

# Policy Reforms in the Telecommunication Industry and Consumers: Empirical Evidence for 15 EU Countries

Emanuele Bacchiocchi<sup>1</sup>

Department of Economics, Business and Statistics, University of Milan

Massimo Florio

Department of Economics, Business and Statistics, University of Milan

Marco Gambaro

Department of Economics, Business and Statistics, University of Milan

4 June 2007

*Abstract:* The aim of the present paper is to study the impact on consumers of privatization and other policy reforms in the telecommunication sector for 15 EU Countries. Particular attention has been paid to the effect of industry changes, as summarized by OECD regulatory indicators, on productivity and prices and, in a second step, on the consumers' satisfaction about quality and prices of the telecommunication service. As a first result, the analysis confirms the importance of market entry regulation in reducing prices and increasing productivity performances, but minimize the role played by privatization per se. The latter and liberalization of the telecommunication market play a role in explaining the consumers' satisfaction about prices and quality of the service, but country fixed effects are more important. Overall, our findings offer only mixed evidence, and somehow contradict, the hypothesis of welfare dominance of a unique reform paradigm in the telecom industry.

Keywords: telecom industry reforms, privatization, impact on European consumers

JEL codes: L32,L33,L96

*Acknowledgments.* We are grateful to Carlo Fiorio for helpful comments, and to Raffaele Doronzo and Giancarlo Manzi for very competent research assistance. The research project has been financed by the 6<sup>th</sup> Framework Programme of the European Union: "Understanding Privatization Policy: Political Economy and Welfare Effects", lead by FEEM.

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<sup>1</sup> Corresponding author: Dipartimento di Scienze Economiche Aziendali e Statistiche – Via Conservatorio 7 – 20122 Milano. Email: emanuele.bacchiocchi@unimi.it

## 1. INTRODUCTION

The telecom sector is not just one of the network industries that experienced a policy paradigm shift over the last twenty years: it has been its core laboratory world-wide, and the one where the reforms started earlier. If one had to pick up a single year as the turning point, 1984 would be the most convenient, with the parallel divestiture of AT&T in the US and of British Telecom in the UK. The meaning of divestiture was however quite different across the two sides of the Atlantic. AT&T was a private regulated monopolist that was broken up in seven regional Bell operating companies. BT was a public corporation, that after privatization was under a regime of regulated duopoly along with another privatized operator, Mercury. In both cases, institutional change, away from regulated and integrated monopoly in the US, and from integrated public monopoly in the UK, were motivated by a willingness to establish competition. Ideological and political shifts under Reagan and Thatcher governments also played a role, and the influence of financial and industrial lobbies. It has been widely acknowledged that to ensure an effective transition to a competitive market, however, divestiture policies need to be accompanied by regulatory reforms. The simple change of the ownership structures, from public to private, in fact, is not sufficient for the market to become effectively opened, breaking up the monopolies, and guaranteeing better conditions for private investors to enter the market. In most countries, governments surrendered their powers to National Regulatory Authorities, with the aim of overseeing and regulating the interactions between incumbents and entrant firms (see Edwards and Waverman, 2006), protecting the consumers, ensure adequate infrastructure investments. The courts were also involved in various ways.

At the same time, a dramatic process of technological change reshaped the industry, and regulators, law-makers had to frequently adjust their views because of entirely new developments.

Some international organizations, notably the OECD, see Conway and Nicoletti (2006), or the Copenhagen Economics (2005), have identified an ideal reform paradigm and tried to measure the progress of countries toward its full implementation. This has been translated into 'regulatory indicators' (OECD) and 'market opening milestones' (European Commission, 2005). Both are policy ratings, based on a number of specific country data, such as the share of public enterprises over the industry turnover, the market share of entrants, the year of establishment of an independent regulator, etc. These indicators are then aggregated in some way and the country is then evaluated as having made a fair or insufficient progress toward the achievement of the overarching policy objective of establishing the industry reform paradigm.

In this paper we want to test whether the reform progress, as measured by summary regulatory indicators, is correlated with benefits to the consumers. After all the final evaluation of the reforms should be based on testing what it delivers to the users of the service, and this is our research motivation. Ideally one would look to detailed case histories, considering long time series (Florio, 2003; and Florio and Puglisi, 2006 do this for BT over forty years). A complementary approach would be to consider cross-country evidence. Under the latter perspective, the EU offers something near to a natural experiment. On one side, there is one policy actor, the European Commission, who pushes towards one reform paradigm, as embodied in telecom directives; on the other sides there are the Member States that, while more or less in compliance with the EU legislation, show big differences in reform design, sequencing, timing, market structures. Another attractive aspect of a cross-country empirical study is that, differently from other network industries, such as electricity, countries are not exogenously constrained in technology adoption by intrinsic geographic characteristics. This allows us to focus on ownership, institutions, competition, and other industry features.

In this paper we focus on prices and productivity trends in the EU-15 (i.e. before accession in 2004 and 2007 of mostly transition countries), and consumers satisfaction with prices and quality of fixed telephone service. A similar study in this context has been conducted by the Copenhagen

Economics (2005) for the European Commission. In our study, however, we use different data sources in order to enlarge the dataset and increase the number of observation. Moreover, we also investigate the impact on the other prices borne by consumers, such as monthly telephone subscription and connection charge. Furthermore, differently from this study, we use the REGREF indicators for market regulation, as proposed by the OECD. For customers' satisfaction we use three waves of the Eurobarometer survey (2000-2002-2004), while for prices and other industry features we use Eurostat and Itu data.

Our main findings offer only mixed support to the telecom reform paradigm. Privatization, while it seems to be correlated with higher consumers' satisfaction, is rejected as a determinant of the price they pay. Regulatory variables do not play any role in consumers' satisfaction with quality. Their impact on productivity is modest, while in turn productivity change has a substantial impact on prices, along with entry conditions. These findings suggest that first, the available summary reform indicators, and the comparable statistical information on the telecom industry, does not offer an adequate evidence for cross-country policy evaluation. Thus, as far as we can see, the EU law-makers and regulators are in fact relying more on conjectures and fragmentary evidence than on tested and verifiable empirical models. Second, while some of the estimation results confirm the positive role of competition, other empirical findings contradict some of the mainstream prescriptions. As a consequence, the main message of the paper is that, while further research is needed on the impact of reforms, any strong claim that the standard telecom reform package, including privatization, unbundling, incentive regulation, liberalization, is always beneficial to consumers should be dismissed. Our results suggest that there is scope for a lot of welfare-improving national variations. What is probably good somewhere, is not necessarily good elsewhere. Giving policy ratings to countries, as if there were just one avenue to welfare improving reforms, seems to be far from evidence-based diagnosis and therapy.

The structure of the paper is the following one. The next section presents our research motivation; we move then to an overview of telecom reforms in the EU; section 4 presents our data sources and some descriptive statistics; section 5 is about modelling price and productive dynamics; section 6 offers probit estimation of consumer satisfaction with prices and quality; the last section concludes with suggestions for further research and policy implications.

## 2. RESEARCH MOTIVATION

According to Laffont and Tirole (2000), before the 1980s the telecom industry was almost everywhere considered a natural monopoly because of large fixed costs. Consequently, governments did not allow competition, that was considered wasteful, and in most countries the industry was either nationalized or, as in the US, a private monopoly under strict regulation. The latter was in the form of cost-plus pricing rules, with wide scope for cross-subsidies. Basically, the business users' tariffs had a high mark up to allow for long-run marginal cost pricing rules applied to residential users; international and long-distance national paid for losses in the local calls segment of the business; accession charges were low and uniform, to offer universal access to rural users, and so on. These pricing rules distorted incentives for allocative and productive efficiency. Consequently the level and structure of prices were 'wrong'. This picture was said to motivate divestiture of incumbents, incentive regulation (meaning the use of price caps instead of rate-of-return), and liberalization. At the same time, there was the perception that new technologies, particularly the diffusion of microwave communication, could weaken the traditional case for natural monopoly.

The new paradigm that emerged was in favour of breaking up the incumbent, privatizing it when a

public corporation, or otherwise force it to divest part of its capacity in favour of entrants or force them to allow access to competitors to their networks, establish independent regulators to administer new licenses and design price caps, enhance competition everywhere. In some more extreme views, after a transition period under asymmetric regulation to protect entrants, full liberalization could be applied, and sector regulator abolished, surrendering their residual powers to generic competition offices.

Along this line of thinking, some international organizations, such as the World Bank and the OECD, and the EC (with some variations among them), started to build something as a consensus telecom reform package, and advised governments everywhere to apply it. For example, the OECD and the EC started to define regulatory indicators and reform milestones, and to evaluate governments as frontrunners or laggards in implementing the policy changes. Minority views, often coming from within the industry, e.g. Harper (1997), who had reservation about full privatization and liberalization because of technological arguments were dismissed without much consideration.

With the benefit of hindsight, twenty years on, we can see that the reform approach was often based on strong assumptions and an over-simplification of a much complex story. The newly established regulators, the courts, governments, and managers, had to learn a lot from real world evolution, and there were a number of unexpected evolutions.

There are three issues that we want to emphasize here to motivate our research interest in testing the reform paradigm instead of just assuming it: technology, ownership, and regulatory issues.

The traditional technology of the industry was based on first, switching, second, transmission capacity, third network software.

Switching basically shifted from analogical codes to digital ones before reform, in the 1970s and early 1980s, and the change in general was successfully managed by state-owned companies in Europe (Millward, 2005), who were able to self finance the necessary investment. The continuous digital technological progress world-wide was such that productivity increase was fast almost everywhere. The number of lines per employee, or per unit of invested capital, increased dramatically under public monopoly. For example, Telecom Italia, a listed public corporation with the Italian Treasury as the majority stakeholder, in 1997 was the best in Europe as for switched lines per employee; for British Telecom, productivity trends were higher in the two decades before divestiture than after it (Florio, 2003, 2007). This was linked to high growth of demand and high in-house research. While the integration between incumbent operating companies and their technology suppliers (for instance between AT&T and Bell laboratories) was widely criticized as anti-competitive, the internalization of R&D was in fact high under monopoly, for a well known Schumpeterian argument (Sterlacchini, 2006 observes that the divested telecoms are now investing in research much less than they used to do<sup>2</sup>).

Moreover, while it is not self-evident that divestiture was needed to foster the adoption of the digital technology opportunities, the case for the decline of natural monopoly in transmission was even more exaggerated. The expectation in the mid 1980s was that microwaves would imply much less sunk cost than wires, i.e. the traditional twisted pair of copper wires. In fact, cellular telephony boomed, and offered the welcome opportunity of mobility to users. However, it was soon realized that the key issue here was the interconnection of wireless and wired transmission, with the former shifting to new systems of data compression, such as asymmetric digital subscriber lines, or of transmission hardware, as optical fibre. To the surprise of many (including the US regulators), the fixed line transmission under the new technologies was much more effective in carrying advanced services, including data and images, so that the Internet revolution happened through the wired transmission, and only to a limited extent, until quite recently, through the wireless. This evolution re-establishes a core natural monopoly element in the industry. The third factor, the evolution of

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<sup>2</sup> According to Sterlacchini (2006) the drop in R&D between 2000 and 2005 was 57% for Deutsche Telekom, 18% for Telefonica, 20% for BT, 12% for Telecom Italia, while France Telecom increased its R&D expenditure by 27%.

advanced software to optimize signalling, combined with the new role of networks, in a sense reinforces the case for decreasing average costs.

These trends pose a number of difficult problems to regulators. While type of services increased, and the distinction between the telecoms, the media industry, and other activities becomes blurred, there was a multiplication of networks. Providers of electricity, water, gas, railways, highways, cable television are all possible network investors, but to invest they need mutual access, and some stability of revenues. Moreover, the local loop, i.e. the final connection of the fixed line with the user, is still the crucial bottleneck, because the possibility to offer competing physical connections to the end user is out of question. Thus liberalization, i.e. allowing the entry of a plurality of players, is far from decreasing the role of regulators, because they should try and find solution to complex two-ways access between networks. The trade-offs arising in this context are huge. The entry in the local market can happen in different ways, through facility-based entry, resale of services, unbundling. Each of the solutions has costs and benefits, and in some case promoting competition, paradoxically, can be expensive, and it is not clear its final impact on prices, because in a sense competition can be rather artificial, because it is supported by heavy-handed regulation. Establishing access pricing in this context gives the regulators extremely wide power, they literally can decide about long term profits and losses of specific companies, and in some cases one can think that we are full circle, to a sort of implicit rate of return regulation, when network owners have to show their 'costs', under a number of possible accounting definitions.

A rather premature announcement of the death of natural monopoly and of public regulatory powers, sheds new light on the issue of ownership rights. While only minority views support re-nationalization of the industry (a vague concept in fact), public ownership of some parts of the networks is no more as out of question as it used be. The EU is neutral on this point, and asks for 'separation' of the network for operations, and a regulation that offers access to everybody. In fact, France and Germany are reluctant to sell their control shares in the incumbents. BT has been forced to establish a separate manager for the network, with a special equality of access board, and more than 200 binding regulatory undertakings. In Italy, the government has recently given the regulator wide powers on the networks.

To sum up, instead of assuming that one reform model is the right one, it seems sensible to learn from experience and testing the welfare impact of reforms. Ideally we would like to have for each country a set of counter-factual histories, where we compare the 'with'-'without'-'with a different one' reform scenarios, and test the impact on productivity, prices, and social welfare. This is a daunting task. We suggest here a shortcut approach. We exploit country variability in Europe and test empirical models where features of the reforms are among the explanatory variables. In the next section we briefly review some of the reforms in the EU countries we consider.

### 3. THE PROCESS OF LIBERALIZATION: AN OVERVIEW

The transformation of the regulation environment in which European telecommunications industries used to operate has been a complex process led by the Commission that has included several different moves with complementarity between sector specific regulation and competition policy as well as interaction between European institutions and member states.

We can identify a common liberalization path in the EU, with the Commission that strongly pushed to promote competition while several countries resisted and often delayed the implementation of regulatory measures.

During the 1980s, a working group on telecommunications was created and later transformed in DG XIII Information Society. In 1987 the Green Paper instituted a legislative programme that included

full liberalization of the equipment sector and progressive opening of services, in conjunction with harmonized European measures in respect of network access, interoperability and interconnection. In 1990 the market for private networks and leased lines was opened and few years later the same happened for mobile communication.

Other Green Papers, first on satellite communications in 1990 and then on mobile and personal communications in 1994 extended the same regulatory principles in these two areas. In 1996 the Full Competition Directive paved the way to the liberalization of fixed telephony from 1998.

Spain, Portugal, Greece and Luxemburg obtained a delay to implement the Full Competition Directive and adopted new competition policy some years later, while few countries anticipated the Commission pressure and began to open telecommunication market during the 1990s.

UK is the most obvious example of a reform frontrunner, but also Finland, Sweden and in part Denmark adopted a similar approach. UK started its liberalization process ahead of all European Countries. After the decision in 1980 to liberalize its telecommunication sector, the UK government proceeded cautiously, granting only to Mercury (part of Cable&Wireless group, privatized before British Telecom) the right to compete first only in national calls and two years later also on international basis, thus creating a close duopoly. In parallel from 1983 onward cable TV operators were granted the right to use their television network to provide telecommunication services in conjunction with BT or Mercury, and in 1985 two licences to provide mobile services were granted to Racal and to the incumbent BT (OECD 2002). Despite the focus on a more appealing market and the strong protection, Mercury's market share grew slowly and in 1995 it was just 10% of the total revenues. In 1984 BT was privatized, floating on the market 51% of capital previously owned by the state. It was also appointed the sector regulatory authority, Oftel, to be later transformed in Ofcom, with the broadening of the activities to television.

The Duopoly policy was abolished in 1991 and since then UK implemented an increasing number of EU telecommunication directives. Thus, although the UK's telecommunications policy was initially developed independently of other Governments and institutions, it has later been adapted to meet external obligations. However with few exceptions UK has led rather than followed EU liberalization measures. With its pioneering policy, UK opened the telecommunication market 18 years before the majority of European countries and the actors gained a valuable experience both in competing and in regulating.

Removing the legal barriers to market entry and establishing pro-competitive regulation at European level was a crucial step. Moreover in the phase prior to 1998 policy and legal coordination across countries with substantially different starting point in the liberalization process had been achieved (Cawley, 2003). The establishment of EU legislation and translation into member state law was, however, only the beginning of a long process.

At European level the Commission was engaged in follow-up work on checking and enforcing implementation both on the regulatory side and on antitrust decisions.

The 1999 Telecommunication Regulatory Review aimed to bring all communication infrastructures and services into a single framework and to improve co-operation between the Commission and national authorities. The result was a proposal of a decision and five directives that were finally adopted in 2003. Following the idea to move from heavy ex-ante regulation to lighter ex-post antitrust decisions, the three core topics were: authorization, access and interconnection. The framework directive deals with aspects common to all areas and the data protection directive extended the coverage of data protection and privacy measures to internet.

The basis of the regulatory framework was instituted at a time when telecommunication was not the mainstream of European policy (Cawley,2003). However, the year 2000 saw the emergence of European integration as a major item on the European political agenda and the growing competition in telecommunication became part of a broader effort to sustain the diffusion of internet and electronic commerce. The focus was shifted more on content related issue such as security, intellectual property and privacy.

With the liberalization of fixed telephony many newcomers entered the voice market but in each country only a handful of operators gained a significant position and the incumbents loose only very slowly market shares.

Telecommunications are complex systems where different elements interact each other and on the whole exhibit significant network economies. Therefore there is not a single act or passage that opens the market, but a set of measures and a continuous policy carried out both by governments and national authorities that enable new operators to offer competitive services.

The organisation, span of control and independence from the political power of national authorities are a major factor in implementing competition. In recent years the area of interconnection and local loop unbundling have gained importance. And finally the lowering of switching cost, as in number portability, can improve the competitive outcome.

**Table 1: Formal entry and market position**

	Number of mobile operator (1999)	Operators offering long distance calls (1999)	Incumbent market share (1999) %	Incumbent market share (2006) %
Austria	4	20	99	68
Belgium	3	10	NA	
Denmark	4	11	97	
Finland	NA	NA	93	
France	3	31	98	98
Germany	4	47	65	57
Greece	3	NA	100	73
Ireland	2	6	99	63
Italy	4	12	95	71
Luxemburg	2	6	100	NA
Netherlands	5	24	90	75
Portugal	3	NA	100	79
Spain	3	10	93	75
Sweden	4	22	70	
United Kingdom	4	26	72	

elaboration on: European Electronic Communication Regulation and Market Report

Number portability enables subscriber to retain their number when they move from one operator to another. Fixed number portability has continued to play an important role in encouraging competition. In October 2006, 31 million mobile subscribers and 15 million fixed subscribers ported their number since the introduction of this possibility.

Unbundling the local loop refers to a series of regulatory measures aimed at providing access to the incumbent's local network, the less duplicable part of telecommunication infrastructure. A trade off can emerge. On one side the availability of local connection at a controlled price enables new competitors to offer telecommunication service particularly broadband access with DSL technology; on the other side, unbundling could be detrimental to competition by retarding the roll out of competing infrastructure inefficiently (Beranes and Bourreau 2005)

In Europe it may appear that local loop unbundling has failed to give a strong push to competition in market for fixed voice telephony. Competition in fixed voice is still mainly based on carrier selection (that requires less investment) probably because the profitability in this area is too low. Unbundling however has a large potential as a means to offer broadband access to end users for entrants without local networks. Moreover as new technology like VoIP gains ground the intensity of competition in voice telephony can be expected to increase (de Bijl and Peiz, 2005). How far as the European consumer benefited from these changes in the regulatory and market environment?

**Table 2: The limited weight of unbundling**

	PSTN local lines (millions)	Total supply of unbundled lines	Unbundling penetration %
Austria	2.99	117	3.9
Belgium	4.5	93	2.1
Denmark	2.11	136	6.4
Finland	2.73	158	5.8
France	33.83	1584	4.7
Germany	37.5	1628	4.3
Greece	5.6	22	0.4
Ireland	1.59	12	0.8
Italy	26.6	1447	5.4
Luxemburg	0.24	2	0.9
Netherlands	7.8	321	4.2
Portugal	3.99	37	0.9
Spain	16.88	538	3.2
Sweden	5.5	102	1.8
United Kingdom	29.6	238	0.8

European Commission 10th Report, 2004

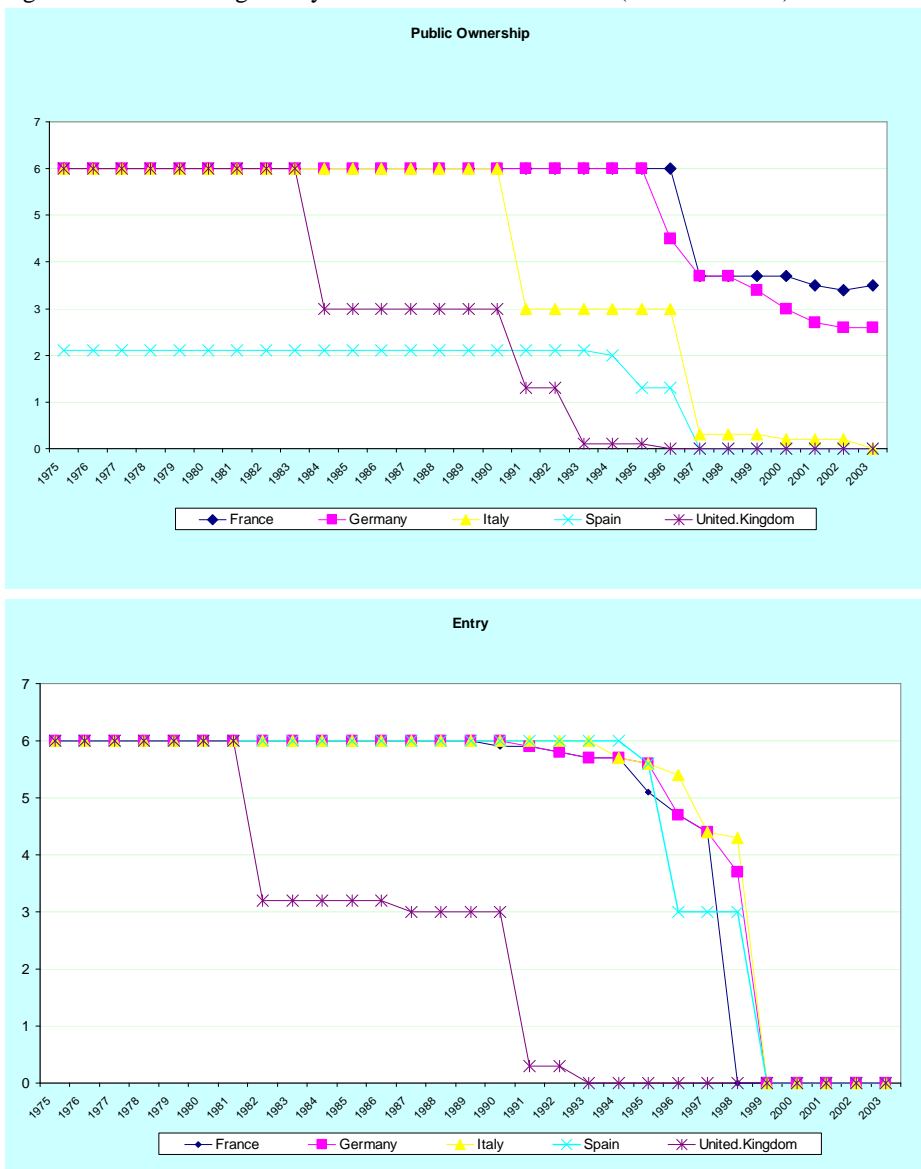
#### 4. DATA AND DESCRIPTIVE STATISTICS

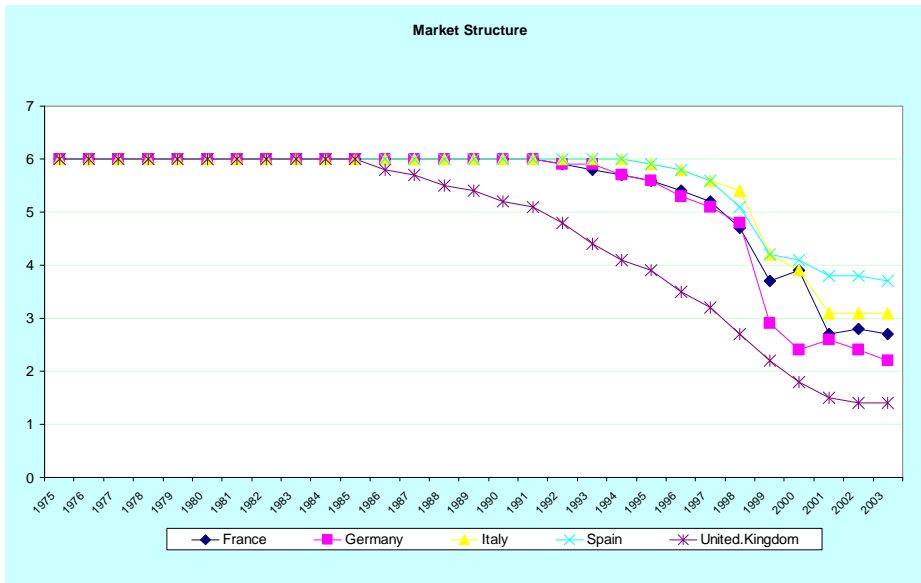
As already mentioned above, the empirical analysis consists in two distinct parts. In the first one we model prices and productivity of the telecommunication sector in order to verify the impact of liberalization process. The investigation concerns the 15 EU Countries for the period 1975-2005, although, due to missing values, the effective sample approximately reduces to the last 15 years. Almost all the information concerning the telecommunication sector comes from the ITU World Telecommunication Indicators (2006) dataset. The database contains time series data, mainly collected from an annual questionnaire sent out by the Telecommunication Development Bureau (BDT) of ITU, for the years 1960, 1965, 1970 and annually from 1975-2005 for around 100 sets of telecommunication/ICT statistics covering telephone network size and dimension, mobile services, quality of service, traffic, staff, tariffs, revenue and investment.

The indicator we use to describe the dynamics of prices is the price of a 3-minute fixed telephone local call (peak rate). We recognize that the choice of local call prices is rather questionable in that the great part of variability in prices is shown in national and international prices. Our choice, however, is based on the fact that, to our knowledge, no comparable long time series for national and international call prices are available for the most part of the EU15 Countries. Short time series for all prices are however available from the Eurostat dataset, and have been used in the consumers' satisfaction analysis. In Table 3, we report local, national and international call prices for 1997, 2001 and 2005, for all EU15 Countries.

Table 3 about here

Figure 1: Trends of regulatory indices across some EU15 (source: OECD)





The policy indicators come from REGREF, an OECD regulatory database (Conway and Nicoletti, 2006) which collects some indicators of privatization, disintegration, liberalization of several services of general interest across some OECD countries. Focussing on the telecommunication market, we use the variable *public ownership*, which measures the degree of public ownership and is coded from 0 (private ownership) to 6 (public ownership), the variable *market structure*, which is an indicator of the market share of new entrants and is coded from 0 to 6 (6 being the smallest market share and 0 being the largest), and the variable *entry regulation*, which is a weighted average of legal conditions of entry in a market and is coded from 0 (free entry) to 6 (franchised to one firm). Although in some cases these variables only take discrete variables, they are allowed to take any value in the 0-6 range and at present the time series starts in 1975 and ends in 2003.

In Figure 1 we report, for some EU countries, the dynamics of the three indicators we use for investigating the impact of deregulation policies on the telecommunication market. From the figure, it is clear that the trend has been, since the beginning of the 1990s, towards a marked reduction of public ownership, a less integrated industry structure and a less regulated access to the market.

The second part of the empirical analysis, instead, concentrates on the relations between consumers' subjective satisfaction, prices of the telecommunication services and market liberalization.

Consumers' subjective satisfaction is measured in the Eurobarometer data set, which collects information about approximately 1,000 people in each European countries in 2000, 2002 and 2004 (for a thorough analysis of the Eurobarometer datasets concerning satisfaction with some services of general interests, see Fiorio et. al., 2007). As the sample reduces to three years, we are able to include in the information set more detailed measures for prices, such as prices for local calls, for national calls and for international calls, together with connection charge and monthly subscription. Such information concerning the price of different calls come from the already mentioned Eurostat dataset, and are available for the period 1998-2005.

## 5. EXPLAINING TELECOMMUNICATION PRODUCTIVITY AND PRICE DYNAMICS

The empirical analysis consists in the specification and estimation of equations for prices,

subscriptions, connection charges, and productivity. Each of these equations includes, among the explanatory variables, aggregate or detailed measures of the level of market opening of the sector.

The econometric model consists of four equations, each of which explains the dynamics of average prices of fixed telephone calls, monthly telephone subscriptions, telephone connection charges and productivity. The analysis has been performed by using dynamic panel data models, where the dynamics mainly concerns lagged dependent variables in order to explain the strong persistence involving both productivity and prices measures.

Let  $p_{it}$  be a measure of telecommunication prices (or productivity) for country  $i$  at time  $t$ ,  $R_{it}$  the vector of regulatory variables for country  $i$  at time  $t$ , which includes entry regulation, public ownership and market structure, and  $X$  a matrix of control variables, we estimate the model:

$$P_{it} = c + R_{it}'\beta + X_{it}'\gamma + \varepsilon_{it} \quad (1)$$

where  $c$ ,  $\beta$ , and  $\gamma$  are parameters to be estimated and  $\varepsilon$  the error term. As the models do include lagged dependent variables, in order to avoid consistency problems, we use the Arellano-Bond estimation procedure. Moreover, as some explanatory variables can not be considered as exogenous, they need to be instrumented in the estimation procedure. As an example, consider the case of the price equation. One of the explanatory variable for the price dynamics is the investment in the telecommunication sector<sup>3</sup>. Especially for the period preceding the denationalization policies, both prices and investments were fixed by the same monopolistic enterprise, making clear the necessity to treat the explanation variable as endogenous.

#### *Prices, monthly subscriptions and connection charges*

We estimate distinct equations for the three components of price for the final consumers. Our choice is based on the fact that, in many cases, an evident decreasing in the price of the service, is followed by a more masked raise of other items (e.g. monthly subscription and connection charge). All the equations, however, have the same structure.

In the first part of the analysis, we include an aggregate indicator of regulatory conditions while the subsequent step is to investigate which, among each single indicators, mainly contribute to explain the dynamics of productivity, prices and the other costs of the telephone bill. We thus repeat the econometric analysis by substituting the aggregate sector indicator with the indicator for the entry regulation, for the amount of the public ownership, and for the market structure, as described above. In Table 4 we report the estimates for different specification of the price equation. As already mentioned, the dependent variable is the price of a 3-minute fixed telephone local call (peak rate). The set of explanatory variables, other than the REGREF measures of the regulatory reforms, also includes control variables such as costs, technological progress and macroeconomic indicators.

Table 4 about here

In the first two equations we simply include an aggregate indicator of the market opening. Both coefficients are positive but when controlling for other variables, the relation between prices and

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<sup>3</sup> On the relationship between regulation and investment see Alesina et al. (2005).

market deregulation becomes significant. In particular, the relation between prices and productivity seems to be strong and extremely robust. Higher productivity contributes at reducing prices<sup>4</sup>. The variable *density*, which is the number of inhabitants per sq. km, can reasonably be considered as a proxy for the costs of building and manage the fixed telephone network. This variable enters with a negative sign and is significantly different from zero.

The other three equations, instead, investigate the effects of each single market condition indicators on prices. The results are quite clear. Once controlled for costs, productivity and other effects, it becomes evident that the effects of liberalization enter only through the market structure. All coefficients are positive but only the one referred to the market structure is significantly different from zero. Instead, the change of the ownership from public to private and the entry conditions do not matter at reducing prices. These results are extremely robust and do not change for all the different specifications.

Table 5 about here

In Table 5 we report the estimation results for different specifications of the telephone connection charge equation. The specifications are very similar to those for prices. The aggregate indicator of the market opening is never significant while, when including the single REGREF indicators, only the market structure, although with a very small magnitude, seems to play a positive role. The technological progress, as expected, enters with a negative sign, while, the number of telephone lines variable enters significantly and with a positive sign. An interesting result concerns the negative and significant relationship between connection charge and local call prices. The third set of equations are related to the residential monthly telephone subscriptions. All the estimates are presented in Table 6.

Table 6 about here

The aggregate indicator of the market opening is never significant, even when controlling for productivity, costs and other effects, but differently from the previous case, neither the single indicators, significantly enter the relation. The local call prices, although weakly, are negatively related to the monthly subscription charge.

### *Productivity*

In this part of the analysis, we specify and estimate the impact of privatization and market liberalization on the productivity performances of the telecommunication sector.

In Table 7 we report the estimated coefficients of four different specifications for the productivity equation. What is extremely clear from the results, is that none of the market opening indicators significantly contributes at explaining the dependent variable. In other words, both privatization and market liberalization do not have any impact on the productivity performances of the telecommunication sector. One possible explanation is that the privatization and liberalization process mainly act in lowering the markup, leaving unchanged the productivity levels.

Table 7 about here

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<sup>4</sup> As we intend to model the effects of market deregulation on productivity, we consider this variable as endogenous and have been instrumented in the estimation procedure.

## 6. CONSUMERS' SATISFACTION WITH TELECOM PRICES

In the previous section we analyzed whether an objective measure of an important element of consumers' welfare, such as the market price they pay for telecommunication, is strongly influenced by regulatory variables and what is the sign of this relationship. In this section we deepen the analysis by investigating whether subjective measures of satisfaction with telecommunication prices and quality are influenced by market reforms and prices.

As satisfaction to different SGI is coded with ordinal variables, analogously to Eurobarometer (2004), we dichotomize consumers' satisfaction, i.e. answers to questions about prices and quality of SGI are classified into "satisfied" and "not satisfied". In particular, the consumer price satisfaction variable  $S$  is recorded equal to 1 if the respondent states that the price he pays for fixed telephone services is fair, and is recorded equal to 0 otherwise. The consumer quality satisfaction variable is recorded equal to 1 if the respondent states that the quality of the fixed telephone services used is very good, and is equal to 0 if the answer is fairly good, fairly bad or very bad.<sup>5</sup>

The analysis has been conducted by using a probit model of the form

$$\Pr(S = 1 | \mathbf{x}) = \Pr(S^* > 0 | \mathbf{x}) = \Pr(e > -\mathbf{x}\boldsymbol{\beta} | \mathbf{x}) = 1 - \Phi(-\mathbf{x}\boldsymbol{\beta}) = \Phi(\mathbf{x}\boldsymbol{\beta}) \equiv p(\mathbf{x}) \quad (2)$$

where  $S^*$  is the unknown exact level of individual satisfaction,  $\mathbf{x}$  is a matrix of regressors,  $\boldsymbol{\beta}$  is the vector of related coefficients,  $e$  is a symmetric and continuously distributed variable independent of  $\mathbf{x}$  and  $\Phi$  is the standard normal cumulative density function. The matrix  $\mathbf{x}$  includes individual characteristics (i.e. sex, occupation) accounting for individual observed heterogeneity, time-varying country macroeconomic variables (i.e. GDP level and rate of growth) accounting for time-varying heterogeneity, a time fixed-effects to capture any time trend and some time-invariant country-fixed effects to capture any country-specific effects.

The partial effect of  $x_j$  on  $p(\mathbf{x})$  depends on  $\mathbf{x}$  through the standard normal density function,  $\phi(\mathbf{x}\boldsymbol{\beta})$ , as  $\partial p(\mathbf{x}) / \partial x_j = \phi(\mathbf{x}\boldsymbol{\beta})\beta_j$ . The average partial effect (APE) for a continuous variable  $x_j$  is:

$$APE_j = \beta_j \frac{1}{n} \sum_{i=1}^n \phi(\mathbf{x}^i \boldsymbol{\beta}) \quad (3)$$

where  $n$  denotes the number of observations, and  $\mathbf{x}^i \boldsymbol{\beta}$  the value of the linear combination of parameters and variables for the  $i$ -th observation. The APE for a dummy variable is:

$$APE_j = \frac{1}{n} \sum_{i=1}^n [\Phi(\mathbf{x}^i \boldsymbol{\beta} | \mathbf{x}_j^i = 1) - \Phi(\mathbf{x}^i \boldsymbol{\beta} | \mathbf{x}_j^i = 0)]$$

which avoids the problem of setting the dummy variable to means.

All estimates to follow present results in terms of APE. As controls,  $\mathbf{x}$ , we used a set of individual characteristics (including sex, age, marital status, age when finished education, occupation, political views, contribution to household income, and household income, respondent's cooperation as

<sup>5</sup> Some readers might be puzzled by the fact that we include among the non-satisfied those who declared that quality of SGI is fairly good, however this is due simply to increase variability. In fact, only about 5% of consumers across services rate quality of SGI as fairly or very bad.

assessed by interviewer), of country fixed-effects, year dummies, some country-level macroeconomic variables (population density, GDP per capita, GDP growth rate, employment growth rate, Gini index) and some regulatory indicators of entry regulation, public ownership, and market structure and vertical integration.

As mentioned above, we include also telecommunication market prices among independent variables of model (2) to verify whether subjective satisfaction depends on actual prices and whether the relationship between subjective satisfaction and regulatory variables is at all driven by the relationship between regulatory variables and market prices.

In Table 8 marginal effects for price (columns A and B) and quality (columns C and D) satisfaction are reported. In columns (A) and (C) no market price is included while in columns (B) and (D) both first differences and levels of prices are included<sup>6</sup>.

Concerning the consumers' satisfaction about prices, the regulation variables appear to be important in explaining the probability of being satisfied with the price of telecommunication service. When prices are not included, the entry variable is statistically significant with a positive coefficient while, including the price variables, market structure and public ownership become significant but with opposite sign. The percentage of the public ownership is negatively related to the probability of being satisfied while for the market structure indicator, when significant, is exactly the opposite. The smaller is the market share of new entrants, the higher is the probability of being satisfied about the price.

The effect of price indicators in the explanation of consumers' satisfaction is as expected for local, national and international calls prices but only the first and second are significant. The monthly subscription variable enter positively but not significantly.

Finally, as 2000 is the base year, there is no significant evidence towards a significant increase of consumers' satisfaction.

Table 8 about here

The same model structure has been used for investigating the satisfaction about the quality of the service. As already mentioned, all results are reported in columns (C) and (D) of Table 8. Differently from the previous case, the regulation variables seem to be irrelevant in explaining the consumers' satisfaction.

The impact of the price variables is concentrated on the monthly subscription, which is the only one to enter significantly. In particular, monthly subscription enter with a positive sign, which might be explained by the fact that consumers interpret increases in prices to accompany better quality of the service. The trend over the three years considered, shows a slight decrease in the satisfaction, although not statistically significant.

In Table 9 we report all the results of the estimation procedures, including thus the coefficients for the individual effects and the macroeconomic controls.

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<sup>6</sup> As the correlation between monthly subscription and connection charge is 0.97, we decided to omit this latter variable in order to avoid collinearity problems.

## 7. CONCLUDING REMARKS

We have tested the role played by the OECD regulatory indicators in explaining consumers prices and satisfaction in the EU 15. Our findings can be summarized as follows:

- the main drivers of pushing downwards prices of local calls for fixed telephony are productivity, lines density, and market shares of new entrants. GDP change tends to increase prices, through a demand effect. Ownership and entry regulation do not play a statistically significant role.
- Connections charges are also decreased by technological progress, and marginally by market shares of new entrants, while the number of main telephone lines, perhaps surprisingly, increase them. There exists also a negative relation between prices and connection charges. Ownership and entry regulation are again not significant.
- Regulatory variables and ownership do not influence subscription rates, that respond only to productivity, with the expected negative sign.
- Productivity, in turn, is not influenced by any of the three OECD regulatory indicators, and it seems influenced only by its past trend, pointing to technological factors.
- When we consider subjective data from Eurobarometer, the consumers' satisfaction about prices is negatively influenced, as expected, by objective evidence about prices. When prices are not included, the market entry variable is statistically significant with a positive coefficient. Including the prices in the models, the share of public ownership is negatively related to the probability of being satisfied, while the larger is the market share of new entrants, the higher is the probability of being satisfied about the price. Country fixed effects dominate the other factors as explanatory variables, with consumers in Italy, Belgium, Portugal, Greece and the Netherlands less satisfied than in the UK (our benchmark).
- Regulatory variables play no role in explaining satisfaction with quality, and higher prices seem to increase satisfaction (perhaps in recognition of better service?).

While our empirical analysis is severely constrained by data limitations, it is new and it has a much wider scope than any other previous empirical work at EU level. It suggests that ownership change, from public to private, plays no role in explaining prices of local calls, connection charges and subscription rates, productivity, and perceived quality. It has a positive impact (negative sign in the estimated coefficient) on consumers' perception of the price they pay, but this seems to be contradicted by the objective evidence on price. Thus, one key item of the standard reform paradigm, privatization, is far from being supported by empirical analysis.

The market share of entrants seems to play a more positive role, as one would expect in a more competitive environment, but the result is not very strong. The indicator for entry regulation has very limited explanatory power. Overall, it seems that technology and demand factors, combined with unidentified country features, have much more explanatory power than other variables.

We do not interpret our results as an outright rejection of the standard reform paradigm. Perhaps the dynamics of international and long distance calls may offer a picture more consistent with it, but long term comparable series are not available to us. Perhaps the OECD regulatory indicators fail to capture the subtle details of the reforms, but the Market Opening Milestones data used by Copenhagen Economics (2005) in an important study commissioned and frequently cited by the European Commission do not seem to add much to the OECD indicators. Future research should try to expand the empirical analysis by type of services, technology, demand variables, and better regulatory variables.

Having said this, we must conclude that up to now it would be less than prudent to state that in the EU 15 the reform experiment is supported by clear evidence. It is probably too early to discern policy implications from our findings, but we would suggest two of them for future investigation. First, the role of privatization per se has probably been exaggerated. There is some evidence that

market shares of new entrants is welfare improving, but the positive impact of competition does not seem to be affected by public ownership: this finding should be considered in the recent debates about who should own the main telecom networks. Should ownership separation of the network be implemented, public ownership is an option to be reconsidered. Moreover, if the network is not going to be separated from the incumbent, a public stake into the incumbent is an alternative option to be considered as well.

Second, technological factors are key drivers, and cuts in the R&D budget of privatized telecoms is bad news. It seems that there is still wide scope for the EU governments to think about their active role in the design of a telecommunication policy. The European Commission should pay more attention to the strategic objectives, including protection of consumers from market power, and less to the details of the reform. Country institutional characteristics do matter, and a unique reform approach is not warranted.

## References

Alesina A., Ardagna S, Nicoletti G. and Schiantarelli F. (2005), Regulation and Investment, *Journal of the European Economic Association* 3, 791-825.

Bacchiocchi E., Grasseni M. and Florio M. (2004), The Missing Shock: The Macroeconomic Impact of British Privatisation, *Applied Economics* 37, 1585-1596.

Bacchiocchi E. and Florio M. (2004), Privatisation shocks and aggregate output: Testing for macroeconomic transmission channels, *Milan Research Papers in Economics, Business and Statistics*, Berkeley University Electronic Press.

Beranes E. and Bourreau M. (2005), An Economist's Guide to Local Loop Unbundling, *Communication & Strategies* N.57 pp 13-32

Cave M., Prosperetti L. and Doyle C. (2006), Where are we going? Technologies, markets and long-range public policy issues in European communications, *Information Economics and Policy* N.18 pp242-255

Cave M. and Crandall R. (2001), *Telecommunications Liberalization on the Two Sides of the Atlantic*, AEI –Brookings Joit Center for Regulatory Issues, Washington DC

Conway P. and Nicoletti G. (2006), Product market regulation in non-manufacturing sectors in OECD countries: measurement and highlights, *OECD Economics Department Working Paper*, forthcoming.

Cawley R. (2003), The European Union and world telecommunications market, in: G. Madden (ed) *World Telecommunication Markets, The International Handbook of Telecommunication Economics* vol III, Edward Elgar Cheltenham (UK).

Chang H., Kosky H. and Majumdar S. (2003), Regulation and investment behaviour in the telecommunications sector: policies and patterns in US and Europe, *Telecommunication Policy* 27,

677-699.

Cherry B. and Bauer J. (2002), Institutional arrangements and price rebalancing: empirical evidence from the United States and Europe, *Information Economics and Policy* 14 pp 495-517.

Copenhagen Economics (2005), Market Opening in Network Industries: Final Report, European Commission DG Internal Market.

Copenhagen Economics (2005), Market Opening in Network Industries: Sectoral Analyses, European Commission DG Internal Market.

De Bil P., Peitz M., 2005, Local Loop Unbundling in Europe: Experiences, Prospects and Policy Challenges, *Communication & Strategy* 57, 33-58

Edwards G. and Waverman L. (2006), The Effects of Public Ownership and Regulatory Independence on Regulatory Outcomes, *Journal of Regulatory Economics* 29, 23-67.

Fiorio C.V., Florio M., Salini S. and Ferrari P.A. (2007), Consumers' Attitudes on Services of General Interest in the EU: Accessibility, Price and Quality 2000-2004, Nota di Lavoro FEEM, N. 2.

Florio M. (2003), Does Privatization Matter? The Long-Term Performance of British Telecom over 40 Years, *Fiscal Studies* 24, 197-234.

Florio M. (2007), Telecom Italia 1997-2007: A case study in privatization failure, DEAS Working Paper Series n. 13, Department of Economics, University of Milan.

Florio M. and Puglisi R. (2006), Public ownerships, privatization and regulation: social welfare counterfactuals for British Telecom, UNIMI - Research Papers in Economics, Business, and Statistics 1017, University of Milan.

Grzybowski L. (2005), Regulation of Mobile Telephony across the European Union: An Empirical Analysis, *Journal of Regulatory Economics* 28:1 pp 47-67

Harper J. (1997), Monopoly and Competition in British Telecommunications. The Past, the Present and the Future, Pinter, London.

Hultkrantz L. (2002), Telecommunication liberalization in Sweden: is intermediate regulation viable?, *Swedish Economic Policy Review* 9, 133-161.

IDC (2002), Monitoring European Telecoms Operators: Final Report, ECSC – EC – EAEC Brussels.

Kiisky S. and Pohjola M. (2002), Cross-country diffusion of the internet, *Information Economics and Policy* 27 pp 297-310.

Laffont J.J. and Tirole J. (2000), Competition in telecommunications, The MIT Press, Cambridge (MA).

Mason R. and Valletti T. (2001), Competition in Communication Networks: Pricing and

Regulation, *Oxford Review of Economic Policy* 17(3) pp 389-415.

Millward R. (2005), *Public and Private Enterprise in Europe: Energy, Telecommunications and Transport 1830-1990*, Cambridge, Cambridge University Press.

OECD (2001), (2003) and (2005), *Communications Outlook*, OECD, Paris.

OECD (2006), *Telecommunication regulatory institutional structures and responsibilities*, Working Party on Telecommunication and Information Services Policies OECD Paris.

OECD (2002), *Regulatory reform in UK*, *Review of Regulatory Reform*, OECD, Paris.

Ovum (2003), *Barriers to competition in the supply of electronic communications networks and services*, A final report to the European Commission, ECSC-EC Brussels.

Peitz M. (2003), *On access pricing in telecoms: theory and European Practice*, *Telecommunication Policy* 27 pp729-740.

Resende M. and Facanha L. (2005), *Price-cap regulation and service quality in telecommunications: an empirical study*, *Information Economics and Policy* 17, 1-12.

Sterlacchini S. (2006) *The R&D Drop in European Utilities. Should We Care About It?*, DRUID Working Paper No. 06-19, Copenhagen Business School.

## APPENDIX A: TABLES

Table 3: Price indicators for international, national and local 10 minutes calls for the three years 1997, 2001 and 2005. All prices are in Euro (source OECD).

Countries		1997	2001	2005
Austria	International calls to USA (10 minutes)	0.389583	0.188889	0.101389
	Local calls (10 minutes)	0.034028	0.047917	0.034028
	National calls (10 minutes)	0.185417	0.053472	0.040972
Belgium	International calls to USA (10 minutes)	0.326389	0.1	0.109722
	Local calls (10 minutes)	0.03125	0.0375	0.0375
	National calls (10 minutes)	0.100694	0.0375	0.039583
Denmark	International calls to USA (10 minutes)	0.3	0.133333	0.109722
	Local calls (10 minutes)	0.03125	0.028472	0.025694
	National calls (10 minutes)	0.068056	0.028472	0.025694
Finland	International calls to USA (10 minutes)	0.354861	0.222222	0.229167
	Local calls (10 minutes)	0.014583	0.015972	0.016667
	National calls (10 minutes)	0.058333	0.061111	0.065278
France	International calls to USA (10 minutes)	0.304167	0.150694	0.102083
	Local calls (10 minutes)	0.03125	0.027083	0.022917
	National calls (10 minutes)	0.09375	0.067361	0.057639
Germany (including ex-GDR from 1991)	International calls to USA (10 minutes)	0.320139	0.057639	0.057639
	Local calls (10 minutes)	0.029861	0.029861	0.027083
	National calls (10 minutes)	0.144444	0.057639	0.034028
Greece	International calls to USA (10 minutes)	0.314583	0.146528	0.147917
	Local calls (10 minutes)	0.011111	0.025	0.021528
	National calls (10 minutes)	0.176389	0.068056	0.051389
Ireland	International calls to USA (10 minutes)	0.209028	0.104861	0.104861
	Local calls (10 minutes)	0.040278	0.035417	0.034028
	National calls (10 minutes)	0.136806	0.065278	0.056944
Italy	International calls to USA (10 minutes)	0.309722	0.138194	0.091667
	Local calls (10 minutes)	0.015972	0.017361	0.015278
	National calls (10 minutes)	0.106944	0.072222	0.052083
Luxembourg (Grand-Duché)	International calls to USA (10 minutes)	0.317361	0.072222	0.067361
	Local calls (10 minutes)	0.025694	0.021528	0.021528
	National calls (10 minutes)	.	.	.
Netherlands	International calls to USA (10 minutes)	0.366667	0.054167	0.059028
	Local calls (10 minutes)	0.023611	0.022222	0.022917
	National calls (10 minutes)	0.065972	0.033333	0.034028
Portugal	International calls to USA (10 minutes)	0.350694	0.145139	0.132639
	Local calls (10 minutes)	0.01875	0.020833	0.025694
	National calls (10 minutes)	0.140972	0.050694	0.045139
Spain	International calls to USA (10 minutes)	0.261806	0.184028	0.078472
	Local calls (10 minutes)	0.013889	0.019444	0.019444
	National calls (10 minutes)	0.140972	0.083333	0.058333
Sweden	International calls to USA (10 minutes)	0.226389	0.048611	0.045833
	Local calls (10 minutes)	0.019444	0.020139	0.020139
	National calls (10 minutes)	0.056944	0.020139	0.020139
United Kingdom	International calls to USA (10 minutes)	0.159722	0.159722	0.088889
	Local calls (10 minutes)	0.045139	0.040278	0.030556
	National calls (10 minutes)	0.073611	0.053472	0.030556

Table 4: Price equation estimates

Dep.Var.: D.fixed local price (log)	P1	P1a	P2	P2a	P2b
D.telecom liberalization indicator	0.087 0.162	0.081*** 0.000			
D.entry regulation			0.017 0.69	0.013 0.081	0.012 0.104
D.public ownership			0.046 0.378	0.006 0.498	0.004 0.713
D.market structure			0.032 0.708	0.133*** 0.000	0.124*** 0.000
LD.fixed local price (log)	0.835*** 0.000	0.042** 0.009	0.833*** 0.000	0.044** 0.006	0.039* 0.019
L2D.fixed local price (log)	0.031 0.684	0.031* 0.012	0.034 0.663	0.019 0.124	0.025 0.054
D.productivity (log)		-0.967*** 0.000		-0.988*** 0.000	-0.979*** 0.000
D.telecom inv st line (log)		-0.028 0.311		-0.004 0.898	0.008 0.782
D.mob subscribers st line (log)		0.036*** 0.000			0.035*** 0.000
D.isdn channels st lines (log)		0.004* 0.016		0.000 0.879	0.002 0.315
D.tel lines st pop (log)		0.410* 0.011			0.286 0.095
D.density (log)		-5.798*** 0.000		-7.330*** 0.000	-6.154*** 0.000
D.pc_gdp		0.816*** 0.000		1.190*** 0.000	0.668*** 0.000
Constant	0.044 0.086	0.002 0.835	0.045 0.09	0.033*** 0.000	0.026** 0.006
N	173	155	173	156	155

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

*st line* and *st pop* stay for standardized by main telephone lines and by population, respectively

Table 5: Telephone connection charge equation estimates

DepVar: D.tel connection charge (log)	C1	C1a	C2	C2a	C2b
D.telecom liberalization indicator	0.005 0.738	0.011 0.499			
D.entry regulation			-0.011 0.275	-0.007 0.473	-0.008 0.413
D.public ownership			0.007 0.619	0.004 0.760	0.004 0.771
D.market structure			0.033 0.107	0.040* 0.030	0.044* 0.034
LD.tel connection charge (log)	1.165*** 0.000	0.907*** 0.000	1.146*** 0.000	0.896*** 0.000	0.889*** 0.000
L2D.tel connection charge (log)	-0.254** 0.001	-0.127 0.115	-0.249** 0.001	-0.115 0.156	-0.108 0.181
D.fixed local price (log)		-0.046*** 0.001		-0.051*** 0.000	-0.045*** 0.001
D.telecom inv st line (log)		-0.037 0.393		-0.025 0.560	-0.024 0.581
D.mob subscribers st line (log)		-0.006 0.567			-0.008 0.468
D.isdn channels st lines (log)		-0.003 0.139		-0.004 0.075	-0.004 0.081
D.tel lines st pop (log)		0.644** 0.005		0.560* 0.017	0.639** 0.009
D.density (log)		0.583 0.479		0.427 0.606	0.465 0.575
D.pc_gdp		-0.175 0.368		-0.227 0.233	-0.237 0.230
Constant	-0.005 0.589	-0.001 0.926	-0.003 0.64	0.004 0.760	0.007 0.562
N	185	167	185	168	167

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001.

*st line* and *st pop* stay for standardized by main telephone lines and by population, respectively.

Table 6: Telephone subscription equation estimates

DepVar: D. tel subscription (log)	S1	S1a	S2	S2a	S2b
D.telecom liberalization indicator	-0.001 0.839	0.002 0.836			
D.entry regulation			0.001 0.749	0.003 0.495	0.005 0.325
D.public ownership			-0.005 0.452	-0.003 0.636	-0.005 0.485
D.market structure			0.000 0.970	-0.005 0.630	-0.005 0.610
LD.tel subscription (log)	0.809*** 0.000	0.698*** 0.000	0.801*** 0.000	0.757*** 0.000	0.690*** 0.000
L2D.tel subscription (log)	0.031 0.602	0.117 0.127	0.036 0.549	0.064 0.340	0.119 0.119
D.fixed local price (log)		-0.010 0.125		-0.013* 0.039	-0.009 0.163
D.telecom inv st line (log)		-0.001 0.970		-0.004 0.863	-0.005 0.803
D.mob subscribers st line (log)		0.008 0.143			0.009 0.097
D.isdn channels st lines (log)		-0.001 0.611		-0.001 0.576	-0.001 0.601
D.tel lines st pop (log)		-0.003 0.980		0.040 0.738	-0.028 0.823
D.density (log)		0.812 0.129		0.800 0.150	0.885 0.101
D.pc_gdp		-0.040 0.711		-0.007 0.951	-0.024 0.827
Constant	0.007* 0.035	0.005 0.373	0.007* 0.045	0.004 0.513	0.003 0.607
N	177	155	177	156	155

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001.

*st line* and *st pop* stay for standardized by main telephone lines and by population, respectively.

Table 7: Productivity equation estimates

DepVar: D. fixed productivity average (log)	L1	L1a	L2	L2a
D.telecom liberalization indicator	-0.041 0.52	-0.035 0.622		
D.entry regulation			-0.001 0.979	0.001 0.99
D.public ownership			-0.044 0.429	-0.038 0.531
D.market structure			-0.002 0.981	-0.003 0.973
LD.productivity (log)	0.833*** 0	0.841*** 0	0.832*** 0	0.838*** 0
L2D.productivity (log)	0.012 0.886	0.011 0.899	0.014 0.86	0.015 0.86
D.telecom inv st line (log)		-0.117 0.49		-0.118 0.493
D.isdn channels st lines (log)		0.01 0.339		0.009 0.406
D.tel lines st pop (log)		-0.547 0.466		-0.619 0.436
D.density (log)		-1.104 0.809		-0.839 0.859
Constant	-0.033 0.203	-0.024 0.612	-0.035 0.188	-0.022 0.663
N	161	153	161	153

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001.

*st line* and *st pop* stay for standardized by main telephone lines and by population, respectively.

Table 8: Price and Quality satisfaction: main estimation results from the probit model.

	Marginal effects: Price		Marginal effects: Quality	
	A	B	C	D
<i>Regulation variables</i>				
Public ownership	-0.007	-0.040***	-0.003	0.003
Market structure	0.017	0.100***	0.002	0.002
Entry regulation	0.027***	0.016	-0.007	-0.006
<i>Price variables</i>				
lprice local		-0.419***		-0.117
lprice national		-0.351***		-0.007
lprice international		-0.128		-0.021
ltel subscription		0.131		0.197***
Dlprice local		0.079		0.154***
Dlprice national		0.000		-0.034
Dlprice international		0.000		0.008
Dltel subscription		0.000		-0.187**
<i>Individual characteristics</i>	Yes	Yes	Yes	Yes
<i>Macroeconomic controls</i>	Yes	Yes	Yes	Yes
<i>Year dummies</i>				
year=2002	-0.026	0.002	-0.016	0.016
year=2004	0.191***	0.020	-0.016	-0.059
<i>Country fixed effects</i>				
Austria	-0.304	0.403***	0.087	0.057***
Belgium	-0.375**	-0.597***	-0.715***	-0.965***
Denmark	-0.261	0.405***	0.082	0.049
Finland	-0.308	0.401**	0.081	0.065***
France	-0.364	0.289	0.209***	0.087
Germany	-0.219***	-0.164	0.003	-0.143
Greece	-0.494**	0.392***	0.094	-0.918***
Ireland	-0.263	0.401**	0.078	0.062***
Italy	-0.570***	-0.636**	0.084	-0.998***
Luxemburg				
Netherlands	-0.380	-0.590***	-0.888***	-0.978***
Portugal	-0.482**	0.388***	0.087	-0.948***
Spain	-0.490**	0.371***	0.155**	-0.725
Sweden	-0.269	0.409***	0.093	0.071***
Constant	2.087	-10.943**	-4.052	-21.855***
Observations	38479	35831	38847	36180
Pseudo-R2	0.081	0.078	0.051	0.044
Log-Likelihood	-23054720	-21358410	-8027321	-8016795

Robust p values in brackets - \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

Table 9: Price and Quality satisfaction: complete estimation results from the probit model.

	Marginal effects: Price		Marginal effects: Quality	
	A	B	C	D
<i>Regulation variables</i>				
Public ownership	-0.007 [0.454]	-0.040*** [0.000]	-0.003 [0.660]	0.003 [0.632]
Market structure	0.017 [0.191]	0.100*** [0.000]	0.002 [0.805]	0.002 [0.886]
Entry regulation	0.027*** [0.000]	0.016 [0.122]	-0.007 [0.109]	-0.006 [0.309]
<i>Price variables</i>				
lprice local		-0.419*** [0.000]		-0.117 [0.125]
lprice national		-0.351*** [0.000]		-0.007 [0.826]
lprice international		-0.128 [0.158]		-0.021 [0.717]
ltel subscription		0.131 [0.103]		0.197*** [0.007]
Dlprice local		0.079 [0.247]		0.154*** [0.000]
Dlprice national		0.000 [0.999]		-0.034 [0.198]
Dlprice international		0.000 [0.993]		0.008 [0.619]
Dltel subscription		0.000 [1.000]		-0.187** [0.016]
<i>Year dummies</i>				
year=2002	-0.026 [0.369]	0.002 [0.961]	-0.016 [0.414]	0.016 [0.454]
year=2004	0.191*** [0.000]	0.020 [0.753]	-0.016 [0.313]	-0.059 [0.256]
<i>Country fixed effects</i>				
Austria	-0.304 [0.411]	0.403*** [0.000]	0.087 [0.395]	0.057*** [0.001]
Belgium	-0.375** [0.044]	-0.597*** [0.000]	-0.715*** [0.006]	-0.965*** [0.000]
Denmark	-0.261 [0.419]	0.405*** [0.004]	0.082 [0.284]	0.049 [0.294]
Finland	-0.308 [0.579]	0.401** [0.019]	0.081 [0.424]	0.065*** [0.000]
France	-0.364 [0.173]	0.288888889 [0.134]	0.209*** [0.000]	0.0875 [0.176]
Germany	-0.219*** [0.000]	-0.164 [0.218]	0.003 [0.938]	-0.143 [0.312]
Greece	-0.494** [0.037]	0.392*** [0.002]	0.094 [0.507]	-0.918*** [0.000]
Ireland	-0.263 [0.573]	0.401** [0.014]	0.078 [0.429]	0.062*** [0.000]
Italy	-0.570*** [0.000]	-0.636** [0.041]	0.084 [0.144]	-0.998*** [0.000]
Luxemburg				

Netherlands	-0.380 [0.378]	-0.590*** [0.000]	-0.888*** [0.000]	-0.978*** [0.000]
Portugal	-0.482** [0.016]	0.388*** [0.000]	0.087 [0.416]	-0.948*** [0.000]
Spain	-0.490** [0.013]	0.371*** [0.004]	0.155** [0.011]	-0.725 [0.375]
Sweden	-0.269 [0.630]	0.409*** [0.003]	0.093 [0.323]	0.071*** [0.000]
<i>Individual characteristics</i>				
sex=2	-0.014* [0.057]	-0.011 [0.138]	0.007 [0.179]	0.003 [0.368]
age	-0.007*** [0.000]	-0.007*** [0.000]	-0.000 [0.698]	-0.000 [0.662]
age squared	0.000*** [0.000]	0.000*** [0.000]	0.000 [0.304]	0.000 [0.201]
Civst=2	0.004 [0.689]	0.003 [0.788]	-0.012 [0.160]	-0.011* [0.058]
Civst=3	-0.045*** [0.000]	-0.045*** [0.000]	-0.019* [0.082]	-0.016*** [0.006]
age when finished education	0.009*** [0.000]	0.008*** [0.000]	0.000 [0.996]	-0.000 [0.694]
(age when finished education) squared	-0.000*** [0.000]	-0.000*** [0.000]	-0.000 [0.817]	0.000 [0.628]
occup8=2	-0.019 [0.229]	-0.020 [0.214]	0.001 [0.859]	-0.003 [0.734]
occup8=3	-0.015 [0.301]	-0.008 [0.610]	0.008 [0.356]	0.010 [0.152]
occup8=4	-0.021 [0.138]	-0.016 [0.270]	0.009 [0.264]	0.008 [0.186]
occup8=5	-0.010 [0.518]	-0.009 [0.599]	0.004 [0.635]	0.003 [0.689]
occup8=6	-0.069*** [0.000]	-0.067*** [0.001]	-0.012 [0.305]	-0.011 [0.244]
occup8=7	-0.030* [0.066]	-0.031* [0.066]	0.002 [0.851]	-0.004 [0.662]
occup8=8	0.129*** [0.000]	0.122*** [0.000]	0.020 [0.241]	0.014 [0.276]
PoliticsLR=2	0.021** [0.014]	0.024*** [0.009]	0.011 [0.134]	0.011*** [0.008]
PoliticsLR=3	-0.002 [0.875]	0.002 [0.877]	0.010 [0.181]	0.011** [0.019]
PoliticsLR=4	-0.013 [0.177]	-0.010 [0.359]	-0.002 [0.683]	0.000 [0.985]
RespCoop2=2	-0.025** [0.028]	-0.023* [0.061]	0.006 [0.404]	0.002 [0.673]
<i>Macroeconomic controls</i>				
PopDens	0.000 [0.939]	0.020*** [0.000]	0.004 [0.293]	0.005* [0.072]
RealGDPgrothRate	-0.013 [0.120]	-0.006 [0.664]	0.001 [0.905]	0.012* [0.080]
InflRate	0.029***	0.078***	0.006	0.008

	[0.001]	[0.000]	[0.300]	[0.144]
lcp	0.005	-0.006	-0.015	-0.008
	[0.597]	[0.556]	[0.255]	[0.333]
GDP_PER_CAPITA	-0.001	0.011***	0.000	0.003
	[0.551]	[0.004]	[0.964]	[0.189]
EmplGrowthTotalm1	0.012***	-0.051***	0.001	-0.014**
	[0.007]	[0.000]	[0.821]	[0.027]
GINI	-0.012**	-0.007	-0.003	0.006*
	[0.033]	[0.309]	[0.308]	[0.069]
Constant	2.087	-10.943**	-4.052	-21.855***
	[0.321]	[0.012]	[0.267]	[0.002]
Observations	38479	35831	38847	36180
Pseudo-R2	0.081	0.078	0.051	0.044
Log-Likelihood	-23054720	-21358410	-9273422	-8016795

Robust p values in brackets - \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%