194278)
COMP/ COMPC=C	-0.021063 (0.106870)	0.256039 (0.877794)	0.031062 (0.053478)	0.398027^{C} (0.199302)	0.318709^{C} (0.304177)	0.435106^{C} (0.244466)
REGU1	-0.029838 (0.075881)	-0.091635 (0.133329)	0.000954 (0.052272)	-0.494290 (0.236804)	-0.586286 (0.430708)	-0.764490 (0.374490)
REGU2	-0.071868 (0.058576)	-0.093507 (0.112292)	-0.042507 (0.038001)	0.407407 (0.194329)	0.478478 (0.337714)	0.484124 (0.187522)
DMY91	0.027909 (0.024335)	0.027175 (0.035186)	0.034083 (0.041093)	0.447939 (0.265926)	0.569925 (0.473951)	0.329062 (0.227539)
DMY92	0.066636 (0.022829)	0.068688 (0.031506)	0.114634 (0.021194)	0.800196 (0.241801)	1.02479 (0.419428)	0.549616 (0.212054)
DMY93	0.130721 (0.023154)	0.135901 (0.031115)	0.114634 (0.021845)	0.911212 (0.238153)	0.969163 (0.404200)	0.971123 (0.240204)
DMY94	0.180156 (0.024637)	0.204617 (0.033595)	0.122842 (0.021978)	1.50510 (0.242806)	1.67017 (0.415035)	1.30608 (0.228865)
DMY95	0.192267 (0.116496)	0.217641 (0.135792)		2.01093 (0.983991)	2.13814 (1.23016)	
Nobs	249	174	75	160	97	63
R^2	0.69	0.64	0.80	0.78	0.71	0.87
LM-test	49.12*	34.05*	11.98*	4.37**	0.12**	0.14**
Chow-test F(2, 476)	28.60^{CT}			8.07^{CT}		

Note: Standard errors for the coefficient estimates are in parentheses.
* = Favours the random effects model to the OLS model at the 0.01 level of significance.
** = Favours the OLS model to the random effect model at the 0.01 level of significance.
CT = Regression coefficients are statistically significantly different (at the 0.01 level of significance) in the samples of OECD and non-OECD countries.

Table 4. The estimates of the OLS model for the prices of local calls

Variable	OECD LHS=telep
Constant	-2.38556 (2.11500)
GDP	0.172677 (0.156073)
POPC	0.037309 (0.090974)
OWNL	-0.302926 (0.177045)
FOWNL	-0.095218 (0.165284)
COMPL	-0.877374 (0.173027)
REGU1	-0.034632 (0.194755)
REGU2	0.313308 (0.158411)
LCPI	-0.207408 (0.145129)
DMY91	0.052163 (0.160901)
DMY92	0.052163 (0.160901)
DMY93	0.052026 (0.175137)
DMY94	0.101345 (0.179814)
Nobs	65
R^2	0.51
LM-test	0.01**

Note: Standard errors for the coefficient estimates are in parentheses.
** = Favours the OLS model to the random effect model at the 0.01 level of significance.

Table 5. The estimates of the OLS models for residential and business subscription prices

Variable	ALL LHS=ressp	Non-OECD LHS=ressp	OECD LHS=ressp	ALL LHS=bussp	Non-OECD LHS=bussp	OECD LHS=bussp
Constant	0.917390 (0.725626)	-1.70715 (1.40885)	-5.70616 (3.54331)	1.20664 (0.816527)	-2.75102 (1.64669)	-4.84944 (3.69018)
GDP	0.323890 (0.061084)	0.451346 (0.112607)	0.847975 (0.255037)	0.299583 (0.066794)	0.504302 (0.128056)	0.782256 (0.265688)
POPC	0.025938 (0.105281)	-0.237506 (0.175379)	0.665210 (0.135076)	0.106156 (0.120723)	-0.090485 (0.201712)	0.583444 (0.145193)
OWNL	0.340010 (0.341125)	1.57603 (0.617133)	-0.454510 (0.300147)	0.536381 (0.391853)	2.52933 (0.754317)	-0.592407 (0.315700)
FOWNL	0.095627 (0.340076)	0.829346 (0.628639)	0.244013 (0.284281)	0.277318 (0.375752)	1.26878 (0.720868)	0.468760 (0.296274)
COMPL	0.360200 (0.295969)	0.803960 (0.560933)	-0.145883 (0.249484)	0.381999 (0.319490)	0.931921 (0.574326)	-0.193418 (0.260464)
REGU1	-0.474017 (0.222716)	-0.703305 (0.290191)	0.676074 (0.404419)	-0.374493 (0.253610)	-0.204489 (0.326530)	0.443177 (0.430597)
REGU2	-0.588616 (0.241560)	-0.498752 (0.367054)	-0.746523 (0.227352)	-0.714005 (0.261292)	-0.962315 (0.390666)	-0.666804 (0.239185)
LCPI	0.247394 (0.034335)	0.275160 (0.037988)	0.792107 (0.239135)	0.119186 (0.039494)	0.261007 (0.042974)	0.769040 (0.249734)
DMY91	-0.347412 (0.273943)	-0.480038 (0.393372)	-0.234184 (0.253216)	-0.123224 (0.315231)	-0.140684 (0.446671)	-0.252931 (0.279383)
DMY92	-0.440282 (0.246841)	-0.444437 (0.343447)	-0.531647 (0.261704)	-0.292983 (0.278639)	-0.232067 (0.384598)	-0.4556761 (0.285540)
DMY93	-0.182311 (0.251464)	-0.145585 (0.343606)	-0.402459 (0.276985)	-0.003285 (0.283061)	0.144521 (0.382812)	-0.350024 (0.300907)
DMY94	-0.226524 (0.277024)	-0.120949 (0.401229)	-0.766263 (0.281023)	-0.012929 (0.306077)	0.188023 (0.431399)	-0.619007 (0.305191)
Nobs	181	110	71	172	104	68
R^2	0.32	0.45	0.47	0.27	0.44	0.49
LM-test	1.06**	1.05**	0.37**	0.92**	0.11**	6.41*
Chow-test F(2, 476)	63.35^{CT}			78.78^{CT}		

Note: Standard errors for the coefficient estimates are in parentheses.
* = Favours the OLS model to the random effect model at the 0.05 level of significance.
** = Favours the OLS model to the random effect model at the 0.01 level of significance.
CT = Regression coefficients are statistically significantly different (at the 0.01 level of significance) in the samples of OECD and non-OECD countries.

Table 6. The estimates of the OLS models for residential and monthly business prices

Variable	ALL LHS=resmp	Non-OECD LHS=resmp	OECD LHS=resmp	ALL LHS=busmp	Non-OECD LHS=busmp	OECD LHS=busmp
Constant	-0.739937 (0.388071)	-0.129181 (0.743947)	6.07413 (1.74199)	0.190386 (0.439278)	-0.539042 (0.863085)	8.04534 (2.39938)
GDP	0.354212 (0.032744)	0.258097 (0.059712)	-0.038563 (0.125383)	0.318602 (0.036839)	0.341593 (0.067116)	-0.219663 (0.172758)
POPC	-0.029213 (0.057006)	0.002581 (0.093851)	0.063581 (0.066407)	0.015604 (0.067376)	-0.011785 (0.109751)	-0.095707 (0.095102)
OWNL	-0.043110 (0.179705)	0.117823 (0.319934)	-0.015901 (0.147560)	-0.124832 (0.215375)	0.460410 (0.428995)	-0.096781 (0.205157)
FOWNL	0.074771 (0.179055)	0.622372 (0.324706)	-0.262507 (0.139760)	0.492214 (0.206911)	1.33000 (0.413678)	-0.103497 (0.192356)
COMPL	0.048877 (0.155754)	0.320500 (0.230791)	-0.074824 (0.122653)	-0.023222 (0.180095)	0.141236 (0.370771)	0.201894 (0.169144)
REGU1	-0.416323 (0.119618)	-0.629819 (0.156400)	-0.258229 (0.198823)	-0.703120 (0.139154)	-0.831843 (0.183800)	-0.397188 (0.280510)
REGU2	-0.164123 (0.127215)	-0.383090 (0.191970)	0.130693 (0.111772)	0.218648 (0.144915)	-0.044108 (0.227370)	0.434202 (0.155382)
LCPI	0.001578 (0.018177)	0.015886 (0.019845)	-0.610492 (0.117565)	0.000156 (0.021683)	0.014492 (0.024212)	-0.683613 (0.162209)
DMY91	-0.185417 (0.147697)	-0.308638 (0.212906)	0.078562 (0.124488)	-0.146699 (0.173707)	-0.190589 (0.248958)	0.090403 (0.184881)
DMY92	-0.146834 (0.131948)	-0.349557 (0.182670)	0.292216 (0.128661)	-0.199438 (0.152362)	-0.368899 (0.211440)	0.232340 (0.189645)
DMY93	-0.068433 (0.134014)	-0.121134 (0.181911)	0.142995 (0.136173)	-0.175044 (0.156267)	-0.215331 (0.213749)	0.073715 (0.1993388
DMY94	-0.159983 (0.144911)	-0.264509 (0.205356)	0.264709 (0.138159)	-0.194599 (0.167815)	-0.315667 (0.239085)	0.252020 (0.201807)
Nobs	176	105	71	172	105	67
R^2	0.47	0.42	0.67	0.49	0.50	0.63
LM-test	5.73*	0.29**	0.29**	4.89*	1.13**	0.75**
Chow-test F(2, 476)	83.64^{CT}			42.75^{CT}		

Note: Standard errors for the coefficient estimates are in parentheses.
* = Favours the OLS model to the random effect model at the 0.05 level of significance.
** = Favours the OLS model to the random effect model at the 0.01 level of significance.
CT = Regression coefficients are statistically significantly different (at the 0.01 level of significance) in the samples of OECD and non-OECD countries.

Table 7. The estimates of the random effect and the OLS models for the quality of telecom services: waiting list for main lines

Variable	ALL LHS=wait	Non-OECD LHS=wait	OECD LHS=wait
Model	Random	Random	OLS
Constant	8.33005 (1.07121)	10.8542 (1.64480)	50.7990 (9.06781)
GDP	-0.00040 (0.000033)	-0.451669 (0.177400)	-4.54345 (0.862145)
POP	-0.321258 (0.374004)	-0.826024 (0.252878)	-0.236148 (0.923076)
OWNL	2.30391[L] (0.554419)	1.01841[L] (0.412428)	2.10538[L] (1.87856)
FOWNL	1.23840[L] (0.767824)	0.153733[L] (0.697527)	-3.42328[L] (1.74682)
COMPL	1.70976[L] (0.549286)	2.33465[L] (0.968137)	-5.67260[L] (1.55050)
REGU1	0.538358 (0.498702)	0.612541 (0.342948)	-2.66186 (2.53934)
REGU2	-0.778561 (0.563313)	1.019326 (0.760088)	-0.559139 (1.45657)
YD1	0.037758 (0.148395)	-0.128393 (0.122257)	0.602523 (1.68529)
YD2	0.282869 (0.161327)	0.155273 (0.124921)	0.489142 (1.61618)
YD3	0.375551 (0.165550)	0.165484 (0.127181)	3.18062 (1.73778)
YD4	0.666991 (0.180433)	0.337129 (0.141917)	2.97163 (1.66322)
Nobs	203	136	67
R^2	0.43	0.28	0.72
LM-test	85.24*	11.90*	0.38**
Chow-test F(2, 476)	180.30[CT]		

Note: Standard errors for the coefficient estimates are in parentheses.
* = Favours the random effect model to the OLS model at the 0.01 level of significance.
** = Favours the OLS model to the random effect model at the 0.01 level of significance.
CT = Regression coefficients are statistically significantly different (at the 0.01 level of significance) in the samples of OECD and non-OECD countries.

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