

# ETLA

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**LIBERALISATION, REGULATION AND  
UNIVERSAL SERVICE PROVISION  
IN THE EUROPEAN  
TELECOMMUNICATIONS MARKETS**



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**ABSTRACT:** This paper will empirically examine how the telecommunications markets of various European countries have responded in their universal service provision to the regulatory and institutional arrangements in their telecommunications sectors. Our data comprises information with regard to the telecommunications markets of 22 European countries during the period of 1990-1995. Our data suggest that opening up telecommunication markets to competition has had a notable, positive impact on the provision of universal service in Europe. The allowance of foreign ownership in the telecommunications markets seems to further enhance universal service provision. Who regulates the European telecommunications markets at the national level appears to be more important than whether telecommunications companies are state or privately owned.

**KEY WORDS:** Telecommunications sector, universal service, regulatory reform, technology policy, Europe

**TIIVISTELMÄ:** Tutkimus selvittää empiirisen aineiston valossa kuinka erilaiset telekommunikaatiosektoria koskevat sääntelykeinot ja institutionaaliset järjestelyt ovat vaikuttaneet yleisen telepalvelun (universal service) tarjontaan Euroopan telekommunikaatiomarkkinoilla. Tutkimusaineistoon sisältyy informaatiota 22 Euroopan maan telekommunikaatiomarkkinoilta vuosilta 1990-1995. Tutkimustulokset viittaavat siihen, että kilpailun vapauttamisella telekommunikaatiomarkkinoilla on ollut merkittävä, positiivinen vaikutus yleisen telepalvelun tarjontaan Euroopassa. Ulkomaalaisomistuksen salliminen näyttää entisestään lisäävän yleisen telepalvelun tasoa. Tutkimustuloksista ilmenee, että on tärkeämpää kuka säätelee telekommunikaatiomarkkinoita kansallisella tasolla kuin se ovatko teleoperaattorit valtion vai yksityisten tahojen omistamia.

**AVAINSANAT:** Telekommunikaatiosektori, yleinen telepalvelu, sääntely, teknologiapolitiikka, Eurooppa



**Heli Koski**

**Liberalisation, Regulation and Universal Service Provision in the European Telecommunications Markets**

**SUMMARY**

This paper will empirically examine how the telecommunications markets of various European countries have responded in their universal service provision to the regulatory and institutional arrangements in their telecommunications sectors. Our data comprises information with regard to the telecommunications markets of 22 European countries during the period of 1990-1995.

It appears that the most influential policy approach affecting universal service provision in European telecommunications markets has been the allowance of competition. Our data suggest that opening up telecommunication markets to competition has had a notable, positive impact on the provision of universal service in Europe. The allowance of foreign ownership in the telecommunications markets seems to further enhance universal service provision in that it is positively related to the penetration rates of fixed telephone lines and to the availability of public pay phones.

Generally, it seems that who regulates the European telecommunications markets at the national level is more important than whether telecommunications companies are state or privately owned. Our empirical findings indicate that the separation of operational and regulatory functions have positive impacts on universal service quality in the European telecommunications markets. However, our estimation results

emphasise to a greater extent the importance of the presence of an independent national regulatory authority in universal service provision of telecommunications. The empirical results of this study suggest that European countries that regulate their national telecommunications markets under a ministry might benefit remarkably from the establishment of an independent national regulatory authority in their telecommunications markets.

## 1. Introduction

The telecommunications sector is regarded world-wide to be of fundamental importance to society in that it provides the core infrastructure to business and social activities. The performance of telecommunications networks may thus remarkably contribute to the wealth of a country. The realisation of the socio-economic importance of telecommunications markets has also led to large-scale reforms in the telecommunications markets in Europe, particularly within the European Union (EU). The majority of the EU member countries were due to fully liberalise their telecommunications markets by the beginning of 1998<sup>1</sup>. Further policy efforts to increase efficiency in the telecommunications sector include privatisation of the incumbent telecommunications operators and separation of regulatory and operational tasks in the telecommunications markets.

In addition to efficiently operating telecommunications markets, telecommunications policy in Europe has another common target: universal service provision. European Union legislation determines universal service as follows: *“Universal service is a defined minimum set of services of specified quality which is available to all users independent on their geographical location and, in the light of specific national condition, at an affordable price”*. In other words, universal service is defined to comprise three essential aspects: the penetration rates, quality and prices of telecommunications services. The national definitions of universal service outside the EU may vary, but high penetration rates and quality of telecommunications services as well as affordable telecommunications service prices are global communications policy goals.

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<sup>1</sup>A longer transition period has been permitted to five EU member countries: Greece, Ireland, Luxembourg, Portugal and Spain.

The literature comprises extensive documentation on the regulatory reform in world telecommunications markets (see, e.g., Noam, 1992; Wellenius and Stern (Eds.), 1994; OECD, 1995a,b; Cave, 1997a,b; Katz, 1997)<sup>2</sup>. Also, the issue of universal service provision is widely discussed both in academic research papers and in publications concerning practical technology policy in telecommunications markets.<sup>3</sup> The relationship between exercised technology policy in the telecommunications market and universal service provision has been of particular interest in the discussion. Nevertheless, we are not aware of any systematic empirical investigation that explores this relationship.<sup>4</sup> This paper will empirically examine how the telecommunications markets of various European countries have responded in their universal service provision to the regulatory and institutional arrangements in their telecommunications sectors.

The most important changes in European telecommunications policy during the past decade involve privatisation and liberalisation of telecommunications markets and separation of operational and regulatory functions in the telecommunications sector. This paper will empirically examine how various exercised policy approaches have affected universal service provision in terms of penetration rates, prices and quality of telecommunications services in Europe. Our data comprise information on 22 European countries - of which 15 represent current EU member countries and 7 non-EU countries – during the period of 1990-1995.

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<sup>2</sup> We may also note here the recent report of the European Commission (1998a) that gives detailed information on EU telecommunications legislation and policy since 1984.

<sup>3</sup> Also, European Union policy stresses the importance of universal service in telecommunications. The European Commission recently published its first report that aims at monitoring the provision of universal service in the EU telecommunications sector, Communication from the Commission (1998b).

<sup>4</sup> 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.

Our data suggest that opening up telecommunication markets to competition has had a notable, positive impact on universal service in telecommunication in Europe. The allowance of foreign ownership in telecommunications markets seems to further enhance universal service provision in that it is positively related to the penetration rates of fixed telephone lines and to the availability of public pay phones. It seems that who regulates the European telecommunications markets at the national level is more important than whether telecommunications companies are state or privately owned. Our empirical investigation finds clear differences in universal quality when the operator regulates the market itself than when telecommunications operation and regulation are separated. However, our data suggest that even more important than mere separation of telecommunications regulation from operation for universal service provision in telecommunications is whether or not the telecommunications market is regulated by an independent national regulatory authority. The presence of an independent national regulatory authority in the telecommunications market seems to improve universal service provision in that it increases the penetration rates of mobile telephones and public pay phones. It also has clear impacts on the pricing of local telephone calls in the European telecommunications markets.

The outline of the paper is as follows. Section 2 discusses the principal policy approaches exercised in the regulatory reform of the telecommunications markets and introduces the corresponding variables of interest in our empirical exploration. Section 3 presents in more detail our database from the European telecommunications sector and the variables used in the empirical estimations. It also introduces the estimated econometric models. Section 4 provides the estimation results with regard to the impacts of regulatory reform on universal service provision in the European

telecommunications markets. Section 5 outlines the major empirical findings and concludes.

## 2. Regulatory reform in the telecommunications markets

This section will discuss the following key forms of regulatory and institutional (re)organisation of the European telecommunications markets: privatisation, the allowance of foreign ownership, opening up markets to competition and separation of regulatory and operational tasks in the telecommunications markets. It also introduces the independent variables of interest in our applied investigation. This section focuses on the expected impacts of various telecommunications policy approaches on universal service provision, i.e. the quantity, quality and prices of telecommunications services.

Our database captures the four fundamental arrangements of regulatory reform in the telecommunications sector by the following variables:

### **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 if 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.

Our empirical analysis primarily concerns the performance of local telecommunications markets. For this reason, in most cases, we need dummy variables that describe the privatisation and liberalisation of local telecommunications markets (OWNL, FOWNL, COMPL). Correspondingly, in explaining the diffusion of mobile phones, we use regulatory and institutional dummies concerning the cellular phone markets (OWNC, FOWNC, COMPC). The penetration rates of fixed telephone lines, instead, concern not only local telephone service provision but also national and international telephone service provision. 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. We will next discuss in more detailed each policy variable and their expected impacts on universal service provision in the telecommunications markets.

*Privatisation:* The main reason for privatising the government-owned telecommunications operators in Europe arises from the efficiency gains privately owned companies are expected to offer compared to bureaucratic state-owned companies. Also, privatisation is seen as a means to raise capital for building a telecommunication infrastructure that satisfies the unmet demand (particularly in poor countries) for telecommunications services (see, e.g., Noam and Kramer, 1994). In general, privatisation is - due to an increase in investments in the telecommunications sector - expected to enhance universal service provision: variables STATE OWN/OWNL/OWNC are expected to be negatively related to the penetration rates

and quality of telecommunications services. Also, an increase in efficiency achieved from transforming the bureaucratic government organisation into a privately held company is expected to result in lower prices in the telecommunications sector or positive relationship between state-ownership variables and prices.

*The allowance of foreign ownership:* Privatisation is necessary precondition for the allowance of foreign ownership, but it has not led to opening up telecommunications market to foreign investors in all countries (see, e.g. OECD, 1995b). Foreign investors bring more capital into the telecommunications market of a country, and consequently, the allowance of foreign ownership (i.e. variables FOR OWN/OWNL/OWNC) is expected to be positively related to both the penetration rates and quality of telecommunications services. The impact of foreign ownership on the prices of telecommunications services seems ambiguous. On the one hand, the allowance of foreign ownership 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 financial investors but act also as telecommunications operators - improve the organisation and management of the operating entities by providing with their technical and organisational expertise in commercial telecommunications service provision. Consequently, the costs of operation and expansion of the telecommunications infrastructure may decrease and result in lower prices of telecommunications services. On the other hand, it seems likely that foreign investors choose countries where the profit margins and the returns of investments are higher. Then, particularly when competition is not allowed in the telecommunications market, the presence of foreign investors may not have any impact on the prices of telecommunications services.

*Competition:* Economic theory suggests that 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. This suggests that variables COMP/COMPL/COMPC are positively related to telecommunications service quality and negatively related to prices of telecommunications services. 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 network connection and prices of local calls represent such a subsidised service category. Thus, we expect that - due the tariff re-balancing related to the liberalisation of the telecommunications sector – the variable COMPL (the allowance of competition in the local telecommunications markets) is positively related to the prices of network connection and local calls.

We do not expect that opening up telecommunications markets to competition affects remarkably the penetration rates of basic telephone services, since in most countries telecommunications operator(s) have had both before and after regulatory reform the responsibility to provide universal basic telephone service. In other words, the relationship between the variable COMP and the penetration rate of fixed telephone lines may not be statistically significant. Since the markets for mobile telephone services still have 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. Thus, the variable COMPC

is expected to be positively related to the variable describing the diffusion of cellular telephones<sup>5</sup>.

*Regulatory authority:* Regulation in the telecommunications markets is necessary during the period of transition, when the markets are legally open to competition but incumbent monopoly operators still have substantial market power.<sup>6</sup> Regulation concerning prices, quality and quantity of telecommunications services and entry to the telecommunications markets in particular are needed to prevent the abuse of monopoly power by incumbent telecommunications operator, to ensure fair competition and universal service provision. It has been widely acknowledged that incumbent telecommunications operator should not regulate its own market area. Separation of operational and regulatory functions is regarded to be of fundamental importance to the performance and functioning of European telecommunications markets. Still, at the beginning of the 1980s, the telecommunications markets were regulated by national telecommunications monopoly in various European countries. The separation of telecommunications regulation from operation was generally undertaken 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. In

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<sup>5</sup> Unfortunately, we do not have sufficient price data from the mobile telephone markets.

<sup>6</sup> The countries (e.g. UK), which opened up their telecommunications markets to competition, suggest that the period of transition from a monopolistic market environment to effective competition in the telecommunications sector may be long (see, e.g., Armstrong, 1997).

other words, we expect that the variable REGU1 is negatively related to the price variables and positively related to the variables describing the penetration rates and quality of telecommunications services.

The economic theory of regulation (e.g. Stigler, 1971; Peltzman, 1976; Becker, 1983; Laffont and Tirole, 1991; Laffont, 1994) suggest that governmental regulation may not be optimal from society's point of view, since regulatory authorities under government are part of the political process. This may lead to politically biased regulatory decisions that maximise the political support of the regulatory authority instead of the welfare of a society. Governmental regulation may also increase uncertainty in the telecommunications markets, since the regulatory principals of the government may alter according to the power relations of political parties. These notions have led to the establishment of an independent regulatory authority separated from political decision-making and run by the experts in various countries

The regulatory capture theory further suggests that 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 the ones of 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 operator supports 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 (variable REGU2) 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.

This section has discussed the independent variables of interest in our empirical investigation. In the following section, we will briefly introduce other independent variables (i.e. control variables), the dependent variables, and the econometric model used in the estimations.

### **3. Data and econometric model**

The first half of the 1990s witnessed a great variety in the phase of implementation of regulatory reform among the telecommunications markets of European countries. Cross-country data from European countries during this period provide a great opportunity to empirically explore the relationship between various technology policy approaches and universal service provision in the telecommunications sector. In this section, we will first define the dependent and independent variables used in our empirical examination. Then, we will present the econometric model that is estimated for exploring the relationship between regulatory reform and universal service provision in European telecommunications markets.

We use the World Telecommunications Indicators database of ITU (International Telecommunications Union) that comprises information regarding 202 countries during the years 1980-1995. We have data with regard to universal service provision from 22 European countries - 15 (current) EU countries and 7 non-EU countries - during the period of 1990 to 1995 (see Annex 1 for the list of countries). 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:** The dependent variables of our study describe the level of universal service provision in terms of the penetration rates, quality and prices of telecommunications services in Europe during the first half of the 1990s. The first group of dependent variables concerns the scope of universal provision with regard to the three central factors that describe the extensiveness of the communications infrastructure of a country, i.e. the spread of fixed and mobile telephone services and the availability of public pay phones. The following variables are used for capturing these variables:

- **TELEP** = log of the number of main telephone lines<sup>7</sup> per 100 inhabitants.
- **CELLUP** = log of the number of cellular mobile telephone subscribers per population.
- **PAY PHONE** = log of the number of public pay phones<sup>8</sup> per population.

The second group of dependent variables measures telecommunications service affordability by prices. 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.

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<sup>7</sup> 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 ).

<sup>8</sup>Public payphones include the total number of all types of public telephones including coin- and card-operated ones.

- **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<sup>9</sup>. We use the following variable as an indicator of telecommunications service quality:

- **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:** Independent variables of interests in our study concern the phase of regulatory reform in the telecommunication markets of various European countries during the first half of the 1990s. We use dummy variables that describe the degree of privatisation (STATE OWN, OWNC, OWNL) and liberalisation (FOR OWN, FOWNC, FOWNL, COMP, COMPC, COMPL) of the telecommunications markets and the type of authority (REGU1, REGU2). These variables and their expected relationship with universal telecommunications service provision are discussed in the previous section. In addition, we use the following control variables as explanatory variables:

- **GDP** = log of the gross domestic product of a country (US \$).
- **POP** = log of the population of a country.
- **EU** = 1 if a country is the member of EU, 0 otherwise.
- **DMY91..DMY95** = 1 for the years 1991-1995, 0 otherwise.
- **CPI** = Consumer Price Index (1987=100).

The gross domestic product (GDP) is used for describing the wealth of a country. Richer countries have greater financial resources to provide with universal service: 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.

The variable POP controls for the size of a country in terms of the number of its inhabitants. It is used for capturing heterogeneity of countries in their costs of building and maintaining telecommunications networks or in their costs of providing universal service in telecommunications. The variable EU distinguishes the European Union member countries - which have a joint telecommunications regulation framework determined by EU legislation and regulation - from other European countries. 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 variable describing consumer price index (CPI) is used as an explanatory variable in the price equations for capturing changes in the level of consumer prices in general.

Table 1 outlines descriptive statistics, mean values and their standard deviations, with regard to our dependent and independent variables. We may note that, generally, the markets for cellular telephone services were more open and more advanced in their privatisation than the markets for local telephone services in Europe during the period of 1990-1995. National regulation of European telecommunications markets during that period typically took place under a government. About 94 % of the observations concern telecommunication markets where operational and regulatory tasks are separated – i.e. 6 % is still operator-regulated - but only about 15 % of them relate to telecommunications markets with independent national regulatory authorities.

Before presenting the estimation results, we briefly introduce the estimated econometric model.

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<sup>9</sup> 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.

**Econometric model:** We estimate two models for each dependent variable, the OLS model (see Model 1) and the random effects model<sup>10</sup> (see Model 2) that assumes that the country-specific constant terms are randomly distributed across the countries and estimates a separate random disturbance term,  $u_i$ , for each country. The selection of the proper econometric models was based on the Lagrange Multiplier (LM) test (See Tables 2-6 for the results of the LM-tests)<sup>11</sup>. The estimated models can be written as follows:

$$Y_t = \alpha_1 + \beta_1 GDP_t + \beta_2 POP_t + \beta_3 EU_t + \beta_4 STATEOWN_t + \beta_5 FOROWN_t \\ + \beta_6 COMP_t + \beta_7 REGU1_t + \beta_8 REGU2_t + \beta_9 CPI_t \times I + \sum_{i=10}^{14} \beta_i DMY91..95, \quad (\text{Model 1})$$

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

$$Y_t = \alpha_1 + \beta_1 GDP_t + \beta_2 POP_t + \beta_3 EU_t + \beta_4 STATEOWN_t + \beta_5 FOROWN_t \\ + \beta_6 COMP_t + \beta_7 REGU1_t + \beta_8 REGU2_t + \beta_9 CPI_t \times I + \sum_{i=10}^{14} \beta_i DMY91..95, \quad (\text{Model 2})$$

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  $E[v_{it}v_{js}] = 0 \quad \forall t, s \text{ if } i \neq j$ .

$Y_t$  = dependent variable measuring the performance of the telecommunications sector at time t (i.e. TELEP/CELLU<sub>t</sub>/PLOC<sub>t</sub>/RESSP<sub>t</sub>/BUSSP<sub>t</sub>/RESMP<sub>t</sub>/BUSMP<sub>t</sub>/ WAIT<sub>t</sub>).

<sup>10</sup> 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.

<sup>11</sup> 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. The Lagrange multiplier test is based on the OLS residuals and it tests 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):

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

The next section will present the estimation results of the above econometric models that explore the relationship between regulatory reform and universal service provision among the telecommunications markets of 22 European countries.

#### **4. The impacts of regulatory reform on universal service provision: estimation results**

This section will discuss the impacts of regulatory reform on universal service provision in the European telecommunications markets in light of the empirical evidence provided by our database. It will present the estimation results of the econometric models and, on that basis, discuss the implications of privatisation, liberalisation and different regulatory authorities in the telecommunications markets for the penetration rates, prices and quality of telecommunications services.

Tables 3-6 show the results of the estimated econometric models. The estimation results with regard to the variable GDP indicate that, as expected, richer European countries are more successful than poorer countries in providing universal telecommunications service. Clearly, both the penetration rates of fixed and mobile telecommunications services and the quality of telecommunications services (measured by the number of unmet applications for fixed network connections) are higher in rich countries. Also, richer European countries provide better availability of public pay phones than poorer ones do. Flat-rate telecommunications service prices - subscription and monthly access prices both for residential and business customers - are also, as we expected, higher in richer European countries.

The estimated coefficients on the variable POP show that universal service provision in terms of penetration rates and quality of telecommunications services is notably more difficult in largely populated countries. A higher number of inhabitants

indicates lower penetration rates of both fixed and mobile telecommunications services and fewer public pay phones per population. Also, waiting lists for fixed telecommunications network connections are longer in bigger countries. On the other hand, it seems that large markets exhibit economies of scale in telecommunications service provision, which is reflected in the flat-rate service prices. In particular, residential subscription prices and both residential and business monthly access prices to fixed telephone networks are clearly lower in countries with higher numbers of inhabitants.

The member countries of the European Union seem to differ to some extent provision from the other European countries with regard to their universal telecommunications service. The penetration rates of both fixed telephone lines and cellular telephone services are distinctly higher in the EU countries than in other European countries. It appears that residential subscription prices of fixed telephone services do not differ markedly between the EU and non-EU countries but business customers, instead, have cheaper access to telecommunications networks in the EU countries than elsewhere in Europe. Also, it seems that telecommunications operators in the EU countries charge residential customers, on an average, higher monthly access prices than operators in the non-EU countries do. We find no statistically significant difference in either the availability of public pay phones or the number of unmet applications for fixed network connections between the EU and non-EU countries.

We were not able to estimate coefficients for the variable DMY95 and, consequently, our data comprises estimates only for the time dummies DMY91..DMY94. The estimated coefficients of the time dummies are positive and statistically significant in the estimated equations with regard to the penetration rates

of fixed telephone lines and cellular telephones services. This result indicates that the first half of the 1990s has been a period of vigorous telecommunications service network expansion in the European telecommunications markets. The estimated coefficients of the time dummies are not statistically significant in the equations describing telecommunications service prices and quality.

We will next discuss the estimation results with regard to the variables describing various telecommunications policy factors. First, we consider the estimated impacts of privatisation on universal service provision in the European telecommunications markets. Our data do not suggest clear differences in most of the considered factors of universal telecommunications service provision between markets where telecommunication operators are state-owned and those with privately owned operators. We have two statistically significant findings concerning the relationship between state ownership and universal service provision in telecommunications. The first finding relates to the monthly telecommunications access prices for residential customers: it seems that state-owned telecommunications companies charge lower residential monthly subscription prices than privately owned companies do. This result may indicate that residential subscription prices are to some extent subsidised by other telecommunications services when the telecommunications operator is state-owned. Secondly, our data suggest that state ownership in the telecommunications markets is related to higher penetration rates of public pay phones. In this respect, state-owned telecommunications operators seem to better reach their universal service obligation than the privately owned ones.

Our estimation results indicate that opening up telecommunications markets to foreign investors provides additional capital to these markets, which enhances universal service provision to some extent. The allowance of foreign ownership seems

to facilitate the penetration of fixed telephone lines and increase the availability of public pay phones in the European markets. It does not, however, have any statistically significant effect on the diffusion of cellular telephones. We do not find much evidence that the expertise of foreign investors would increase the technical efficiency of telecommunications operator(s) and, therefore, decrease telecommunications service prices. Only residential monthly prices are notably lower when the local telecommunications market is open to foreign investors than they would otherwise be. Prices of local calls are not statistically significantly related to the allowance of foreign ownership. On the other hand, the subscription prices for fixed telephone network access - both for residential and business customers - are distinctly higher in local telecommunications markets that are open to foreign investors. This finding may indicate – given that the allowance of foreign ownership led to actual foreign investments in the national telecommunications markets - that foreign investors seek high profit margins and do not benefit consumers by lowering telecommunications service prices. It may also be related to tariff re-balancing - that in general increases the prices of network connection and local calls and decreases the prices of long-distance and international calls - which is more advanced in countries that also lead other countries in opening up their telecommunications markets. The relationship between the variables describing the allowance of foreign ownership and the number of unmet applications for fixed network connections is not statistically significant.

The estimation results with regard to the variables describing the allowance of competition in the telecommunications markets appear to be largely in accordance with our expectations. The variable COMP is statistically significantly related to neither the penetration rates of fixed telephone lines nor the availability of public pay

phones. Instead, opening up cellular telephone markets to competition seems to remarkably facilitate the diffusion of cellular telephones. Opening up markets to competition has not led, on an average, to remarkably different flat-rate service prices in the European telecommunications markets. Only monthly business access prices are notably higher in competitive markets than they would otherwise be. The prices of local telephone calls are clearly lower in competitive local telecommunications markets than in monopolistic markets. This result is contrary to our expectation of the impacts of tariff re-balancing in competitive telecommunications service markets. Rather, it supports traditional economic theory suggesting that monopoly operators in the local telecommunications markets abuse their market power in telecommunications service pricing. Moreover, this result indicates that even if the local telecommunications markets lack effective competition, the mere threat of market entrant(s) remarkably affects the market behaviour of incumbent operators, lowering telecommunications service prices. This finding is further supported by the negative and statistically significant coefficient on the variable COMPL explaining the number of unmet applications for basic network connections. It thus seems that competition in telecommunications markets also has a positive impact on the quality of telecommunications services.

It seems quite plausible that the estimation results with regard to the diffusion of mobile telephones and service quality in terms of the number of unmet applications for fixed telephone network connections are related to one another. The allowance of competition in local markets means that cellular service providers may compete with the supplier(s) of the fixed network connection. Then, especially when the waiting list for a fixed telephone network connection is long, it seems probable that mobile telephones substitute to some extent demand for fixed telephone lines. Consequently,

our evidence of higher quality of communications services in competitive local markets may be related more to the actions of the suppliers of cellular network connection (i.e. to their market entrance) than to the market behaviour of incumbent local telecommunication operators providing access to the fixed telephone network.

In summary, our estimation results suggest that the fear of the negative influence of competition on universal service provision - expressed especially by various monopoly operators in European telecommunications markets during the ongoing regulatory reform (see, e.g., OECD, 1993) - is groundless. Our empirical findings indicate that competition in telecommunications markets enhances universal telecommunications service provision.

The mere separation of operational and regulatory tasks in the European telecommunications markets seems to have a statistically significant impact on neither the penetration rates nor prices of telecommunications services. The variable REGU1 is, however, negatively and statistically significantly related to the variable WAIT: the separation of operational and regulatory functions in telecommunications markets seems to provide higher service quality.

We find some clear differences in universal service provision between telecommunications markets that are regulated by independent regulatory authorities and government-regulated telecommunications markets. First, it seems apparent that the presence of an independent regulatory agency facilitates the diffusion of mobile telephones in European telecommunications markets. This finding indicates that the regulatory environment under governmental telecommunications policy decisions is not as favourable to the diffusion of innovative communications services as that established by an independent regulatory agency. The presence of an independent regulatory agency seems to further improve universal service provision in that it is

related to higher penetration rates of public pay phones among the sampled countries. These findings support the regulatory capture theory, suggesting that the quantities of provided services are higher when the regulatory agency is independent from the political decision-making process.

Prices of local calls are higher when the markets are regulated by independent regulatory agencies than they would otherwise be. This finding is probably related to tariff re-balancing in the telecommunications markets. Telecommunications markets under an independent regulator seem to provide to some extent more cost oriented service prices. However, flat-rate charges for a fixed network connection are not statistically significantly related to the variable REGU2. Nor we find evidence that those telecommunications markets regulated by an independent regulator agency would provide higher service quality than government regulated markets.

The next section will summarise and concisely discuss our estimation results with regard to universal service provision in the European telecommunications markets.

## **5. Conclusions**

It appears that the most influential policy approach affecting universal service provision in European telecommunications markets has been the allowance of competition. Our data suggest that opening up the telecommunications market to competition has had various positive impacts on universal service in telecommunications in Europe. Competition seems to facilitate the diffusion of cellular telephones. Also, the quality of services is higher in competitive local telecommunications markets in that the waiting list for a connection to the fixed telephone network is notably shorter and prices of local calls are clearly lower.

The allowance of foreign ownership in telecommunications markets seems to further strengthen the positive market impacts from competition, since it has clear positive implications for the penetration rates of fixed telephone lines and to the availability of public pay phones. However, it seems that the prices charged for a fixed network connection are higher in countries that allow foreign ownership in their local telecommunications markets. As suggested above, this finding may be related at least to two factors, i.e. to foreign investors seeking high profit margins or to tariff re-balancing that is more advanced in countries that lead other countries in opening up their telecommunications markets. Unfortunately, we do not have data on prices of long-distance and international calls to further investigate the relationship between regulatory reform and tariff re-balancing in the telecommunications sector.

Privately owned telecommunications companies may not have more incentives to provide universal service in telecommunications than state-owned operators have. On contrary, our data suggest that the availability of public pay phones is lower in privatised telecommunications markets than it is in state-owned markets. Generally, it seems that who regulates the telecommunications sector at the national level, particularly whether or not the telecommunications market is regulated by independent regulatory agency, is more important than whether telecommunications companies in European telecommunications markets are privately or publicly owned.

The separation of operational and regulatory tasks in telecommunications markets seems to be related to higher telecommunications service quality: the waiting lists for fixed network connections are longer when the operator regulates the market itself than they would otherwise be. This result should, however, be interpreted with caution, since our database comprises only one measure of service quality, i.e. the number of unmet applications for fixed network connections. A more profound

applied investigation with various different measures of telecommunications service quality is needed to explore the relationship between regulatory reform and service quality in the telecommunications markets.

Our data do not suggest that the mere separation of telecommunications regulation from operation would provide any other remarkable benefits in terms of universal service provision in telecommunications than those related to service quality. Instead, the presence of an independent regulatory agency seems to be of fundamental importance in affecting universal service provision in many respects. Particularly, the presence of an independent national regulatory authority in European telecommunications markets seems to create a market environment that facilitates greater diffusion of mobile telephones than governmental regulation. Also, those European telecommunications markets regulated by an independent regulatory authority provide higher penetration rates of pay phones. Furthermore, the presence of an independent regulatory authority seems to be, to some extent, related to a degree of tariff restructuring in the telecommunication sector: government regulated markets seem to provide lower (i.e. less cost-oriented) prices of local calls than markets regulated by independent regulatory agencies.

Our empirical findings indicate that the separation of operational and regulatory functions has a positive impact on universal service quality in European telecommunications markets. However, our estimation results emphasise to a greater extent the importance of an independent national regulatory authority to universal service provision in telecommunications. The empirical results of this study suggest that European countries that regulate their national telecommunications markets under a ministry might remarkably benefit from the establishment of an independent national regulatory authority in their telecommunications market.

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**Annex 1. List of countries****EU countries:**

Austria (since 1995)  
Belgium  
Denmark  
Finland (since 1995)  
France  
Germany  
Greece  
Ireland  
Italy  
Netherlands  
Portugal  
Spain  
Sweden (since 1995)  
United Kingdom

**Non-EU countries:**

Bulgaria  
Estonia  
Hungary  
Lithuania  
Norway  
Poland  
Romania  
Switzerland

Table 2. Descriptive statistics

Variable	Mean (Std.Dev.)	
TELEP	-12.59736	(1.13231)
CELLU	-5.81249	(4.53730)
PAY PHONE	-5.99512	(0.68142)
PLOC	-2.10552	(0.47279)
RESSP	4.93059	(0.73475)
BUSSP	5.31266	(0.80643)
RESMP	2.04222	(0.75240)
BUSMP	2.42935	(0.51673)
WAIT	6.82904	(7.27779)
GDP	26.23994	(1.25401)
POP	16.55739	(1.06084)
STATE OWN	0.74123	(0.40430)
OWNL	0.67692	(0.47129)
OWNC	0.29231	(0.45836)
FOR OWN	0.39600	(0.47822)
FOWNL	0.38462	(0.49029)
FOWNC	0.67692	(0.47129)
COMP	0.18277	(0.37367)
COMPL	0.21538	(0.41429)
COMPC	0.49231	(0.50383)
REGU1	0.93846	(0.24219)
REGU2	0.15385	(0.36361)
LCPI	5.10247	(1.01635)
EU	0.69231	(0.46513)

Table 2. The estimates of the random effects models for the penetration rates of main lines per 100 persons and cellular phones and the OLS model for the penetration rate of public pay phones

Variable	LHS = TELEP	LHS = CELLUP	LHS = PAY PHONE
Constant	4.41952 (0.990207)	-1.29071 (3.51779)	-7.57805 (1.31844)
GDP	0.116786 (0.028156)	0.531385 (0.087567)	0.166366 (0.081148)
POP	-0.257318 (0.064521)	-1.166745 (0.231870)	-0.229401 (0.082854)
EU	0.401910 (0.128150)	1.65585 (0.459811)	0.00888 (0.161301)
STATE OWN/ C=OWNC	0.068884 (0.040419)	0.026470 (0.511050) <sup>c</sup>	1.06557 (0.225690)
FOR OWN/ C=FOWNC	0.250956 (0.125347)	-0.33957 (0.297079) <sup>c</sup>	0.769119 (0.200040)
COMP/ C=COMPC	-0.015964 (0.062361)	0.502048 (0.184041) <sup>c</sup>	-0.007195 (0.256022)
REGU1	-0.085486 (0.056518)	-0.209060 (0.236759)	-0.148463 (0.233048)
REGU2	-0.010010 (0.046205)	2.63292 (0.687155)	0.850992 (0.217386)
DMY91	0.044330 (0.015974)	0.340945 (0.131724)	0.047786 (0.168823)
DMY92	0.089796 (0.016528)	0.494177 (0.150373)	-0.071107 (0.173541)
DMY93	0.144633 (0.016754)	0.861855 (0.146641)	0.059497 (0.177437)
DMY94	0.194172 (0.016969)	1.43539 (0.151631)	0.137933 (0.180189)
Nobs	105	71	99
R <sup>2</sup>	0.55	0.59	0.48
LM-test	32.54*	45.43*	1.19*

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.

Table 3. The estimates of the OLS model for the prices of local calls

Variable	LHS=PLOC
Constant	3.89146 (5.90813)
GDP	0.170022 (0.257770)
POP	-0.190478 (0.276804)
EU	0.101797 (0.196121)
OWNL	-0.038527 (0.193456)
FOWNL	-0.006785 (0.203202)
COMPL	-0.507367 (0.210024)
REGU1	-0.024119 (0.191565)
REGU2	0.381278 (0.189248)
LCPI	-1.56976 (0.805769)
DMY91	0.177358 (0.166413)
DMY92	0.252770 (0.187974)
DMY93	0.268892 (0.189520)
DMY94	0.327290 (0.207669)
Nobs	70
R <sup>2</sup>	0.38
LM-test	4.08*

Note: Standard errors for the coefficient estimates are in parentheses.

\* = Favours the OLS model to the random effects model at the 0.05 level of significance.

Table 4. The estimates of the OLS models and the random effects models for residential and business subscription prices

Variable	LHS=RESSP	LHS=BUSSP
Model	The OLS model	The random effect model
Constant	5.02085 (1.53770)	7.99984 (2.52082)
GDP	0.363279 (0.094672)	0.167461 (0.133690)
POP	-0.748539 (0.122257)	-0.484360 (0.208332)
EU	0.213840 (0.165756)	-0.417637 (0.328173)
OWNL	-0.077572 (0.196616)	-0.093398 (0.125633)
FOWNL	0.726136 (0.202144)	0.738717 (0.298224)
COMPL	-0.214127 (0.247092)	-0.124828 (0.174736)
REGU1	0.349175 (0.236272)	0.183775 (0.177728)
REGU2	0.276673 (0.219694)	0.054844 (0.142178)
CPI	0.464979 (0.106642)	0.142969 (0.115695)
DMY91	-0.133747 (0.175747)	-0.009692 (0.059830)
DMY92	-0.262009 (0.180383)	-0.003363 (0.063362)
DMY93	-0.354660 (0.184971)	-0.094050 (0.064897)
DMY94	-0.347910 (0.186421)	-0.164684 (0.071112)
Nobs	93	86
R <sup>2</sup>	0.50	0.41
LM-test	0.11**	15.00*

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 effects model at the 0.01 level of significance.

Table 5. The estimates of the OLS models and the random effect models for residential and monthly business prices

Variable	LHS=RESMP	LHS=BUSMP
Model	The OLS model	The random effect model
Constant	-0.047464 (0.941443)	-1.54655 (1.58859)
GDP	0.520330 (0.064262)	0.559527 (0.090228)
POP	-0.668268 (0.078907)	-0.672493 (0.135460)
EU	0.368422 (0.096367)	0.156636 (0.204216)
OWNL	-0.293470 (0.116558)	-0.021884 (0.108121)
FOWNL	-0.447704 (0.119892)	0.242333 (0.192632)
COMPL	-0.141523 (0.145381)	0.090959 (0.146291)
REGU1	-0.174642 (0.136163)	0.125436 (0.146647)
REGU2	0.158569 (0.128047)	0.001577 (0.117963)
CPI	0.000463 (0.061903)	0.049350 (0.080216)
DMY91	-0.007802 (0.104283)	0.008881 (0.057055)
DMY92	0.037865 (0.106349)	-0.062764 (0.059116)
DMY93	0.020213 (0.109091)	0.031609 (0.060324)
DMY94	0.0052023 (0.109427)	-0.021004 (1.58859)
Nobs	89	83
R <sup>2</sup>	0.68	0.54
LM-test	5.76**	8.10*

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 effects model at the 0.05 level of significance.

Table 6. The estimates of the OLS model for the quality of telecom services: waiting list for main lines

Variable	LHS=WAIT
Constant	47.7950 (14.1692)
GDP	-4.77583 (0.707132)
POP	5.19995 (0.872065)
EU	1.18887 (1.57697)
OWNL	1.67764 (1.78334)
FOWNL	-1.81579 (1.64832)
COMPL	-4.69380 (2.01829)
REGU1	-4.92425 (2.29413)
REGU2	0.008612 (1.93700)
DMY91	-0.217910 (1.70080)
DMY92	0.943108 (1.74613)
DMY93	0.657430 (1.78055)
DMY94	0.653903 (1.79928)
Nobs	92
R <sup>2</sup>	0.58
LM-test	3.40*

Note: Standard errors for the coefficient estimates are in parentheses.

\* = Favours the OLS model to the random effects model at the 0.01 level of significance.



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