

# ASPECTS OF REGULATION AND COMPETITION IN EUROPEAN TELECOMMUNICATION MARKETS

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# Abbreviations

3SLS	Three-Stage Least Squares
(A)DSL	(Asymmetric) Digital Subscriber Line
AIC	Akaike Information Criterion
AR-(G)ARCH	Autoregressive-(Generalized) Autoregressive Conditional Heteroskedasticity
ART	Autorité de Regulation des Télécommunications, the French regulator
BNetzA	Bundesnetzagentur, the German regulator
BT	British Telecom, the British Incumbent
CAR	Cumulative Abnormal Returns
CAV	Cumulative Abnormal Volatility
CAPEX	Capital Expenditures
CPI	Consumer Price Index
cp(n)p regime	calling-party-network-pays regime
DTAG	Deutsche Telekom Aktiengesellschaft
EC	European Commission
ERG	European Regulators Group
EU	European Union
FRIACO	Flatrate Internet Access Call Origination
GLS	Generalized Least Squares
HHI	Herfindahl-Hirschman-Index
iid	independent and identically distributed
IP	Internet Protocol

*Abbreviations (continued)*

IPO	Initial Public Offering
IV	Instrumental Variable
KPN	Koninklijke PTT Nederland, the Dutch incumbent
LRIC	Long-Run Incremental Cost
MDF	Main Distribution Frame
MNP	Mobile Network Provider
MOU	Minutes of Usage
NRA	National Regulatory Agency
NYSE	New York Stock Exchange
OPTA	Onafhankelijke Post en Telecommunicatie Autoriteit, the Dutch regulator
PTS	Post- och Telestyrelsen, the Swedish regulator
SMP	Significant Market Power
US SEC	United States Securities and Exchange Commission
VDSL	Very High-Speed Digital Subscriber Line
WTO	World Trade Organization

# 1 Introduction

"Today, ICT<sup>1</sup> is an integral part of almost every other sector of the economy, and this key set of technologies represents as much as 40 percent of overall productivity growth."

(Viviane Reding, member of the European Commission responsible for Information Society and Media, October 2008)<sup>2</sup>

Telecommunications ("external" ICT) has become an integral part of our every-day life. In almost every industry, telecommunications is used for the communication with customers and providers and also to offer information and to collect information. Moreover, telecommunications provides the virtual and the physical infrastructure for connecting regional markets worldwide, which results in a comprehensive integration of parallel markets. In addition, telecommunications does not only influence existing industries but it enables the establishment of new business models and completely new markets like social platform markets (e.g. Facebook or MySpace) or search engines (e.g. Google or Yahoo). It is thus the central pre-condition for economic growth and social welfare. Turning to private households, telecommunications is used to plan and organize leisure activities. In particular, more and more information, services and also activities are provided via telecommunication infrastructure virtually connecting people around the world. Today, private customers do not only use telecommunications to access information and services. In line with Web 2.0, they even provide own information on the basis of existing platforms for other users (e.g. video platforms like YouTube, information platforms like Wikipedia or information services like Twitter), which turns them from being passive telecommunication users to active service and information creators.

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<sup>1</sup>Information and Communication Technology

<sup>2</sup>Information based on the EU KLEMS database, 2007. The EU KLEMS project, funded under the Sixth Framework Programme, collected data on capital (K), labor (L), energy (E), materials (M) and services (S) to provide a database on economic growth, productivity and employment creation and capital formation at the industry level.

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Even governmental and health services are organized and provided via the internet. So-called e-Government and e-Health services replace familiar off-line services. Moreover, the communication between governmental institutions and citizens or private companies changed from a postal way of communications to an electronic or semi-electronic way of communications (e.g. income tax information exchange).

The particular importance of telecommunications for economy and society is mainly due to the ongoing restructuring process of the sector since the late 1980s, which comprises both transmission technologies and services and which is based on a fundamental re-thinking of economic knowledge. Before the worldwide wave of liberalizations, governments agreed that telecommunication sectors could be operated most efficiently as a monopoly with one single, vertically integrated provider in all telecommunication markets. Even before the liberalization, telecommunications has been considered as a key sector for society and national growth and, in particular, for national sovereignty and national security. These coincident assumptions among European governments caused the provision of telecommunication infrastructure and services by a state-owned company (Holmes and Young, 2002).

The reduction of foreclosures among European states and upcoming neo-liberal economic ideas at the end of the 1980s led to a comprehensive change in the common view of network-based markets. The "single European market programme", which was introduced to European telecommunication markets in line with the neo-liberal economic wave, follows the aim of the integration of European Union (EU) member states' markets to a single European market (Armstrong and Bulmer, 1998; Wallace, 2000). In line with this change of perspectives, network-based sectors are considered to consist of individual, but dependent markets, which could be integrated much easier, independently from upstream or downstream markets. However, the integration requires a sufficient preparation on the European level, on the national level and also on the sub-national level of telecommunications. In particular, markets could only be integrated if economic structures and technological deployments are at a comparable level across these markets. It is thus necessary to prepare and coordinate the complex integration process across all

European Community/EU member states, which requires an adequate regulatory system providing milestones to be reached for the harmonization of member states' markets and the subsequent European-wide integration. Additionally, this regulatory regime has to provide a set of measures to monitor and to control the process from an ex-ante and an ex-post perspective to foster the national implementation.

The European regulatory system is exceptional, as it is based on a two-stage model. On the higher stage, the European Parliament in coordination with national governments and the European Commission (EC) offers regulatory guidelines as a common framework for all EU member states. National governments and regulators have to adjust national regulatory habits to these common guidelines. On the lower stage, the national stage, European guidelines have to be adopted to national laws taking into account national distinctions. While the higher-stage requirements guarantee a common regulatory approach across all EU member states, the lower-stage settings allow for an adequate environment of national freedom taking into account national differences and securing the sovereignty of national governments.

This two-stage approach was implemented to foster the integration process within European member states and, simultaneously, to enable the proximity of National Regulatory Authorities (NRAs) to the regulated sector. However, freedom of transposition opens room for national differences in the implementation. Due to the consideration of national distinctions, member states have reached different stages of competition and efficiency exacerbating the integration process as a whole. While the transition from monopolistic national telecommunication markets started already in 1988, it is an ongoing process even today, which has not reached its termination in any of the European telecommunication markets. The EU and the EC were aware of the comprehensive challenges of market integration already at its very beginning because of the strong sovereignty of the EU member states (Narjes, 1988). The complexity of the integration process is twofold: Firstly, member states follow individual political and economic aims, thus, reducing the speed of legal convergence and market convergence. Secondly, legal adjustments directly influence technological developments, which were hardly foreseeable at the end of the

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1980s and also when markets were fully liberalized a decade later. Even shortly after the liberalization, the technological deployments and subsequent changes in telecommunication markets required an adequate legal framework with a high level of flexibility for adjustments and continuity.

With a sequence of so-called Regulatory Packages, the EC provides the higher-stage framework. Regulatory Packages are strategic instruments which offer a transparent legal setup in the integration process. By now, three Regulatory Packages have been installed, each preparing a particular milestone for the European market integration. Former Regulatory Packages have opened national markets to competition and laid down a common regulatory basis (the First Regulatory Package). The Second Regulatory Package was implemented to adjust the legal setting to the upcoming technological deployments after the liberalization and to harmonize market structures and regulation schemes based on this unexpected market development. The Third Regulatory Package, introduced in December 2009, concentrates on national regulatory systems and explicitly limits governments' sovereignty in their national telecommunication sector. With this particular focus on the national administrative system, the last Regulatory Package includes new instruments to foster the final preparation for the actual integration of national markets. However, it also incorporates rules for markets which are much more dependent on national distinctions and in which the legal framework and the given structures could be adjusted much more slowly.

From the technological perspective, telecommunication systems could be separated into two to three layers depending on the underlying model:<sup>3</sup> The infrastructure layer comprises the physical infrastructure and, thus, the basis for all superior layers. The physical infrastructure includes the cable ducts and the cables as well as the relevant transmission infrastructure like cell towers. Based on this basic infrastructure, the transmission system is installed. It comprises transmitters and signal amplifiers, which are necessary

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<sup>3</sup>The Open System Interconnection (OSI) Reference Model assumes seven layers separating the individual layers based on a more detailed technical structure. However, I refrain from this more detailed approach as it provides no additional information for the economic analysis of this thesis.

for an adequate transmission of data. Thus, the transmission layer is an intermediate layer in the sense that it covers both infrastructure elements for signal transmission and also routing elements. On the highest layer, services are provided. In contrast to the transmission system, services are, to a far extent, infrastructure independent. However, limitations in offered services come from infrastructure capacity.<sup>4</sup>

The transition from the natural-monopoly perspective to the neo-liberal perspective initiated a comprehensive technological revolution not only on the service layer but also on the content transmission layer. Examples are the rapid development of the internet and the installation of transmission systems for mobile communications. The ongoing developments on the service layer and the transmission layer require an adequate physical infrastructure, which meets the growing demand for transmission capacity. However, more complex services and the comprehensive developments in transmission technologies reduce the relative value of the physical infrastructure over time. As a result, the single-market perspective based on the neo-liberal political development aggravates the position of physical infrastructure providers. To a far extent, it neglects market interrelations and the internalization of positive externalities from physical infrastructure investments on other markets along the telecommunication value chain. The divergence of the relative value of physical infrastructure and the relative value of services leads to an under-investment challenge as physical infrastructure providers bear the investment risk but can refund their investments at most partially due to access price regulations under the First and the Second Regulatory Package (Cave and Vogelsang, 2003; Foros, 2004; Kotakorpi, 2006).

Moreover, the particular protection of customer rights in the context of European telecommunication regulation initiated a new understanding of telecommunications leading to upcoming competition on the service level. This has altered the role of users from passive consumers of provided services to more and more active customers offering services themselves. While telecommunications mainly consisted of analogue telephony

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<sup>4</sup>Additionally, service providers could also limit the availability of their services to one infrastructure as is done e.g. by Apple.



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until the late 1980s, the upcoming development of the internet allows customers to access new information sources and to choose from a broad range of services, which are either complements or substitutes to familiar services. In line with Web 2.0, customers even offer own information and services on the existing infrastructure. In consequence, service providers and customers use the existent infrastructure much more comprehensively but do not compensate for investment costs or congestion on the lines due to regulation. While infrastructure and transmission system operators are (technically) able to discriminate between single traffic generators, current regulation prohibits traffic-based fees (net neutrality) (Wu, 2005; Economides and Tag, 2009).

In contrast to individual service and infrastructure providers, national governments consider the impact of the availability of high-quality infrastructure from a macroeconomic perspective. As described above, telecommunication infrastructure is a key pre-requisite of economic growth. Due to their broader view, national governments internalize the externalities of infrastructure provision and support the installation of infrastructure where private investments would not occur because of too low returns on investments. Therefore, governments offer public aid and support the roll-out of high-quality infrastructure using alternative measures of more dynamic regulation.<sup>5</sup>

In most EU member states, fix-line infrastructure access is provided on a monopolistic basis. Thus, investments in this infrastructure directly affect services as they increase capacity or reduce transmission costs. Turning to platform competition, i.e. competition between infrastructures, additional positive externalities of investments exist: If one network provider increases its infrastructure availability or the quality of its lines, not only its own customers benefit from such an action. Moreover, with interconnected networks, also customers of competitors benefit due to a reduction of congestion or due to the availability of higher-quality services. In contrast to fix-line networks, this is a key issue

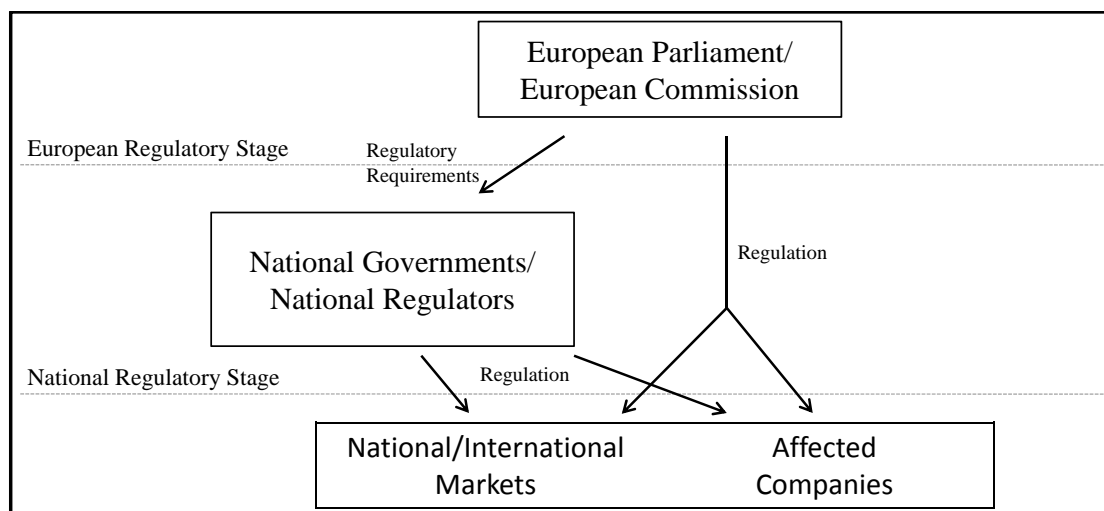
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<sup>5</sup>With the Third Regulatory Package, the EU requirements follow this national development as regulatory requirements, also on the European level, move from a balanced approach of static and dynamic regulation, i.e. securing competition and, on the other hand, providing incentives for investments, in the direction of a more dynamic approach.

in mobile network markets as infrastructure providers are mostly vertically integrated.<sup>6</sup> However, access regulation ignores this investment externality, which deters investments in the sense that cost-based regulation even increases the externality and reduces returns on investments.<sup>7</sup>

This thesis considers four key issues of regulation in the European telecommunication sector, which are the two-stage regulatory structure in the EU, the roles of national governments in their telecommunication sectors, the effect of service competition on infrastructure provision and regulation and its impact on investment externalities with competing infrastructures.

Figure 1.1: The European Regulatory System



## Overview of the Individual Chapters

Figure 1.1 provides an overview of the European regulatory system and its impact on infrastructure provision and service competition. In Chapter 2, I consider the relevance of alternative EC regulatory instruments on addressed companies and markets. The EC disposes a set of regulatory measures, with which it can affect national and international

<sup>6</sup>Even today, the market share of separated mobile network providers, mobile virtual network providers (MVNOs), is below 10 percent in EU member states.

<sup>7</sup>Cost-based regulation is the approach preferred by the EC for all telecommunication infrastructure markets.

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telecommunication markets. Besides Regulatory Packages as described above, firstly, it provides regulatory guidelines, which have to be adopted to all national markets by national governments and national regulators. Moreover, the EC also intervenes if it suspects particular market regulations in individual member states to be insufficient to reach common EU aims or not to be in line with the Regulatory Packages. Based on this type of interventions, national governments have to adjust national telecommunication laws or the regulatory and market practices in their countries. While these two types of interventions only indirectly affect national telecommunication markets, the EC can also directly intervene in a specific market if it finds one company or a group of companies to abuse significant market power (SMP). The EC mainly intervenes in line with the incumbent provider's action either by addressing the national regulatory practice and the competition system or by addressing the company under suspicion. In Chapter 2, I analyze how these alternative instruments affect expected companies' reactions proxied by their net present values employing an event study approach where I consider both returns and volatility of returns. In doing so, I provide more insights into the expected companies' reactions to directed market interventions in comparison to indirected approaches, which could be affected and adjusted by national governments and regulators to meet national market distinctions better.

The particular role of national governments in the European regulatory system is the subject of Chapter 3. National governments are strongly integrated with their national telecommunication sectors: On the one hand, governments determine the legal framework for telecommunication companies, which national regulators implement to markets, and, consequently, influence the path for national telecommunication market developments. Moreover, national governments also elect the presidential chambers of NRAs directly affecting the way how laws are implemented to markets. On the other hand, most EU member states hold shares in their former monopolists and support infrastructure investments employing alternative measures of public aid. These dichotomous roles of national governments are main drivers for differences across EU member states' telecommunication market situations. Regulatory Packages demand a strict separation

of the roles of governments, which requires the separation of tasks in multiple national ministries. However, combining instruments of multiple roles of the government could also be a valuable approach for the implementation of particular aims in the European integration process of national telecommunication markets as a whole. I discuss these alternative roles of governments and their interests in national telecommunication markets in Chapter 3.

While Chapters 2 and 3 focus on the impact of regulation and the regulation system as a whole, Chapters 4 and 5 consider the behavior of affected companies and the interplay of markets under the given regulatory system.

Comprehensive technological deployments since the liberalization resulted in a divergence of the transmission and the service layers from the physical infrastructure layer in the sense that infrastructure providers can decreasingly internalize the externalities of their infrastructure provision. As the physical infrastructure is the key pre-requisite for telecommunication service provision, a political debate on the European and the national level demands service providers and service users to support physical infrastructure provision. The economic literature repeatedly identifies service competition to be a driver of infrastructure investments (Röller and Waverman, 2001; Wallsten, 2001, 2002; Heimeshoff, 2007). However, standard closed-form estimation models do not clarify, how service competition and upcoming competitive infrastructures affect infrastructure provision. In Chapter 4, I compare the results of a closed-form model with the outcomes of a more structural estimation approach where I instrument demand variables in the investment equation. The closed-form approach assumes service competition to be a direct driver of infrastructure investments and ignores correlations between other explanatory variables and the demand variables. In contrast, with the more structural estimation approach, direct service competition effects on investments can be distinguished from indirect ones. I do this analysis both for fix-line infrastructure investments and mobile infrastructure investments and, additionally, consider competition and investment externalities between the two infrastructures.

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Chapter 5 extends the analysis to investment externalities between competing infrastructures. European mobile markets consist of mainly three to four fully vertically integrated providers, which are interconnected with each other. If one mobile network provider invests in its infrastructure to expand availability or to increase capacity and service quality, these investments affect own customers and also the communication habits of own customers with customers of competing network providers. Investments either reduce the price for on-net and off-net calls or increase infrastructure quality of the investor's network increasing the traffic of the investors' network. Moreover, cost-reducing investments reduce interconnection charges and, thus, increase the traffic from competitors' networks to the investor. I analyze investment externalities by employing a model brought forward in Dewenter and Haucap (2005) and extend their analysis adding traffic information. Additionally, I compare the impact of alternative regulation schemes and calculate the investment effect on own profits and on competitors' profits both in a micro-theoretical and a micro-econometrical model.

Chapter 6 summarizes the main findings of the previous chapters and highlights the key links between the alternative chapters. From these results, policy conclusions are derived, which strongly support the demand for further empirical analyses to improve the understanding of telecommunication markets as a whole and the particular situation of European telecommunication markets.

# 2 European Telecommunication Regulation – Effects on Telecommunication Providers

## 2.1 Introduction

Regulation intends to change the behavior of companies with SMP to enforce market competition or to move a market to a state of higher efficiency. Affected companies have to react to regulatory changes and adjust their market-related strategies. Due to their adjustment in strategies, expected future profits and, thus, companies' net present values change.

In the EU, telecommunication regulation is a two-stage scheme: On the higher stage, the EU Parliament in cooperation with the EC and EU member states determines the common regulation scheme, which, subsequently, has to be transposed to national laws taking into account country distinctions. While these long-term guidelines join into Regulatory Packages, which provide the framework to harmonize regulation across member states, the EC uses various regulatory measures to foster market competition and efficiency. These measures could be categorized into three classes depending on the addressees, cross-market interventions, country-addressing interventions and company-specific interventions.

Cross-market interventions refer to regulatory instruments which affect a particular market type in all member states. In contrast to Regulatory Packages, cross-market interventions focus on a distinct issue in a market which expectedly hampers upcoming competition or efficiency and which exists across all national markets (e.g. Regulation 2887/2000/EC on local loop competition). Country-addressing interventions differ from

cross-market interventions as they pick up an issue which is found only in one national market (EC, 1997). This might either arise from a governmentally accepted dominance of one company or it might stem from an insufficient transposition of regulatory guidelines. While these two types of EC interventions require the implementation to national laws by national governments and their adoption to markets by NRAs, the EC also directly intervenes if it suspects a company to abuse its dominant position in a particular market (Articles 81, 82 and 87 of the Treaty Establishing the European Community and Regulation 134/2004 EC) (company-specific interventions). In this chapter, I analyze the expected outcomes of alternative announcements and compare the results of the different types of interventions to each other.

At the point in time when a regulatory announcement is published, it does not directly lead to a change in market structures or companies' behavior. However, owners of affected companies react to these publications, either taking into account forthcoming transpositions to national laws or other changes in the competition of the addressed markets due to adjustments in companies' strategies. Under the assumption of rational shareholders, stock price reactions have been used multiply as a proxy for market reactions on announcements.<sup>1</sup> The consideration of how an announcement changes shareholders' expectations is based on the deviation of stock price returns from a known path. This deviation is assumed to be a linear transformation of a representative firm owner's expectation about how a shock affects future cash-flows. Thus, one can directly "measure" the monetary impact of an unexpected event by considering stock prices.

What is heavily criticized with this so-called event study methodology is, firstly, that stock prices follow an autoregressive process (Salinger, 1992) and, secondly, that significant shocks are accompanied by changes in stock price volatilities, in particular when the effect of an announcement is unclear (MacKinlay, 1997; Lütkepohl, 2006). Both of these criticisms cannot be taken into account with the traditional event study approach which only focuses on current returns but ignores the time structure and the volatility

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<sup>1</sup>Schwert (1981) provides a broad overview of studies, including regulation studies. After 2000, stock price reactions have been used also comprehensively in the context of telecommunications as will be discussed below.

of returns.<sup>2</sup> For considering the impact on volatilities it is recommended to use two-step methods which modulate the error term structure of the return estimation as an autoregressive process.

Two-step AR-ARCH-/GARCH-models enable the successive consideration of a shock on returns and on volatilities. While, usually, the lag structure is assumed to be exogenously given for the return and for the volatility estimations, I select the optimal lag length based on an iterative estimation approach.

The following results can be drawn from the estimations: Firstly, cross-market interventions and country-related interventions increase the stock-price returns of an affected company. Secondly, company-addressing actions reduce the stock price returns and, simultaneously, reduce the volatility in returns. In contrast, other companies in the same market remain unaffected. These findings provide evidence that regulatory interventions and changes in the regulation structure fulfil the aims of the EU Parliament. The EC intervenes if it suspects a market situation not to reach the desired status under the given legal structure. The estimation results show that (expected) firm reactions correspond to the EC intention. Moreover, if a particular company is addressed, the effect on expected future profits does not significantly differ from cross-market- or company-related interventions, but stock price volatilities are reduced. In consequence, regulatory interventions are interpreted differently by companies depending on the type of interventions but not necessarily on the subject.

The remainder of this chapter is organized as follows: Section 2 gives an overview of the event study literature and highlights key findings in the context of telecommunication regulation. Afterwards, the alternative types of EC interventions are specified in more detail and the respective hypotheses are derived (Section 3). Section 4 explains how pre-estimations are implemented. Subsequently, a descriptive overview of the employed variables is given and the estimation results of the pre-estimations are summarized and discussed. Moreover, a descriptive overview of the variables of the main estimations

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<sup>2</sup>A detailed discussion is given in the introduction to the chapter "Nonlinearities in Financial Data" in Campbell et al. (1997).



is provided (Section 5). Section 6 discusses the estimation results. The last section summarizes the key findings, concludes the chapter and gives an outlook for further research.

## 2.2 Literature Review

This section considers the existing literature on company and market regulation and its impact on the value of affected companies. As an ongoing discussion of methodological improvements is in place for the event study approach, I start with a broader overview. Event studies were originally used to consider regulatory changes in financial markets. Examples are Stigler (1961) or Officer (1973), who both analyze the 1934 introduction of the Securities Act and the establishment of the Securities and Exchange Commission (SEC) and how NYSE stock prices reacted to this introduction of regulation. As the SEC provides guidelines on stock exchanges, it directly addresses the shareholders' behavior influencing shareholders' evaluation of companies.

Schwert (1981) proposes alternative ways, how event studies could also be used in a broader context of regulation, not only to measure the impact on the addressees but to gain information about the expected reactions of addressees. Thus, event studies are also adopted to non-financial markets; this opens a broader range for the implementation of the event study methodology. Considering a change in the structure of non-financial markets differs from considering changes in financial market structures in the sense that a regulation does not address shareholders' behavior but the strategic behavior of the related company by assuming rational behavior of agents.<sup>3</sup>

Binder (1985) focuses on alternative weaknesses of event studies. Among others, he highlights the importance of the correct announcement date. By assuming the announcement date to be a priori unknown, he finds only little evidence for stock price reactions on regulation. Following his argumentation, uncertainty of the first announcement date strongly weakens the validity of an event study analysis. However, with the upcoming

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<sup>3</sup>E.g. in the context of telecommunications, Schwert proposes to adopt event study-based measures to evaluate frequency licenses.

internet and the online availability of information, news are offered simultaneously to a larger group of interested parties. Thus, announcements should have a stronger effect on share values. Moreover, the online storage of information also enables a detailed back-tracing of information, which makes it easier to find the most relevant announcements for event study analyses. As a consequence, a larger range of studies on single events or event groups have been implemented after around 1995/1996.

While the previous papers provide an overview of the steps of adopting the event study methodology to economic regulation analyses, the following studies focus on the implementation of event studies in the context of telecommunication markets.<sup>4</sup>

Considering the development of Deutsche Telekom stock prices, Rudolph and Johanning (2004) compare the announcement of changes in regulation with announcements of management decisions. They choose the period between 1997, i.e. shortly after the IPO of Deutsche Telekom, and 2002. Thus, Rudolph and Johanning's work covers a period of comprehensive changes in the company culture from a former public monopolist to a more privately-owned company<sup>5</sup>, and, simultaneously, the transition period from monopoly to regulated competition in the German telecommunication sector. The authors show that management decisions have a significantly stronger effect on stock prices than regulatory decisions, both being mostly negative in the period under consideration. Ehrmann et al. (2005) extend the analysis of Rudolph and Johanning by adopting additional news until March 2005. While the latter find significantly positive stock price reactions before 2001, their results turn negative for the second half of the observation period.

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<sup>4</sup>Despite knowing of the pitfalls of event studies in the context of antitrust and the evaluation of mergers and acquisitions (see e.g. McAfee and Williams, 1988; Shleifer and Vishni, 2003), the event study methodology is a commonly accepted method in competition economics (Whinston, 2006). It has been used for the evaluation of alternative topics which comprise among others anticompetitive horizontal mergers (Eckbo, 1983; Stillman, 1983; Eckbo and Wier, 1985) or the evaluation of antitrust decisions and merger control (Duso et al., 2008; Neven and Zenger, 2010).

<sup>5</sup>The German state held 61 percent of Deutsche Telekom shares in 1997 and reduced its participation to 42.8 percent by 2002.

Bel and Trillas (2005) use the event study approach to gain more insights into the interplay of governmental ownership, regulation and company activities in a study on the Spanish incumbent Telefonica. Regulatory changes between 1996 and 2000 altered not only the market structure but had an effect on the internal structure of Telefonica (see also Kole and Lehn, 1997). In particular, Bel and Trillas consider the following agency problem: The state keeps a Golden Share in Telefonica, thus, preventing the company's takeover. In contrast, no powerful shareholders exist which build a counterpart to the government. The authors expect that in this protective situation, management decisions are strongly affected by the government. In line with Ehrmann et al. (2005), Bel and Trillas find regulation to have a significantly positive impact on stock price returns for the period until 2000. With regard to liberalization, the authors argue that a positive impact on shareholder value stems from the expectations about an increase in demand. Instead of considering the effect of regulation on the incumbent provider, Krouse and Park (2003) use a broader data set covering both incumbents and new entrants on the local exchange level and consider how the introduction of the 1996 Telecommunications Act in the United States changed net present values of affected companies. They find no significant impact of the announcement on the incumbents' stock prices but significantly positive excess returns on competitors' stock prices. Krouse and Park argue that this result is strongly in line with the intention of this new legal framework as the introduction of competition reduces market concentration in favor of the entrants, thus enhancing competition in local telecommunication markets. In a quite similar approach, Bittlingmayer and Hazlett (2002) analyze the effect of changes in regulation on American broadband companies and find that deregulation decisions increase shareholder values. Approvals on the deregulation of long distance markets have no significant effect on internet providers' stock prices whereas denials negatively affect stock prices.

In contrast to most of the previous studies, I use data for multiple companies active in multiple countries and markets. In doing so, I consider the impact of regulation announcements for incumbent and entrant providers. I focus on regulation announcements of the EC which are less susceptible to a potential endogeneity challenge as characterized

e.g. in Duso and Röller (2003) or in Bel and Trillas (2005). The EC can choose from a set of various regulatory instruments, which provoke alternative reactions. In the next section, I provide an overview of the types of interventions and their expected impact on affected companies.

## 2.3 Regulation in Europe

Regulation in the EU is based on a two-stage approach, in which the EC coordinates, monitors and controls common steps of regulation across all EU member states. One key instrument are Regulatory Packages with which the EU Parliament in cooperation with national governments and the EC offers a common set of directives to harmonize the steps from monopoly to competition in the EU member states. The member states have to adopt these guidelines to national laws taking into account country distinctions.<sup>6</sup>

However, during implementation processes, problems become obvious which have not been expected in advance or which arise due to technological innovations and market developments. After the introduction of the Regulatory Packages, the EC adopts multiple steps to remedy these specific problems of the transposition process and unexpected market developments (e.g. local loop access regulation or the repeated interventions in line with Golden Shares). While these steps ease the process of the installation of competition and efficiency, they do not directly address particular national market issues. In contrast to national regulators, the EC takes a superior position: It monitors markets from a cross-national perspective and intervenes if it suspects national markets and rules not to satisfy the EC's regulatory requirements. One known example is the decision on

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<sup>6</sup>While the First Regulatory Package of 1998 has been installed to coordinate a harmonized move from monopolistic to competitive markets, this move rapidly turned to an acceleration of technological and demand evolution. Therefore, the Second Regulatory Package was adopted in 2002/2003, which seeks to balance static and dynamic regulation aims, i.e. competition aims as well as investment and innovation aims. A detailed discussion is provided in the initial proposition for the new regulatory framework by the EC, [http://ec.europa.eu/information\\_society/topics/telecoms/regulatory/new\\_rf/documents/com2000-393en.pdf](http://ec.europa.eu/information_society/topics/telecoms/regulatory/new_rf/documents/com2000-393en.pdf). In line with the 2006 market review of the Second Regulatory Package, new guidelines were discussed which even stronger take into account customers' behavior in line with the development of Web 2.0. [http://ec.europa.eu/information\\_society/policy/ecommm/tomorrow/roadmap/index\\_en.htm](http://ec.europa.eu/information_society/policy/ecommm/tomorrow/roadmap/index_en.htm). Please see also the discussion in Chapter 4.

international mobile communication roaming.<sup>7</sup> Following the EC, both approaches support companies as a whole as they reduce bureaucratic challenges, give a more reliable framework for NRAs' actions and reduce market barriers.

With its interventions, the EC seeks to increase competition and efficiency in a market under scrutiny either tackling problems in line with the introduction of a Regulatory Package or technological deployments or in the consequence of the market definition and the resulting competitive behavior of market participants. As the intervention intends to heal the addressed issue, this should also increase the affected companies' firm values.

**H1 (Type 1: Cross-market interventions):** The EC's activities to introduce and establish competition and more efficiency in telecommunication markets improve the performance of the affected telecommunication companies and, thus, increase their firm values as a whole.

Besides cross-national steps of interventions, the EC's services also monitor individual national markets as do national regulators. However, they base their consideration on common European requirements and analyze whether individual national regulation is in line with European guidelines. This EC initiative is accompanied by regular queries on the implementation of the guidelines and also by queries on national regulators' market monitorings. If the EC services identify a national telecommunication law or its regulatory implementation not to be in line with European requirements, the EC intervenes by addressing its concerns to the national authorities in charge. Subsequently, the national government has to remedy its telecommunication law or the NRA has to adjust its market implementation. If national institutions refrain from such a step, the EC brings the case to the European Court of Justice. An example of such a far-reaching decision has been the intervention in line with regulatory holidays in the context of the German

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<sup>7</sup>The EC ordered mobile network providers (MNPs) to reduce termination rates stepwise to a predetermined level and, beginning in March 2007, reduced the upper bound wholesale price using cross-market regulation for all EU member states. More information is provided in the latest regulatory intervention in this context: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:167:0012:0023:EN:PDF>. Additional information about the tariff structure can be found here: <http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/07/251>

VDSL roll-out.<sup>8</sup> After the EC has multiply remarked its concerns without amendments of the German government, it brought the case to the European Court of Justice in June 2007. The case was decided in December 2009 impeding the German intention.<sup>9</sup>

If the EC intervenes on a particular issue in a national market it suspects the previous situation not to be in a stage of adequate competition and not to turn to competition in the near future under the current national telecommunication rules (Monopolies Commission, 2009). The EC's action therefore intends to improve the market situation and, thus, the situation of the market players as a whole.<sup>10</sup> As asymmetric national market boundaries are reduced and more transparency is provided by such an intervention, companies in the addressed market should benefit from the EC's action, which increases their firm values.

**H2 (Type 2: Country-addressing interventions):** Shareholders expect a positive impact of market-structural EC interventions on firm values.

While the activities described so far concern issues which comprise markets as a whole, the EC also intervenes if it suspects individual market participants to hamper competition. Similar to country-addressing interventions, the EC first informs the company about its concerns. Afterwards, it warns the company and brings the case to the European Court of Justice if the company does not adjust its behavior in line with the EC's recommendation. Multiple examples exist in which mainly former monopolists have been part of such a process, e.g. KPN for abusing its dominant position for mobile call termination in 2002 or France Telecom to pay back state aid in 2004. In contrast, there are also cases in which entrants are suspected to be in an anti-competitive position such as the state aid decision on Mobilcom in 2003.

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<sup>8</sup>The German government wanted to change national telecommunication laws to enable regulatory holidays to the incumbent if the national regulator Bundesnetzagentur would have decided VDSL to be a new market. This example is discussed in more detail in Chapter 3.

<sup>9</sup><http://www.euractiv.com/en/infosociety/eu-court-sets-precedent-germany-telecoms-ruling/article-188017>

<sup>10</sup>Please see also Bel and Trillas (2005) with regard to regulators' decisions concerning total markets.

Moreover, the EC is obliged to consider cases of major players' mergers, demergers and acquisitions, including infrastructure sharing between providers or common licence acquisitions. It intervenes or accepts a project imposing conditions if it suspects subsequent market concentration to hamper competitors. Examples are the merger of the two Scandinavian incumbents Telia and Sonera in 2002 or the 3G mobile network sharing agreement in the UK in 2003. As in general most of the companies face trials concerning forms of anti-competitive behavior or the prohibition of a future supremacy, this type of intervention should have a negative impact on the value of the respective firms.<sup>11</sup>

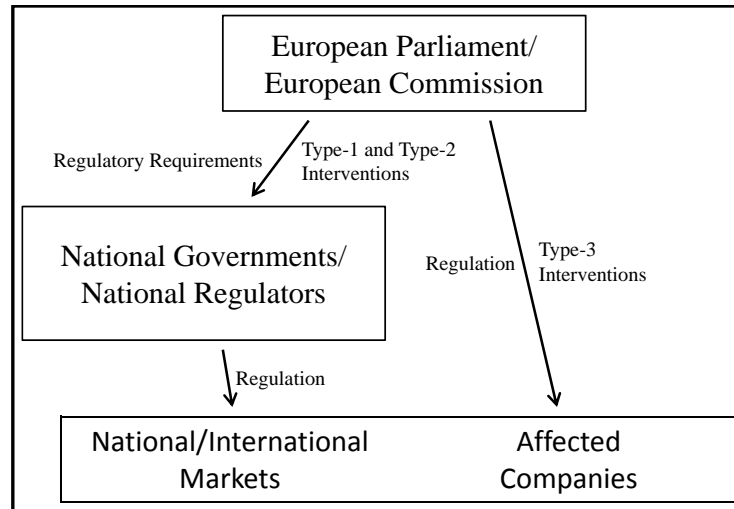
**H3 (Type 3: Company-specific interventions):** Company-specific interventions reduce the shareholder value of the addressed firms.

The first and the second hypotheses concern interventions, which relate to the telecommunication sector as a whole or to a particular market whereas the third hypothesis focuses on individual companies' actions (see also Figure 2.1). While the first two types of interventions require national institutions to adopt and apply regulation measures to national markets, the third approach directly addresses particular companies' behavior in the markets. Thus, from the first two types of interventions to the third type, the EC's actions turn from a superior cross-national or national level of interest to a firm-specific one. As actions are much more focussed with type-3 interventions they should also receive more attention by shareholders.

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<sup>11</sup>Please note that company-addressing actions are a gray area between regulation and antitrust actions particularly in markets with an ex-ante dominant provider. Rey (2002) identifies four criteria how to distinguish regulation from antitrust issues. These are, firstly, *procedures and control rights* in the sense that regulatory authorities have more powerful instruments to intervene on firm behavior than antitrust authorities, secondly, *timing of oversight*, which means the issue of ex ante interventions (typically regulation) and ex post interventions (typically antitrust), thirdly, *information intensiveness and continued relationship* meaning that regulators have to cultivate a continuous relationship to the market and the companies, and, finally, *relationship to political powers* comprising the impact of politicians on the agency. While individual NRAs actively take over antitrust tasks, such as the UK regulator OFCOM (see Chapter 3), current regulation habits in the preparation of the Third Regulatory Package try to increase regulators' independence from political authorities and also, to some extent, the proximity of regulators to markets. In the further analysis, I consider cases of individual company-specific interventions from the regulatory perspective keeping in mind the ongoing transition from pure regulation to antitrust actions of the EC in the telecommunication sector. In addition, please see also Knieps (2003), Neumann (2003) and Vogelsang (2003).

Figure 2.1: Overview of Alternative Types of EC Regulatory Interventions



**H4a:** The impact of EC interventions on stock price returns increases from cross-market and country interventions to individual company requirements in absolute terms.

Type-1 and type-2 interventions require the adoption of EC regulations to national laws taking into account national distinctions. Even with the knowledge of forthcoming interventions, the actual market implementation has an ex ante unknown outcome. Therefore, stock price volatilities should be higher with type-1 and type-2 interventions than with type-3 interventions as no intermediate authority provides additional uncertainty about the actual implementation of outstanding regulatory requirements.

**H4b:** EC interventions reduce stock-price volatilities from cross-market and country interventions to individual company requirements.



## 2.4 Empirical Implementation

In the event study literature, two approaches for explaining shocks exist, which either focus on stock price returns or on volatilities. For analyzing both returns and volatilities, it is necessary to decompose one effect from the other. A common approach from the financial literature is the AR-GARCH model (Autoregressive-Generalized Autoregressive Conditional Heteroscedasticity model) (Ferenstein and Gasowski, 2004; Lütkepohl, 2006). In AR-GARCH models, the stock price return path is estimated using the standard AR approach and assuming a GARCH process for the error term structure. I employ the AR-GARCH model to estimate the stock price returns development for the companies under scrutiny assuming a total observation window of 201 days around the event (100 days before and 100 days after the event). The lag-structure of the AR and the GARCH process are determined by iteration as described below. In contrast, in standard event studies, either no autocorrelation or a one-period lag structure for stock price returns is assumed. These approaches are special cases of the approach which I adopt here as I allow the model to calibrate to the optimal time structure.

I employ the following three-step estimation approach: I first estimate stock price returns for the 201-days observation window for each event. Afterwards, I estimate the error term structure to get information about the return volatilities. For each observation window, each of the two steps is iterated until the best estimator is found. The selection of the best estimator is based on the Akaike Information Criterion (AIC) as described in Lütkepohl (2006) and as used in a magnitude of time series prediction studies.<sup>12</sup> Finally, I use the results of the first two steps to consider the effect of events in windows with three alternative lengths around the event date (3, 7 and 11 days).

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<sup>12</sup>In a previous version of this chapter, I have double-checked results using the Bayes/Schwartz Information Criterion for the AR process and for the GARCH process. This method dedicates more weight to the number of explanatory variables. Nevertheless, results with regard to lag-length change only slightly.

For the first two steps, I assume the following return and error term equations:<sup>13</sup>

$$\begin{aligned} R_{it} &= \alpha_{Ri} + \sum_{j=0}^{j<t} \beta_{it-j} R_{it-j} + \beta_{TI} TI_t + \varepsilon_{it} \\ \varepsilon_{it} &= \sigma_{it} \nu_{it} \end{aligned} \quad (2.1)$$

$R_{it}$  is the stock price return of firm  $i$  in period  $t$  and  $TI_t$  corresponds to the returns of a market index at date  $t$ .  $\nu_{it}$  is white noise following an iid(0,1) process. The first equation corresponds to the standard AR-part of an AR-GARCH model. With the GARCH assumptions, the error term of the return equation satisfies the second equation and  $\sigma_{it}$  is determined by the following process (Bollerslev, 1986):

$$\sigma_{it}^2 = \alpha_{\sigma i} + \sum_{p=0}^{P<t} \beta_{\varepsilon it-p} \varepsilon_{it-p}^2 + \sum_{q=0}^{Q<t} \beta_{\sigma it-q} Var(\sigma_{it-q}^2) \quad (2.2)$$

with  $Var(\varepsilon_{it} | \varepsilon_{it-1}, \varepsilon_{it-2}, \dots) = \sigma_{it}^2$ ,  $E(\varepsilon_{it}) = 0$ ,  $Cov(\varepsilon_{it}, \varepsilon_{is}) = 0$ ,  $t \neq s$ . When all  $\beta_{\sigma i}$ 's equal zero, the process is an ARCH model as described in Engle (1982).<sup>14</sup>

In contrast to other event study approaches which postulate a specific lag length, the approach chosen here keeps the estimation flexible in the sense that each estimation is multiply repeated employing the ARCH or the GARCH restrictions to determine the optimal lag-length based on the AIC.

In the third step, I focus on the individual event window and analyze if and how an event causes a deviation from the expected returns and the volatilities process. Abnormal returns ( $AR$ ) and abnormal volatilities ( $AV$ ) are assumed to be normally iid with zero means over the observation period but not necessarily in the event window. Therefore, abnormal returns and abnormal volatilities are given by the following equations:

$$\begin{aligned} AR_{id}^m &= R_{id}^m - \hat{R}_{id}^m \\ AV_{id}^m &= \sigma_{id}^{m2} - \hat{\sigma}_{id}^{m2} \end{aligned} \quad (2.3)$$

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<sup>13</sup>The event index is neglected as long as the consideration of a single event is sufficient.

<sup>14</sup>For more details, please see e.g. Campbell et al. (1997).

$m$  marks the event,  $i$  the firm and  $d$  the date of the observation.  $\hat{R}_{id}^m$  and  $\hat{\sigma}_{id}^{m2}$  are the estimates of equations (2.1) and (2.2) for each event. Daily abnormal returns and volatilities are cumulated around the event day to obtain the cumulated abnormal returns and the cumulated abnormal volatilities with

$$\begin{aligned} CAR_i^m &= \sum^{2\tau+1} AR_{i\tau}^m \\ CAV_i^m &= \sum^{2\tau+1} AV_{i\tau}^m \end{aligned} \quad (2.4)$$

I compare the results of three alternative event windows with a length of three, seven and eleven days before and after the event ( $\tau = 3, 7, 11$ ).

I use alternative exogenous variables, which explain cumulative abnormal returns and volatilities:

$$\begin{aligned} CAR_i^m &= \alpha^{m,r} + \text{expl. var.}' \beta_{\text{expl},i}^{m,r} + \text{control var.}' \beta_{\text{contr},i}^{m,r} + \eta_i^{m,r} \\ CAV_i^m &= \alpha^{m,v} + \text{expl. var.}' \beta_{\text{expl},i}^{m,v} + \text{control var.}' \beta_{\text{contr},i}^{m,v} + \eta_i^{m,v} \end{aligned} \quad (2.5)$$

Exogenous variables are classified in explanatory variables *expl. var.*, which are cross-market, addressed-country and addressed-company dummies, and control variables *control var.*, which are fix-line, mobile, incumbent, foreign fix-line and foreign mobile and combinations of these variables.

Although the AR-GARCH approach improves the estimate of stock price return developments, it still has some pitfalls known from the standard approach. In particular, it assumes the independence of stock price returns at the same point in time,  $\text{corr}(R_{it}, R_{jt}) = 0$ , and across different series across time,  $\text{corr}(R_{it}, R_{js}) = 0, \forall i \neq j, s \neq t$ . Multivariate GARCH models exist which adjust the variance-covariance matrix to take stronger into account cross-sectional correlations by simultaneously estimating returns of multiple companies. However, these approaches are only implemented in studies with a low number of companies due to the exponential growth of processing capacity requirements in the number of considered companies and the lag-length employed (Lütkepohl, 2006). Because of the high number of companies in my sample, I refrain from these multivariate AR-GARCH models and follow the standard approach by adding market indices to the model to control the cross-company structure at least partially. Nevertheless, this approach cannot completely absorb cross-company correlations.

## 2.5 Data and Pre-Estimations

### 2.5.1 Data Description

To test the hypotheses, I use information on EC decisions, which were selected for the time period between January 1, 2000 and December 31, 2008. Announcements, not actual decisions, are employed as it is explained in the literature that the first announcement of a significant change should affect stock prices as soon as it is available (Binder, 1985). This information is taken from the database Cullen International, which collects per-day information on changes in telecommunication regulation and competition. The selected news are displayed in Table A.1 in Appendix A.1.1.

Thomson Financial Datastream provides share values for about 90 companies characterized as telecommunication companies in the selected countries, which are EU-15 countries as well as Norway and Switzerland during the observation period. From this schedule, five companies had to be excluded because they are listed after mid 2006 and, thus, might be stronger affected by the firm-specific value-finding processes of the market. Subsequently, I re-examined the remaining companies by collecting information about firm activities from their websites. Additional companies were excluded from the sample as either the companies are not active in the field of interest, i.e. fix-line or mobile telecommunications, or as not enough stock price data points are available for the observation period.

After these corrections, I ended up with 2447 independent event-company combinations whereof 816 are combinations with incumbents. 32 events concern cross-market related issues, 6 events concern country-related topics and 26 events concern company-related announcements. There exists an over-representation of incumbent-events in particular in the first years of the sample as most incumbents have been listed over the whole observation period.<sup>15</sup> Some companies are active both in fix-line and mobile markets in multiple countries. However, no or only little information could be collected on their activities in these countries and markets. What would be most interesting are market

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<sup>15</sup>Exceptions are Telia Sonera, listed since June 14, 2000, Telekom Austria, listed since November 21, 2000, Telenor, listed since December 05, 2000, and Belgacom, listed since March 22, 2004.

shares and sales ratios. Nevertheless, the only information, which is available from company websites and information systems, is the particular market, this means either fix-line or mobile markets, and the year of entry and exit. Furthermore, information about the regional reach is obtained, i.e. whether a company is active in Europe or globally. Information about multi-market activities is collected from alternative information sources including Bureau van Dijk's Amadeus database and the companies' websites.

I employ two alternative market indices, the Dow Jones 600 Telecommunications Index Europe (Telecom Index) and the Dow Jones 600 Technology Index Europe (Technology Index). The first includes major European telecommunication companies meaning also some of the companies under scrutiny of the analysis. Therefore, a spurious correlation challenge might exist in particular when analyzing the impact of cross-market announcements. For these events, the impact on returns is probably mainly explained by the change of the index. Additionally, regulation announcements potentially also affect other companies of the index (see Rudolph and Johanning, 2004). Therefore, the actual effect might be downward-deterred in absolute values both for returns and for volatilities. To control for this issue, the Technology Index is used as it excludes any telecommunication companies. It does not cover companies from the telecommunication sector but from sectors which perform very similarly over the sample period. Some minor endogeneity might still exist as the products and services of technology companies mainly depend on adequate telecommunication infrastructure (such as software etc.). However, this challenge could be neglected.

The descriptive statistics of the variables used in the step-1 and step-2 estimations are displayed in Table 2.1. The figures are mean variables in the sense that for each event, I calculated the descriptive statistics of the observation window and aggregated results over all events and all companies. The resulting mean values and the standard deviations of the means are displayed here. *returns* is the daily relative change in stock prices, *std.dev.(returns)* is the calculated mean standard deviation of returns, *Telecom Index* and *Technology Index* variables are daily relative changes of the indices and, similarly, the *std. dev.* terms correspond to the mean standard deviations of the index returns. By

Table 2.1: Mean Descriptive Statistics of the Variables of Steps 1 and 2

	<b>Pooled</b>		<b>Incumbents</b>		<b>Entrants</b>	
	<b>Mean</b>	<b>Std. Dev.</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Mean</b>	<b>Std. Dev.</b>
Mean(returns)	-0.0018	0.0076	-0.0015	0.0038	-0.0019	0.0089
Std. Dev.(returns)	0.2996	0.1875	0.2298	0.0651	0.3346	0.2167
Mean(Telecom Index)	-0.0002	0.0005	-0.0002	0.0005	-0.0002	0.0005
Std. Dev.(Telecom Index)	0.0073	0.0032	0.0076	0.0032	0.0071	0.0032
Mean(Technology Index)	-0.0003	0.0007	-0.0003	0.0008	-0.0003	0.0007
Std. Dev.(Technology Index)	0.0094	0.0041	0.0099	0.0041	0.0092	0.0041
Obs.	2447		816		1631	

comparing the pooled results with the incumbents' and with the competitors' results, it is found that average returns are at a comparable level. However, average standard deviations are much more volatile for competitors than for incumbents.

The descriptive statistics of step-3 dependent and explanatory variables are displayed in Table 2.2 and in Table 2.3, respectively.

Table 2.2 shows only small cumulative abnormal returns and also volatilities around the announcement dates. Following Rudolph and Johanning (2004), changes in European regulations are probably of a minor interest for shareholders. This might be due to the fact that the result of regulation is not directly linked to returns but is a long-run driver of companies' profits. Furthermore, the low values could also stem from the estimation approach for predicted returns functions of step 1 and step 2. As the approach is the result of an iterative estimation optimization, this technique should meet stock price evolutions much more appropriate than standard techniques. Consequently, the deviation, which is identified around an event, is expected to be less extensive but much more robust.

Means differ only slightly depending on the underlying indices. With a larger window size, entrants CAR are lower when applying the Technology Index, which also affects the pooled estimation outcome. However, estimation results for the incumbents estimations and the consideration of CAV show nearly identical results. In consequence, only little evidence is found for a potential spurious regression problem. With larger

Table 2.2: Descriptive Statistics of the Dependent Variables

<b>3 days</b>	<b>Pooled</b>	<b>Incumbents</b>	<b>Entrants</b>	<b>Fix-Line</b>	<b>Mobile</b>
CAR (Telecom Index)	-0.0001 (0.0076)	-0.0001 (0.0048)	-0.0001 (0.0087)	-0.0003 (0.0076)	-0.0001 (0.0076)
CAR (Technology Index)	-0.0001 (0.0076)	-0.0001 (0.0048)	-0.0001 (0.0087)	-0.0002 (0.0076)	0.0000 (0.0076)
CAV (Telecom Index)	0.0010 (0.0013)	0.0006 (0.0005)	0.0011 (0.0015)	0.0009 (0.0013)	0.0010 (0.0013)
CAV (Technology Index)	0.0010 (0.0013)	0.0006 (0.0005)	0.0012 (0.0015)	0.0009 (0.0013)	0.0010 (0.0013)
<b>7 days</b>					
	<b>Pooled</b>	<b>Incumbents</b>	<b>Entrants</b>	<b>Fix-Line</b>	<b>Mobile</b>
CAR (Telecom Index)	-0.0013 (0.0270)	-0.0015 (0.0179)	-0.0012 (0.0306)	-0.0028 (0.0272)	-0.0007 (0.0266)
CAR (Technology Index)	-0.0009 (0.0270)	-0.0015 (0.0180)	-0.0006 (0.0305)	-0.0021 (0.0271)	-0.0003 (0.0267)
CAV (Telecom Index)	0.0052 (0.0069)	0.0031 (0.0023)	0.0062 (0.0081)	0.0051 (0.0069)	0.0053 (0.0071)
CAV (Technology Index)	0.0052 (0.0069)	0.0031 (0.0023)	0.0063 (0.0081)	0.0052 (0.0069)	0.0053 (0.0071)
<b>11 days</b>					
	<b>Pooled</b>	<b>Incumbents</b>	<b>Entrants</b>	<b>Fix-Line</b>	<b>Mobile</b>
CAR (Telecom Index)	-0.0013 (0.0473)	-0.0019 (0.0305)	-0.0011 (0.0538)	-0.0044 (0.0472)	-0.0003 (0.0468)
CAR (Technology Index)	-0.0007 (0.0470)	-0.0019 (0.0304)	-0.0001 (0.0535)	-0.0034 (0.0471)	0.0003 (0.0463)
CAV (Telecom Index)	0.0105 (0.0139)	0.0063 (0.0046)	0.0126 (0.0163)	0.0104 (0.0139)	0.0107 (0.0143)
CAV (Technology Index)	0.0106 (0.0138)	0.0063 (0.0045)	0.0128 (0.0162)	0.0105 (0.0139)	0.0107 (0.0141)

Note: Variables are means of the relevant category, std. dev. in brackets.

event windows, a stronger reaction exists both for incumbents returns in comparison to entrants returns and for fix-line operators returns in comparison to mobile operators returns. The comparison of the three alternative event windows shows that the seven-days window provides the largest deviation in returns. In contrast, cumulative abnormal volatilities increase with the window size. Controlling for fix-line or mobile operators leads to similar results.

Table 2.3: Descriptive Statistics of the Explanatory Variables

	<b>Mean</b>	<b>Std. Dev.</b>	<b>Min</b>	<b>Max</b>
fix-line	0.5333	0.4990	0	1
mobile	0.7360	0.4409	0	1
fix-line (multi-market activity) (1)	1.7941	2.5841	0	15
mobile (multi-market activity) (2)	1.4334	1.6973	0	9
incumbent (3)	0.3335	0.4715	0	1
foreign fix-line	0.0919	0.2890	0	1
foreign mobile	0.0826	0.2753	0	1
cross-market (4)	0.4843	0.4999	0	1
addressed market (5)	0.1606	0.3672	0	1
addressed company (5)	0.0090	0.0944	0	1
affected company fix-line	0.2795	0.4489	0	1
affected company mobile	0.3551	0.4787	0	1
1 x 4	0.8606	1.9723	0	15
2 x 4	0.6980	1.3932	0	9
4 x 5	0.0523	0.2227	0	1
4 x 6	0.0074	0.0855	0	1

With regard to volatilities, significant differences are only found between incumbent and entrant providers: Entrants stock prices react much more volatile on announcements, which might be due to the stronger heterogeneity in this group. In contrast, no significant differences in volatilities exist between fix-line and mobile operators.

Let us next turn to Table 2.3. In 26.9 percent of company-event combinations, companies are involved, which are active in both fix-line and mobile markets, in 26.4 percent only fix-line and in 46.7 percent only mobile companies are involved. Due to double-markets activities, fix-line and mobile means do not sum up to 1. On average, each fix-line provider (mobile network provider) is active in 1.8 (1.4) European markets over the observation period. No provider in the sample has left one market and afterwards entered another. About one third of the companies are incumbent providers in one country but are also active in another country as a new entrant. These companies are counted only once (as incumbents), as stock prices cannot be disentangled based on country-market activities. One special case is Telia Sonera, which is the incumbent in



Sweden and in Finland after the companies merged in 2002. Less than 10 percent of fix-line and of mobile providers are active in countries other than the EU-15 countries, Norway or Switzerland. Dummies for regulation-addressed companies are used to separate addressed companies from others in the same market.

Table 2.4: Summary Statistics and Test Results of the Iterative Estimation Process

Pooled	Technology Index			Telecom Index		
	Mean (Std. Dev.)	Minimum (Share Min.)	Maximum (Share Max.)	Mean (Std. Dev.)	Minimum (Share Min.)	Maximum (Share Max.)
<b>AR</b>						
lag ar	3.826 (1.675)	0 (0.056)	6 (0.193)	4.114 (1.899)	0 (0.048)	7 (0.133)
Chi_sq (df)	76.6 (4.914) (77.5)	0.000	1553.6	77.8 (5.122) (77.0)	0.000	1561.1
log likelihood	43.0 (200.3)	-347.6	830.1	44.3 (203.3)	-339.8	890.4
<b>(G)ARCH</b>						
lag error_sq (=p)	1.924 (2.152)	0 (0.357)	8 (0.017)	2.097 (2.240)	0 (0.340)	8 (0.014)
lag sigma_sq (=q)	1.980 (1.688)	1 (0.678)	6 (0.095)	2.112 (1.994)	1 (0.675)	8 (0.042)
Chi_sq (df)	35183 (1.886) (1584476)	0.000	7014.8	306.2 (1.954) (12898)	0.000	617316
log likelihood	1320.5 (305.4)	-296.2	1191.8	57.8 (212.7)	-293.8	1289.4

Note: lag sigma\_sq = 0 corresponds to an ARCH process, whereas lag sigma\_sq > 0 represents a GARCH process.  
lag error\_sq = 0 and lag sigma\_sq = 0 corresponds to the standard assumption of the usual model.

## 2.5.2 Pre-Estimation Results

Table 2.4 provides pooled summary statistics and test results for the step-1 and the step-2 estimations.<sup>16</sup> Estimations with the Technology Index have an, on average, lower optimum lag length in all three specifications both for the AR and for the GARCH process. Comparing the outcomes of the incumbents estimations and the entrants estimations, the AR process is shorter for the entrants estimations but the (G)ARCH

<sup>16</sup>Tables A.3 and A.4 in Appendix A.1.2 show the results separated for incumbents and entrants.

process is longer, which is in line with the findings on cumulated abnormal returns (Table 2.2). The Chi-square tests and also the Log-Likelihood tests are found to be weak instruments to compare variable and estimation quality because of their broad volatility across the alternative estimations.<sup>17</sup>

The standard approach used in the literature to proxy the actual stock price returns process assumes no explicit time structure, which corresponds to  $ar = 0$  and also  $p = 0$  and  $q = 0$ . If the iteration provides a lag length variance of zero,  $q = 0$ , to be best the ARCH model meets the underlying error term process better than the GARCH model. However, this specification neither exists for the incumbents nor for the entrants models. Moreover, as the combination of  $lag ar = 0$ ,  $p = 0$  and  $q = 0$  is found in no estimation to be the best estimation approach, the AR-GARCH estimator with higher lag lengths always meets the actual stock price development better. In consequence, the pre-estimation results provide evidence that the iterating method is preferable to the standard approaches, in particular for the incumbents estimations.

## 2.6 Estimation Results and Discussion

After the very technical consideration of descriptive statistics and pre-estimation results, let us now turn to the step-3 estimation results and their discussion. Results are provided for multiple estimation specifications starting with the less restricted estimations, including all relevant dummies, subsequently, including additional country controls of the affected companies and, finally, adding also interaction terms. Appendix A.1.3 provides the results of estimations for each event group separately (Tables A.5 - A.7). The step-3 estimation results are based on heteroscedasticity-consistent GLS-estimations of equations (2.5) (based on Huber-White-corrected variance-covariance matrices).

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<sup>17</sup>Moreover, the Chi-square test is not a test to compare specifications of alternative estimations.

Table 2.5: Estimation Results without Control Variables

	Technology Index			Telecom Index		
	CAR (3)	CAR (7)	CAR (11)	CAR (3)	CAR (7)	CAR (11)
cross-market	0.0001 ( 0.0003 )	-0.0002 ( 0.0012 )	0.0014 ( 0.0021 )	0.0002 ( 0.0003 )	-0.0000 ( 0.0012 )	0.0016 ( 0.0021 )
addressed country	0.0012 ** ( 0.0005 )	0.0032 * ( 0.0018 )	0.0054 * ( 0.0031 )	0.0012 ** ( 0.0005 )	0.0030 * ( 0.0018 )	0.0054 * ( 0.0031 )
addressed company	-0.0018 * ( 0.0010 )	-0.0096 *** ( 0.0031 )	-0.0100 * ( 0.0053 )	-0.0019 * ( 0.0010 )	-0.0101 ( 0.0029 )	-0.0113 ** ( 0.0052 )
fix-line	0.0001 ( 0.0004 )	-0.0018 ( 0.0013 )	-0.0050 ** ( 0.0023 )	-0.0000 ( 0.0004 )	-0.0024* ( 0.0013 )	-0.0063 *** ( 0.0023 )
mobile	0.0007 ( 0.0005 )	0.0017 ( 0.0016 )	0.0017 ( 0.0027 )	0.0006 ( 0.0005 )	0.0012 ( 0.0016 )	0.0008 ( 0.0027 )
constant	-0.0009 ( 0.0005 )	-0.0015 ( 0.0020 )	-0.0008 ( 0.0034 )	-0.0008 ( 0.0005 )	-0.0013 ( 0.0020 )	-0.0001 ( 0.0034 )
# Observations	2411	2411	2411	2437	2437	2437
F-Test (df)	2.21 (5)	4.06 (5)	3.38 (5)	2.35 (5)	4.90 (5)	2.21 (5)
R2	0.0040	0.0055	0.0056	0.0040	0.0062	0.0076
	CAV (3)	CAV (7)	CAV (11)	CAV (3)	CAV (7)	CAV (11)
cross-market	-0.0000 ( 0.0001 )	-0.0002 ( 0.0003 )	-0.0006 ( 0.0006 )	0.0000 ( 0.0001 )	0.0000 ( 0.0003 )	-0.0001 ( 0.0006 )
addressed country	-0.0000 ( 0.0001 )	-0.0003 ( 0.0004 )	-0.0007 ( 0.0008 )	-0.0000 ( 0.0001 )	-0.0001 ( 0.0004 )	-0.0001 ( 0.0008 )
addressed company	-0.0006 *** ( 0.0001 )	-0.0033 *** ( 0.0004 )	-0.0065 *** ( 0.0007 )	-0.0005 *** ( 0.0001 )	-0.0028 *** ( 0.0004 )	-0.0054 *** ( 0.0007 )
fix-line	-0.0000 ( 0.0001 )	-0.0000 ( 0.0004 )	0.0002 ( 0.0007 )	-0.0000 ( 0.0001 )	-0.0000 ( 0.0003 )	0.0002 ( 0.0007 )
mobile	0.0000 ( 0.0001 )	0.0001 ( 0.0004 )	0.0005 ( 0.0008 )	0.0000 ( 0.0001 )	0.0003 ( 0.0004 )	0.0009 ( 0.0008 )
constant	0.0010 *** ( 0.0001 )	0.0053 *** ( 0.0005 )	0.0106 *** ( 0.0010 )	0.0009 *** ( 0.0001 )	0.0050 *** ( 0.0005 )	0.0099 *** ( 0.0010 )
# Observations	2411	2411	2411	2431	2431	2431
F-Test (df)	16.32 (5)	23.62 (5)	19.26	9.92 (5)	15.04 (5)	14.27 (5)
R2	0.0020	0.0021	0.0023	0.0019	0.0019	0.0019

Note: \*\*\*, \*\*, \* represent significance at the 1, 5 and 10 percent significance level, standard errors are displayed in brackets.

From the discussions in line with Hypothesis 1, a positive impact of type-1 interventions should exist as this type of interventions is implemented to increase competition and market efficiency after the adoption of the Regulatory Packages is found to be insufficient. The coefficients of **cross-market interventions** are significantly positive, in particular with larger event windows and when controlling for country differences.

Due to the complexity of such regulatory adjustments, interested groups gain detailed information prior to the date of the official implementation via rumors and leading announcements and actions. In consequence, the findings are in line with Binder (1985) and Sallinger (1992) who both argue that stock prices already adjust before the actual date of an official announcement. Concerning volatilities, no significant coefficients are found. Only the interaction term with fix-line operators provides evidence for a significantly higher volatility. Thus, the estimation results confirm Hypothesis 1 of a positive impact of cross-market regulation on stock prices.

Following the second hypothesis, **regulation addressing individual national markets** should have a positive impact on stock prices. The EC adopts this type of actions suspecting a country's regulation or behavior to favor particular companies. An intervention by the EC is therefore implemented to reduce a potential deterrence, which should increase producer surplus as a whole.

The estimation results support this discussion as the relevant coefficients are significantly positive in all estimations. From the selected news (Table A.1 in Appendix A.1.1), it might be expected that country biases are mainly in favor of the incumbents before regulation is introduced. In consequence, interventions reduce the exceptional position of incumbents, which should have a negative impact on their firm values. I introduce interaction terms for companies' incumbency in a country to the estimations to analyze this extensional aspect. However, the results in Table 2.7 show no significant additional effect leading to the conclusion that the incumbents' stock prices react not significantly different from competitors' stock prices. This finding is in line with the analyses in Krouse and Park (2003) and Bel and Trillas (2005), who also identify positive or, at least, no significantly negative effects on incumbents' stock prices due to country-specific regulations. With regard to volatilities in stock prices, no significant effect could be identified. Following Krouse and Park's (2003) arguments, these results support the expectations that EC interventions approve the effectiveness of the addressed markets, which outweighs the negative direct impact on incumbents.

Table 2.6: Estimation Results with Control Variables

	Technology Index			Telecom Index		
	CAR (3)	CAR (7)	CAR (11)	CAR (3)	CAR (7)	CAR (11)
cross-market	0.0011 (0.0014)	0.0111 * (0.0063)	0.0285 ** (0.0117)	0.0017 (0.0014)	0.0118 * (0.0062)	0.0288 ** (0.0117)
addressed country	0.0014 *** (0.0005)	0.0037 * (0.0020)	0.0064 * (0.0035)	0.0013 ** (0.0005)	0.0030 (0.0020)	0.0054 * (0.0034)
addressed company	-0.0018 * (0.0011)	-0.0097 *** (0.0030)	-0.0099 ** (0.0046)	-0.0019 * (0.0011)	-0.0103 *** (0.0028)	-0.0112 ** (0.0045)
incumbent	0.0000 (0.0003)	-0.0002 (0.0010)	-0.0007 (0.0018)	0.0001 (0.0003)	0.0004 (0.0010)	0.0005 (0.0018)
fix-line	0.0001 (0.0004)	-0.0019 (0.0015)	-0.0047 * (0.0026)	-0.0000 (0.0004)	-0.0025 * (0.0015)	-0.0060 ** (0.0026)
mobile	0.0007 (0.0005)	0.0020 (0.0016)	0.0021 (0.0028)	0.0006 (0.0005)	0.0015 (0.0016)	0.0010 (0.0028)
foreign fix-line	0.0006 (0.0006)	0.0025 (0.0024)	0.0011 (0.0040)	0.0008 (0.0006)	0.0025 (0.0024)	0.0011 (0.0041)
foreign mobile	-0.0002 (0.0005)	0.0008 (0.0019)	0.0034 (0.0034)	-0.0002 (0.0005)	0.0009 (0.0018)	0.0032 (0.0033)
constant	-0.0020 (0.0015)	-0.0015 (0.0020)	-0.0285 ** (0.0121)	-0.0008 (0.0005)	-0.0138 ** (0.0064)	-0.0282 ** (0.0121)
country dummies included						
# Observations	2411	2411	2411	2437	2437	2437
F-Test (df)	0.99 (17)	2.37 (17)	2.48 (17)	1.03 (17)	2.83 (17)	2.97 (17)
R2	0.0061	0.0124	0.0130	0.0061	0.0136	0.0149
	CAV (3)	CAV (7)	CAV (11)	CAV (3)	CAV (7)	CAV (11)
cross-market	0.0002 (0.0003)	0.0006 (0.0014)	0.0008 (0.0028)	0.0003 (0.0003)	0.0013 (0.0014)	0.0020 (0.0027)
addressed country	0.0000 (0.0001)	-0.0001 (0.0005)	-0.0002 (0.0009)	0.0000 (0.0001)	0.0002 (0.0005)	0.0004 (0.0009)
addressed company	-0.0004 *** (0.0001)	-0.0018 *** (0.0004)	-0.0034 *** (0.0009)	-0.0002 ** (0.0001)	-0.0011 ** (0.0005)	-0.0021 ** (0.0010)
incumbent	-0.0006 *** (0.0000)	-0.0032 *** (0.0002)	-0.0065 *** (0.0005)	-0.0006 *** (0.0000)	-0.0032 *** (0.0002)	-0.0065 *** (0.0005)
fix-line	0.0000 (0.0001)	0.0001 (0.0004)	0.0004 (0.0008)	-0.0000 (0.0001)	0.0000 (0.0004)	0.0003 (0.0008)
mobile	0.0000 (0.0001)	0.0003 (0.0004)	0.0009 (0.0008)	0.0001 (0.0001)	0.000 (0.0004)	0.0014 * (0.0008)
foreign fix-line	0.0004 *** (0.0001)	0.0021 *** (0.0006)	0.0043 *** (0.0012)	0.0005 *** (0.0001)	0.0026 *** (0.0006)	0.0051 *** (0.0012)
foreign mobile	-0.0002 ** (0.0001)	-0.0015 *** (0.0005)	-0.0030 *** (0.0009)	-0.0003 *** (0.0001)	-0.0020 *** (0.0004)	-0.0042 *** (0.0008)
constant	0.0009 *** (0.0003)	0.0052 *** (0.0015)	0.0107 *** (0.0030)	0.0008 *** (0.0003)	0.0044 *** (0.0015)	0.0093 *** (0.0029)
country dummies included						
# Observations	2411	2411	2411	2431	2431	2431
F-Test (df)	13.19 (17)	14.45 (17)	14.79 (17)	12.31 (17)	13.53 (17)	13.80 (17)
R2	0.0566	0.0067	0.0626	0.0607	0.0650	0.0663

Note: \*\*\*, \*\*, \* represent significance at the 1, 5 and 10 percent significance level, standard errors are displayed in brackets.

Table 2.7: Estimation Results with Control Variables and Interaction Terms

	Technology Index			Telecom Index			Technology Index			Telecom Index		
	CAR (3)	CAR (7)	CAR (11)	CAR (3)	CAR (7)	CAR (11)	CAV (3)	CAV (7)	CAV (11)	CAV (3)	CAV (7)	CAV (11)
cross-market (1)	0.0011 (0.0014)	0.0102 (0.0064)	0.0286 ** (0.0119)	0.0017 (0.0014)	0.0109 * (0.0063)	0.0289 ** (0.0119)	0.0001 (0.0003)	0.0000 (0.0014)	-0.0005 (0.0029)	0.0002 (0.0003)	0.0006 (0.0014)	0.0005 (0.0028)
addr. country (2)	0.0018 *** (0.0006)	0.0052 ** (0.0024)	0.0090 ** (0.0043)	0.0018 *** (0.0006)	0.0044 * (0.0024)	0.0075 * (0.0042)	0.0000 (0.0001)	-0.0001 (0.0006)	-0.0002 (0.0012)	0.0000 (0.0001)	0.0002 (0.0006)	0.0005 (0.0012)
addr. company (3)	0.0017 (0.0015)	-0.0017 (0.0036)	-0.0041 (0.0070)	0.0020 (0.0015)	-0.0002 (0.0033)	-0.0020 (0.0065)	-0.0007 *** (0.0001)	-0.0042 *** (0.0007)	-0.0086 *** (0.0013)	-0.0006 *** (0.0002)	-0.0036 *** (0.0009)	-0.0072 *** (0.0018)
incumbent (4)	0.0002 (0.0003)	0.0004 (0.0012)	-0.0009 (0.0021)	0.0003 (0.0003)	0.0009 (0.0012)	0.0019 (0.0021)	-0.0006 *** (0.0001)	-0.0032 *** (0.0003)	-0.0065 *** (0.0006)	-0.0006 *** (0.0001)	-0.0032 *** (0.0003)	-0.0066 *** (0.0006)
fix-line (5)	0.0001 (0.0004)	-0.0019 (0.0015)	-0.0048 * (0.0026)	-0.0001 (0.0004)	-0.0025 * (0.0015)	-0.0060 ** (0.0026)	0.0000 (0.0001)	0.0001 (0.0004)	0.0005 (0.0008)	0.0000 (0.0001)	0.0001 (0.0004)	0.0004 (0.0008)
mobile (6)	0.0007 (0.0005)	0.0021 (0.0016)	0.0020 (0.0028)	0.0006 (0.0005)	0.0016 (0.0016)	0.0010 (0.0028)	0.0000 (0.0001)	0.0003 (0.0004)	0.0009 (0.0008)	0.0001 (0.0001)	0.0006 (0.0004)	0.0014 * (0.0008)
foreign fix-line	0.0006 (0.0006)	0.0023 (0.0023)	0.0011 (0.0039)	0.0008 (0.0006)	0.0022 (0.0023)	0.0011 (0.0039)	0.0003 *** (0.0001)	0.0016 *** (0.0005)	0.0033 *** (0.0011)	0.0004 *** (0.0001)	0.0021 *** (0.0006)	0.0041 *** (0.0011)
foreign mobile	-0.0002 (0.0006)	0.0002 (0.0021)	0.0040 (0.0040)	-0.0002 (0.0006)	0.0003 (0.0021)	0.0039 (0.0038)	-0.0002 ** (0.0001)	-0.0015 *** (0.0005)	-0.0030 *** (0.0010)	-0.0004 *** (0.0001)	-0.0021 *** (0.0005)	-0.0045 *** (0.0009)
1 x 5	0.0000 (0.0001)	0.0002 (0.0004)	0.0001 (0.0007)	0.0000 (0.0001)	0.0002 (0.0004)	0.0001 (0.0007)	0.0001 *** (0.0000)	0.0004 (0.0001)	0.0008 *** (0.0002)	0.0000 *** (0.0000)	0.0004 *** (0.0001)	0.0008 *** (0.0002)
1x 6	-0.0000 (0.0001)	0.0003 (0.0004)	-0.0003 (0.0007)	-0.0000 (0.0001)	0.0003 (0.0004)	-0.0004 (0.0007)	-0.0000 (0.0000)	-0.0001 (0.0001)	-0.0001 (0.0002)	-0.0000 (0.0000)	0.0000 (0.0001)	0.0001 (0.0002)
2 x 4	-0.0012 (0.0008)	-0.0047 (0.0029)	-0.0081 (0.0050)	-0.0012 (0.0008)	-0.0043 (0.0029)	-0.0069 (0.0049)	-0.0000 (0.0001)	-0.0001 (0.0006)	-0.0001 (0.0011)	0.0000 (0.0000)	-0.0000 (0.0006)	-0.0002 (0.0011)
3 x 4	-0.0045 ** (0.0019)	-0.0102 ** (0.0049)	-0.0080 (0.0087)	-0.0049 *** (0.0019)	-0.0126 *** (0.0045)	-0.0122 (0.0081)	0.0005 *** (0.0002)	0.0029 *** (0.0008)	0.0064 *** (0.0015)	0.0005 ** (0.0002)	0.0030 *** (0.0010)	0.0064 *** (0.0020)
constant	-0.0020 (0.0015)	-0.0133 ** (0.0065)	-0.0285 ** (0.0121)	-0.0025 * (0.0015)	-0.0138 ** (0.0064)	-0.0284 ** (0.0121)	0.0009 *** (0.0003)	0.0052 *** (0.0015)	0.0107 *** (0.0030)	0.0008 *** (0.0003)	0.0045 *** (0.0015)	0.0093 *** (0.0029)
country dummies included												
# Observations	2411	2411	2411	2437	2437	2437	2411	2411	2411	2431	2431	2431
F-Test (df)	1.00 (21)	2.02 (21)	2.05 (21)	1.08 (21)	2.48 (21)	2.47 (21)	11.78 (21)	12.93 (21)	13.31 (21)	10.44 (21)	11.53 (21)	11.76 (21)
R2	0.0073	0.0137	0.0140	0.0074	0.0150	0.0156	0.0640	0.0698	0.0722	0.0691	0.0748	0.0758

Note: \*\*\*, \*\*, \* represent significance at the 1, 5 and 10 percent significance level, standard errors are displayed in brackets.

**Company-specific regulations** have a significantly negative impact on stock price returns. Moreover, including interaction terms with incumbency provides evidence that the negative effect stems from the combination regulation – incumbency as the explanatory power of the regulation term shifts to the interaction term. The reduction in volatility in line with company-specific regulation underlines these findings. If an intervention addresses single companies, shareholders' interpretations of the action are more akin leading to a significant reduction in stock price volatility. In alternative estimation approaches, I include dummies to consider the reactions of other companies in the market of the addressed companies (see Table A.7). From the previous discussions, we should expect a positive externality on competitors if the SMP of one company in the same market is reduced. However, the estimation results provide only weakly significant evidence, if at all.

Following the discussion in line with **Hypothesis 4**, a stronger reaction in absolute terms for company-related interventions than for cross-market and country-addressing interventions should exist. Moreover, volatilities in reactions should simultaneously be lower. The comparison of the relevant coefficients requires the consideration of the difference in absolute values. If this difference is significantly positive or negative the strength of the impacts differ from each other. Wald test results provide no evidence for significant differences between type-3 intervention coefficients and the coefficients of the other types of interventions for the returns estimations. In the volatility estimations, company-addressing interventions result in a significantly lower reaction than indirected interventions. Including interaction terms between country-addressing interventions and incumbency provides similar results: Firm owners expect no differences in the size of the regulatory impacts on the affected companies dependent on the type but their reactions are more akin with directed interventions. These results confirm the argumentation in line with Hypothesis 4 only partially. By including an additional administrative stage, regulation better meets national distinctions due to regulators' proximity to markets under scrutiny. However, additional interested groups on the national level react on regulatory announcements, which are, firstly, national governments and regulators and,

secondly, also the addressed companies in the market as soon as the announcement of a change in the market structure is available. In consequence, at the point in time of the EC regulatory announcement, companies do not know the actual regulatory adjustment, which will be finally implemented to the markets. This causes uncertainty, which is expressed by higher stock price volatilities. In contrast, directly addressing individual companies excludes the intermediate stage, which reduces regulatory uncertainty and the uncertainty about the final market outcome.

The comparison of the H2 estimation results and the H3 estimation results raises the question whether affected companies discriminate between the type of EC interventions. While no significant difference is identified in absolute values, Wald tests on the difference between the coefficients confirm the idea that companies discriminate. Thus, the estimation results support Hypothesis 4, i.e. companies distinguish between indirected regulation (cross-market-related regulation and country-related regulation) and directed regulation (company-related regulation) with their adjustments of market strategies. However, the strength of reactions does not differ between the types.

The consideration of the control variables provides little evidence for significant differences between fix-line activities, mobile or mixed activities. Mobile providers' stock price returns react in line with fix-line providers' stock price returns, independently of whether an event addresses a particular mobile or fix-line market. In contrast, a significantly negative effect is found for fix-line companies only for the largest event window. While no significant effect on returns exists for the cross-market – fix-line interaction coefficients, a significant increase in volatility is found. Including dummies for foreign-country activities results in an ambiguous picture: Fix-line providers' stock prices are more volatile. However, no such enhancement effect is found with multi-mobile market activities. The volatility effect is even stronger when being active in more fix-line markets.<sup>18</sup> Fix-line regulation has a much stronger impact on market outcomes than mobile regulation, which could be due to the higher market concentration in fix-line markets.

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<sup>18</sup>Estimation results on multi-market activities are displayed in Table A.5 in Appendix A.1.3.



In a nutshell, the findings confirm the idea that affected companies react differently to regulatory interventions by the EC. While the EC uses two alternative instruments to affect the outcome of particular national markets – either by addressing the country, i.e. the government or the regulator, or by addressing individual companies – company reactions to these regulation announcements do not significantly differ. While market-related actions shift the actual market implementation to the national administrative stage and, thus, leave more room for national adjustments, directly addressing companies excludes uncertainty stemming from national influences. However, stock-price reactions prove that company-addressing interventions do not necessarily improve the situation for competitors in the same market.

## **2.7 Conclusion**

In this chapter, I considered how the value of companies is affected by announcements about the adoption of alternative regulatory instruments by the EC. Regulatory interventions are classified into three categories depending on the addressee. The first type of interventions are cross-market approaches to build or change the common regulatory and competition framework of all EU member states. The second type of interventions are actions against particular country laws or habits if the EC finds one company or a group of companies to benefit from the national situation compared to competitors due to the actual implementation of the EU regulatory guidelines. The last type of interventions are actions against particular companies. Each of these interventions affects the market structure or the behavior of individual companies, which changes companies' expected future profits and, thus, their net present values.

By employing a modified event study approach, I have considered how these alternative types of interventions are evaluated by the market. While the first two types, cross-market and country-interventions, address markets as a whole, the last type directly addresses individual companies. However, all approaches are implemented to enforce competition and to increase efficiency. Cross-market- and country-related types

of interventions are found to have a significantly positive effect on stock price returns, which is in line with the intention of the EC. Similarly, a negative effect exists for the last type as this kind of interventions is implemented to weaken an anti-competitive advantage of the addressed company or group of companies. Nevertheless, no significant differences in the size of the reactions is found between alternative types of interventions but in the strength and the direction.

These results provide new insights into the intentions of European regulations and how to employ the EC regulatory instruments more effectively. With regard to particular national market interventions, the EC can choose between two instruments, which are country-related interventions or company-related interventions. The market outcome depends on the EC's suspicion whether national administrations implement their aims adequately. While country-related interventions leave room for adjustments to national distinctions in the implementation process, company-related interventions exclude this adjustment step. Although the expected size effect on companies is independent from the type of interventions, indirected interventions of regulatory adjustments result in more uncertainty about the actual implementation as regulation is additionally adjusted by governments and regulators on the national stage after the European announcement. Therefore, companies are aware of forthcoming regulatory changes but they do not know the actual implementation to the market structure which raises uncertainty.

Moreover, the estimation results provide evidence that country-related interventions lead to similar expectations of incumbents' and competitors' shareholders even if the reason for an intervention is existing significant market concentration in favor of the incumbent. These results support the findings in the literature on national regulations. Following Krouse and Park's (2003) argumentation, the efficiency increase of interventions outweighs the negative direct impact on the incumbent's firm value. On the other hand, company-related interventions, which mostly address incumbent providers, result in no significant externalities on competitors.

The event study methodology is an established approach to evaluate regulatory actions. So far, it has been mostly used for single company considerations in telecommunications (Rudolph and Johanning, 2004; Ehrmann et al., 2005; Bel and Trillas, 2005). Employing it to multi-companies studies allows for an econometric analysis of market reactions to regulatory changes. Nevertheless, some pitfalls have to be kept in mind, which require attention also in future work: Firstly, a selection bias exists as only larger, listed companies could be considered. In regulated markets, new entrants are mostly smaller and not necessarily listed at a stock exchange, which means that larger providers are over-weighted in a sample. Secondly, the methodology strongly relies on expectations about the future outcome of today's regulation as stock prices represent discounted expected future profits. Finally, multi-companies studies require the consideration of cross-company effects. Multiple GARCH models allow the consideration of cross-effects. However, estimation complexity still demands a short-time structure.

Nevertheless, until today the empirical consideration of single changes in regulatory patterns is mostly reduced to descriptive comparisons as a change in regulation can hardly be statistically isolated from other market drivers because of its long-term orientation. The event study methodology is an instrument to bring a regulator's long-run expectations about a regulatory intervention down to a short-run evaluation of the market.

# 3 The National Regulatory Structure against the Background of the European Regulatory System

## 3.1 Introduction

Multiple political powers affect regulation and, thus, the development of telecommunications on the European level, the national level and the sub-national level. The EU Parliament and the EC seek to reach the objective of a pan-European integration of member states' telecommunication markets and provide the necessary regulatory instruments on both the European and the national level. National governments support this aim but are additionally interested in not losing national sovereignty. Moreover, national governments follow aims, which are not primarily in line with the integration process but which have to address individual member states' goals and which have to tackle individual member states' challenges. Due to the key role of telecommunications for economic development, national governments are comprehensively engaged in their national telecommunication sectors in alternative roles. In this chapter, I consider these roles of national governments under the European regulatory framework with a particular focus on the implementation of the first two Regulatory Packages<sup>1</sup> and how they affect the development of national telecommunication markets.<sup>2</sup>

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<sup>1</sup>These are the Regulatory Package of 1998 in line with the liberalization and the Regulatory Package of 2002/2003 for the harmonization of national telecommunication markets preparing the integration process.

<sup>2</sup>I concentrate on the governmental influence on the sector and, to a far extent, refrain from the reverse influence where this is possible.

### *3 The National Regulatory Structure*

A number of studies exist which address the role of the government in particular industries. Seminal papers are the contributions by Stigler (1971) and Peltzman (1976) or, more recently, Henisz and Zelner (2001). Persson and Tabellini (2000) and, subsequently, Duso and Röller (2003) consider the political influence in the context of (de-)regulation. While most studies analyze the role of the government in the economy or in regulated sectors as a whole, the telecommunication sector provides a particular situation, firstly, because of its key role as an input good for other industries and, secondly, because of its historical background as a fully governmentally controlled sector, which has been liberalized. This background caused strong interrelationships between national governments as well as public administrations and incumbent operators and led to personal interdependencies between market participants and governments or between regulators and governments. The strong interrelationships between political powers and telecommunication sectors are under the suspicion of the EC as they might influence competition and the European integration process.

Concerning network-based markets an ongoing debate exists among academics, politicians and infrastructure and service providers about the compatibility of long-run investments with a sunk-cost character and competition on the infrastructure or, also, between alternative infrastructures. The key regulatory challenge is the provision of adequate investment incentives when competition keeps profits low. Against this background, Section 2 provides an overview of the European regulatory system with its instruments and how they are implemented to balance these static and dynamic regulation aims. Moreover, I describe the discussion of competition promotion and infrastructure investments based on the existing European regulatory system.

Section 3 considers the alternative roles of governments as the representatives of states in the telecommunication sector. As lawmakers, governments determine the framework for the development of the sector as a whole. Simultaneously, governments affect strategic decisions of regulators as, in general, national parliaments elect the members of the regulators' presidential chambers, i.e. the strategic departments of regulators. On the other hand, governments are involved in sector participants and directly influence sector

### *3.2 Regulation – the pan-European Perspective*

activities as, in most countries, they still keep minority stakes in telecommunication operators and support the installation of infrastructure with public grants. Combining the measures available in the alternative roles even increases regulatory powers to affect sector activities and to control the sector as a whole. I use examples from the EC Implementation Reports to consider the dichotomous roles of governments in the interplay of investments, competition and regulation and compare the national outcomes.

Section 4 is an extension to the previous sections as it discusses main regulatory changes of the Third Regulatory Package, which have to be adopted to national laws by June 2011, in the light of the current market situation. Thus, Section 4 provides an outlook of expected future developments based on the current momentum in the European market integration process. Section 5 concludes the chapter and highlights some key aspects which require further consideration also under the Third Regulatory Package.

## **3.2 Regulation – the pan-European Perspective**

This section provides an overview of European regulatory instruments mainly from the EC perspective and, subsequently, discusses the double aim of competition enforcement and investments in the context of the First and the Second Regulatory Package.

### **3.2.1 Instruments for Harmonizing Regulation in Europe**

#### **Regulatory Packages**

The EC intends to merge individual telecommunication markets of EU member states to one common EU-wide market and uses both ex ante and ex post measures to implement this comprehensive task. The key pre-requisite is the harmonization of national telecommunication laws. Regulatory Packages determine the framework of regulation harmonization as they provide the guidelines to be implemented to national laws in all member states. Until today, two EC Regulatory Packages are effective. The first was established in line with the liberalization in 1998 as a framework for the transition of former monopolistic markets to efficient and competitive markets. The second was introduced in 2002/2003 to continue the harmonization of national telecommunications

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and to foster and to secure competition aims. Following the first proposal for this Second Regulatory Package, it became necessary to introduce new rules, which meet the unexpected technological and structural changes after the liberalization.<sup>3</sup>

Each Regulatory Package covers a range of multiple guidelines ordered in directives which give more detailed information about how regulation should be implemented on the national level. For example, the Second Regulatory Package consists of the Framework Directive, which provides the general framework for the implementation of regulation, and five specific directives, which all cover a particular issue in national markets.<sup>4</sup> Member states are obliged to transpose these directives to national laws in a pre-determined period of time taking into account country distinctions.

Due to the growing importance of customers as active information providers, the Third Regulatory Package stronger secures the new role of customers fostering the pan-European integration of telecommunication markets. This last Regulatory Package was set up after the second round of market reviews in 2006, was introduced in December 2009 and has to be transposed to national laws by June 2011.

#### Monitoring and Controlling the Integration Process

While Regulatory Packages provide the strategic perspective for harmonizing European regulation efforts, the EC uses alternative measures and institutions to smooth the long-term regulatory process and to react on current issues. In particular, it demands a vivid exchange of information based on public consultations with interested groups before adopting new regulatory steps or adjusting current regulations. Considering the monitoring procedure, NRAs are obliged to analyze markets on a regular basis and consider whether companies with SMP exist. The results of these analyses are reported to the EC (Framework Directive, article 16). This individual market information offers a comprehensive knowledge stock about national markets as a whole, individual companies with

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<sup>3</sup>[http://ec.europa.eu/information\\_society/topics/telecoms/regulatory/new\\_rf/documents/com2000-393en.pdf](http://ec.europa.eu/information_society/topics/telecoms/regulatory/new_rf/documents/com2000-393en.pdf)

<sup>4</sup>The five specific directives are the Access Directive (2002/19/EC), the Authorization Directive (2002/20/EC), the Universal Directive (2002/22/EC), the Directive on Privacy and Electronic Communications (2002/58/EC) and the Directive on Competition in the Markets for Electronic Communications Networks and Services (2002/77/EC). Please also see Figure A.1 in Appendix A.2.1.

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SMP and also NRAs, national laws and particular aspects of national regulation habits. Based on this information and on own monitoring results, the EC directly intervenes in telecommunication markets if it suspects the situation in a market not to be in line with the EU regulatory framework.

The EC uses mainly three types of instruments to intervene on current regulatory issues depending on the addressee: Firstly, the most comprehensive intervention refers to a particular market type across all member states. It is adopted if the EC expects Regulatory Packages not to meet a particular issue, due to changes in the market structure or due to technological changes (cross-market interventions). Secondly, the EC addresses a member state market if it suspects national regulation to be insufficient or if current or forthcoming regulatory practices benefit one company over its competitors (country-addressing interventions). An example, which will be discussed below, is the roll-out of high-speed internet in Germany. Thirdly, the last type of interventions addresses single companies or a group of companies if SMP is abused (company-specific interventions). While the first two types require reactions by national institutions, the government or the regulator, the last type directly addresses individual companies and, thus, comprises the gray area between regulation and antitrust.<sup>5</sup>

Alternative approaches in line with the harmonization and integration of European telecommunication markets offer a comprehensive set of instruments for the regulation process which are primarily based on a top-down approach due to the coordination of the European integration process (the Regulatory Packages, the monitoring procedures). On the other hand, reverse loops are installed providing input to the EC (consultations with NRAs and other interested groups). Moreover, national distinctions are explicitly recognized in the transposition process of Regulatory Packages to national laws. With this combination of reverse monitoring and controlling mechanisms, the integration process allows for comprehensive sovereignty of national member states. However, national governments use their sovereignty to follow own aims with national telecommunication sectors, which are not necessarily in line with the pan-European integration aim as will be discussed in Section 3.3.

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<sup>5</sup>More detailed information about the alternative instruments of the EC and how their execution affects markets and companies is provided in Chapter 2.



### 3.2.2 Investments and Competition

Telecommunications experienced a comprehensive change in transmission technologies between the late 1990s and about 2004. Radical technological innovations enable much higher transmission rates, which allow for higher-quality services on the existing infrastructure.<sup>6</sup> Although improvements in the transmission technology encourage higher-quality services, the majority of the existent physical infrastructure components remain on their basic level. In consequence, an increasing gap between physical infrastructure development and the transmission technology development exacerbates the internalization of service profits by physical infrastructure operators.

Service providers take up the potential of higher transmission capacities, firstly, by providing more services and, secondly, by providing higher-quality services. This differentiation on the service level increases the attractiveness of telecommunication usage as a whole. As a result, transmission system innovations move telecommunication markets from a "supply push" situation to a "demand pull" situation.<sup>7</sup>

However, the introduction and protection of efficiency and competition is an ongoing challenge within the European integration process. After competition has been installed on the service level, the cumbersome task to be solved is local loop competition, which requires NRAs' and competition authorities' attention until today. As infrastructure providers bear the risk of (not) re-financing investments, they choose the level of infrastructure availability based on company-specific strategic aims but ignore positive externalities provided by their investments. Following Knieps (2007) and Bauer and Bohlin (2007), national telecommunication laws must strictly determine the environment for efficient local loop access negotiations. Consensus exists among politicians, NRAs and telecommunication companies on the essential facility property of the local loop. However, the guidelines in the Second Regulatory Package leave room for interpretation resulting in additional challenges in the national transposition process. As

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<sup>6</sup>Think of, e.g., ADSL, which requires physical adjustments in the street cabinets to enable higher speed services like, e.g., VoIP services (De Bijl and Peitz, 2005).

<sup>7</sup>The impact of service competition on infrastructure provision is considered in Chapter 4 in more detail.

### *3.3 The Dichotomous Roles of Governments in the Telecommunication Sector*

the Regulatory Packages provide no further details on how to implement directives to national laws, lawmakers on the national level have repeatedly chosen an insufficient level of concreteness in the transposition process.

In a nutshell, the EC follows the aim of telecommunication market integration across all EU member states with alternative instruments, which include directed and indirect interventions and ex ante and ex post monitoring and controlling instruments. Regulatory Packages are the key vehicle as they prepare the steps to the integration and guide the comprehensive preparations. The rules provided in this framework have to be transposed to national laws by national governments taking into account national distinctions. As EU member states are at different stages of market competition and infrastructure availability and quality, the guidelines are set at a very high level of abstraction. This provides a particular challenge for NRAs' implementation to markets as national transpositions of highly abstractive guidelines also result in a low level of concreteness in many national telecommunication laws. Moreover, insufficient transposition and in-transparent decision-making on the national stage hamper both competition and, in particular, investments in many EU member states.

### **3.3 The Dichotomous Roles of Governments in the Telecommunication Sector**

Due to the high impact of telecommunications on other sectors, national governments follow multiple dichotomous aims in telecommunication markets. These aims are the transposition of the EU guidelines as well as the installation of a sufficiently high level of infrastructure and service quality and the installation of competition and efficiency. However, they also comprise individual national aims, which directly and indirectly affect the transposition process. Until today, most EU member states are actively engaged in their telecommunication sectors by keeping shares and stakes in the incumbent operator and by providing legal and financial incentives for infrastructure investments. Following

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Levy and Spiller (1994, 1996), institutional endowments of countries in a sector influence the implementation of regulatory rules and directly affect the strategic behavior of regulated companies.

Turning to the link between infrastructure provision and users, governments use their interrelationship to sector companies to support the installation of adequate infrastructure quality and availability. Based on the Universal Service Directive and the Framework Directive (2002/21/EC, Article 8.2), national governments have to balance the roll-out of high quality infrastructure in more profitable regions and the availability of an adequate level of infrastructure quality in less profitable regions. Thus, they have to keep the urban-rural quality differential as low as possible. While this is of minor importance for smaller countries such as the Netherlands, it is a major problem for larger countries with a lower population concentration such as France or Germany. In densely populated areas, companies voluntarily invest as they expect to re-finance their investments in a shorter period of time. In contrast, infrastructure providers are less interested in investing in less densely populated areas because of a lower return-on-investments ratio. Therefore, investments in rural areas are enforced by universal service obligations and public funding to guarantee a basic level of infrastructure capacity. In the following, I consider alternative roles with which governments influence telecommunication competition and investments, how they are implemented and how they interact.

#### **3.3.1 Governments as Lawmakers and Providers of the National Regulatory System**

Governments have to develop and maintain a legal system, which adopts the alternative propositions on infrastructure provision and competition derived from the Regulatory Packages. On the one hand, such a system determines the framework for the current market situation and, on the other hand, it has to be flexible for adjustments in the market structure and in technological developments. Thus, such a framework has to balance static and dynamic regulation aims depending on the underlying intention of governments. The EC is aware of these challenges for national policymakers in the

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transposition process and allows for flexibility, firstly, with regard to adjustments to national distinctions, secondly, in terms of transposition time and, thirdly, due to the concreteness and wording of national laws.

National distinctions comprise geographical and demographical as well as cultural differences and distinctions in national administrative systems. While geographical and demographical aspects are observable and could easily be monitored by European administrations, cultural distinctions and, in particular, aspects depending on national administrative systems are not fix requisites but could mostly be adjusted only with a long-term perspective. This is a key challenge in the telecommunication sector: The administrative system is strongly based on the sector structure before the liberalization with one publicly owned telecommunication provider and a low level of technological change. However, this system hardly meets the market development after the introduction of competition, which hampers the position of competitors due to lagging regulatory flexibility.

The transposition time is the time span between the introduction of a new Regulatory Package and the finalization of its implementation to the national law. While the Regulatory Package determines a final date for the transposition, this requirement provokes criticisms by the EC as national governments have intentionally extended the transposition process. In particular, when transposing the First Regulatory Package, many countries needed more time than the pre-determined period. In less innovative industries, an extension of the implementation time shifts upcoming competition to the future. However, in the telecommunication sector, the extension of the first transposition period came together with the implementation of more comprehensive transmission technologies in fix-line markets (broadband for private customers). Thus, the extension of the transposition period enabled incumbent operators to establish their customer base with no or only little competition, which provided an increasing first-mover advantage. Based on long-lasting contracts, customers were locked in with their providers. Consequently, even the EC requirement of local loop unbundling in 2000 (Regulation No. 2887/2000/EC) has had only a weak effect on competition.

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Table 3.1: National Lawmaking against the Background of the EU Regulatory Guidelines

Year	Country	Statement/Concern
1997	UK	Main principles of the first regulatory package became effective.
	UK	Authorities have hampered local loop access for competitors arguing that the access to the copper loop would not improve local loop competition. In contrast, such a step would jeopardize the development of facility-based competition.
1998	Germany	The incumbent was required to offer unbundled local loop access but only for fully unbundled raw copper lines.
1999	Sweden	The Swedish regulator PTS proposed an amendment to the national Telecommunications Act which enables PTS to unbundle the local loop through licensing conditions.
before 2000	Netherlands	Main Distribution Frame (MDF) access was considered to be a form of special access what contradicted the habits in other countries.
2000	France	Competitors argued that shortcomings in the administrative power of the regulator hamper upcoming competition on the local loop. Moreover, disputes about ADSL provision would have resulted in a barrier to competition, this particularly affects the entry of smaller and medium competitors. In their perspective, public authorities failed to act decisively on the behavior of the incumbent. In consequence, the incumbent operator was able to expand his strong and even dominant position in the broadband market.
2001	France	The EC points out decisive delays in the implementation of local loop competition and the access to collocation sites what would be mainly due to the absence of clear and effective enforcement procedures.
	Netherlands	From 31 December 2000 until mid September 2001, in the crucial time period of local loop unbundling and ADSL roll-out of the incumbent, OPTA was appointed as the Dutch regulator but was not designated as the NRA in charge of executing EC regulation what led to significant delays in the introduction of full unbundled local loop accesses in the Netherlands.
	Sweden	The Swedish Telecommunications Act does not provide the powers to the NRA to demand for the introduction of flatrate internet access call origination (FRIACO) which is found to be a central requisite for retail competition in other countries.
2004	Germany	The German Telecommunications Acts categorizes market squeezing as an abusive strategy. However, the EC doubtfully raises concerns given potentially positive effects on competition. A corresponding resale obligation is also limited until 30 June 2008 and covers only the resale of access services which is bundled with other services.
	Netherlands	The attempt to impose a bitstream access obligation on the fixed-line incumbent operator has been annulled in the court of justice as the obligation could not be derived from the relevant applicable legislation.

Source: Information taken from the respective EC Implementation reports (1998, 1999, 2000, 2001, 2004, 2005).

Turning to the third aspect, due to their long-term perspective, infrastructure investments require non-ambiguous legal rules and a highly transparent regulation pattern, which enable investors to foresee future steps of major adjustments in telecommunication laws. A less concrete level of national law wording offers room for interpretation driving the workload of national and European courts. Therefore, both incumbent and entrant infrastructure providers demand a high level of concreteness in law wordings. Examples, which concern these issues are provided in Table 3.1. Let us shortly consider the case of local loop unbundling in Sweden as it comprises all three aspects: While

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95 percent of Swedish households had access to multiple networks already in 1999 (which mainly comprises fix-line and mobile access), local loop competition was suspected by the Swedish regulator PTS to be insufficient at the time. Therefore, it proposed amendments to the telecommunication law forcing vertically integrated providers with SMP to let competitors into their markets on a cost-based access price. As the Swedish government suspected the proposal of PTS to infringe the Swedish constitution, the process of law adjustments delayed local loop access regulation until 2004. Meanwhile, from 31 December 2000 onwards, EU regulation required operators with SMP in the local loop to provide offers for access to competitors. In consequence, the Swedish incumbent voluntarily opened the local loop for competitors but it chose access prices which were in-competitively high as explained by entrant candidates. Turning to the challenge of lawmaking, the inflexible administrative system caused an insufficient implementation of legal rules providing a significant first-mover advantage to the incumbent. This affected local loop competition for a comprehensive period of time even after the adjustment of the law.

#### **3.3.2 NRAs: From Ministry Departments to (In)Dependent Public Institutions**

The WTO (1996) describes an independent regulator as a regulator being "separate from, and not accountable to, any supplier of basic telecommunications services".<sup>8</sup> While this definition relies on the direct interrelationship of the regulator and the regulated market, the EU regulatory approach extends this definition to the interrelationship of regulated companies and political authorities (Article 3 of the Framework Directive). Moreover, the Framework Directive and the Universal Service Directive require NRAs to control and support users' security interests. The stricter separation of companies and the national administrative system and the simultaneous support of users' rights overweight the demand side in the European regulatory system.

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<sup>8</sup>[http://www.wto.org/english/news\\_e/pres97\\_e/refpap-e.htm](http://www.wto.org/english/news_e/pres97_e/refpap-e.htm)

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Independence of NRAs is legally guaranteed by allocating the administration of shares of telecommunication companies and ownership tasks in different departments than the super-ordinated ministry of the NRA. However, the EC repeatedly raised concerns about the actual implementation of such a separation during the first years after the liberalization and still worries about separation in some member states such as France and, most recently, the Czech Republic (Implementation Report 2008). One key point of criticism is that NRAs are officially separated from governmental authorities in most countries but are accountable to the parliament or other super-ordinated political powers, which determine the legal definitions of NRAs' decision space or budget constraints.

Most NRAs are historically derived from former ministries and adherent public administrations. In consequence, NRAs have adopted personnel and employment structures from their predecessors both for strategic and lower hierarchy units. In most countries, the members of the presidential chamber are elected by national parliaments, nominated by the national president or the ministers in charge. Thus, the members of the presidential chambers have proven consistency with the political parties of their electors before their election.<sup>9</sup> Considering lower hierarchies, NRAs compete with regulated companies for high-skilled employees on the job market. However, as in most EU member states, NRA employees are civil servants, more comprehensive incentives such as higher salaries and a broader perspective of personal development and flexibility make companies much more attractive for job market candidates (ECTA Regulatory Scorecard 2008, executive summary).<sup>10</sup> In many member states such as the UK or the Netherlands, this job market competition between NRAs and regulated companies led to comprehensive turnovers of NRA personnel after the liberalization and resulted in understaffed NRA departments for multiple years. While regulators, such as OFTEL/OFCOM, are aware of the challenge, they can hardly intervene due to requirements of national lawmakers (Implementation Reports 2000, 2001). Moreover, NRA employees were (and still are)

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<sup>9</sup>See the discussion in the Special Opinion ('Sondergutachten') 2003 and 2009, two monitoring reports of the German Monopolies Commission.

<sup>10</sup>The ECTA (European Competitive Telecommunications Association) supports regulation activities in the interest of entrants to telecommunication markets.

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poached by regulated companies, which, firstly, hampers the creation of specific expertise and, secondly, leads to a migration of the existing knowledge stock from NRAs. Deficits in human resource management and, as a consequence, knowledge management hamper the implementation of sustaining regulatory policies.

Additional problems are directly derived from the weakness of human resource management: New entrants complain about the very short-term oriented regulation focus. Following their view arguments, NRAs mainly consider single market aspects but ignore more urgent, broader challenges leading to delays of market developments and providing uncertainty. In particular, new entrants and the EC raised concerns that inefficiencies of NRAs enable incumbent providers to stabilize or even increase their market power. Examples on resulting challenges in local loop competition and investments comprise negotiation time rulings and penalties in the context of local loop access (Germany, 2000), ADSL wholesale pricing (Germany, 2001) or the lack of regulatory interventions in line with incumbents' aggressive pricing mechanisms (Sweden, 2001, and France, 2004).

As most European NRAs are derived from former ministries or subordinated government agencies, they keep their previous organizational structure. While this structure met the requirements of monopolistic markets with low technological deployments and a constant market structure, problems occur with the transition to more dynamic markets with ongoing comprehensive technological developments. Even today, the EC expresses concerns about the efficiency of developing decision processes in NRAs and argues that the lack of timely and pro-active decisions creates barriers to competition and investments. Following the EC argumentation, inflexibility within the organizational structure of NRAs hampers the transition process and the installation of innovative markets.

Some NRAs, in cooperation with their governments, have taken up the criticisms and restructured the internal organization to become more market-oriented as done in the Netherlands or Sweden. Other approaches, such as the UK example, also include the integration of telecommunication-related antitrust tasks and market controls into the scope of NRAs' duties.<sup>11</sup> These reorganizations prove department boundaries to become

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<sup>11</sup>This increase in regulator's powers goes in hand with a reduction of antitrust authorities' competencies.



### 3 *The National Regulatory Structure*

much more permeable for personnel qualified in particular fields of relevance and allow the creation of a flexible, project-oriented knowledge stock within NRAs not fixed to individual employees. Reorganization with the focus on market-orientation made OFCOM a commonly acknowledged group of highly skilled experts who consult the British government as well as the EC in line with regulation and investment decisions.

In consequence, the UK example is repeatedly considered as a benchmark for other NRAs: ECTA recommends that NRAs in other EU member states should receive even more complex regulatory powers including also the possibility of functional separation of regulated companies or decision rights on fining abusive companies based on their turnover.<sup>12</sup> After the functional separation of BT and its local loop unit Openreach in the UK, other NRAs, such as OPTA and PTS, also analyzed whether this approach could be transposed to their countries. However, they refrained from giving a recommendation to their governments due to strong differences to the UK situation. Whether a NRA should be equipped with antitrust instruments to stimulate the double-aim of downstream competition and high-quality infrastructure investments is criticized in the economic literature. In particular, Cave (2006b) and Whalley and Curwen (2008) argue that functional separation within the British incumbent did not have the expected success as the complexity of the task would be too comprehensive for OFCOM with its current personnel and its financial constraints.

Much more attention is paid to the opposite position for NRAs as the Implementation Reports give multiple examples for an insufficient decision space of NRAs. Concerning the interconnection of alternative infrastructures and the access of service providers to the local loop, the French regulator ART was able to intervene in negotiations only if one company formally requested its support or after negotiations have demonstrably failed. New entrants argued that this approach significantly delays upcoming competition. However, even after legal adjustments for increasing ART's powers in 2001, the regulator did not modify its rules of procedures. In consequence, the incumbent France Telecom regularly questioned the decisions of the regulator bringing cases to courts.

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<sup>12</sup>See the ECTA Regulatory Scorecard (2008).

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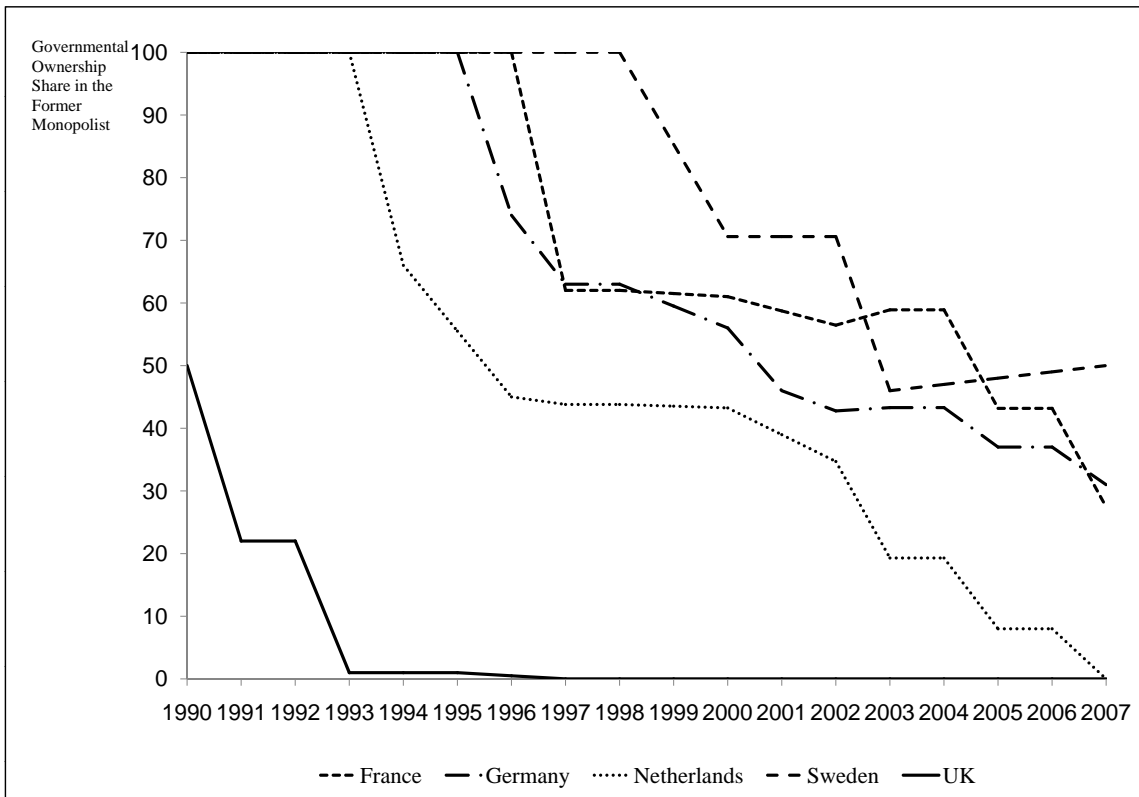
As long as court decisions are pending, this hampers competition-increasing actions by market participants and delays infrastructure investments due to missing legal certainty. Based on this and other examples, the EC suspects incumbents strategically to extend the process of the implementation of regulatory steps by challenging NRAs' decisions, as they know of the high workload of national courts. Such examples provide evidence that, besides lawmaking, also organizational and functional slack within regulatory agencies cause legal uncertainty and, thus, reluctance in investments.

In a nutshell, national governments comprehensively affect the strategic orientation of regulators: Firstly, they elect the members of the presidential chambers and, as lawmakers, determine the decision space of regulators. Secondly, they also indirectly influence the efficiency of NRAs by providing the status and incentive scheme for hiring NRA employees. While NRAs' organizational structures are derived from the predecessor organizations, they are not willing to adjust internal structures, which could provide a more case-based structure and, thus, accelerate regulatory decisions providing investment security. A magnitude of examples in the Implementation Reports show that these short-comings also influence national market developments and also the European integration process.

#### **3.3.3 The Government and the Incumbent – Infrastructure Provision**

Turning from the legal system and the situation of regulators to the markets, we find most governments to be minority stake-holders in national telecommunication incumbents even ten years after the beginning of privatization. Figure 3.1 displays that only the UK and, finally, the Netherlands have completely withdrawn their involvement. In contrast, in other EU-15 countries, public ownership shares were still above 25 percent in 2007. This raises the question of governments' intentions with minority stakes in former monopolists.

Figure 3.1: Public Ownership Share in the Incumbent



Source: Data taken from the OECD Regulatory Index

Following the literature, multiple reasons exist for governments' involvement in companies. One key aspect for public participation is exercising control rights. Minority-stake participation enables governments to affect strategic changes within the incumbent, which comprise its separation or its acquisition by a competitor (Bel and Trillas, 2005). As the EC has multiply brought cases to the European Court of Justice about Golden-Shares rulings in member states,<sup>13</sup> minority participation is a legal equivalent to secure public interests.

The EC heavily criticizes public involvements in former telecommunication monopolists as it suspects such an ownership constellation to affect regulation and competition in the telecommunication sector as a whole. The regulatory framework requires a strict separation of the regulatory agency-related authorities and the authorities administrating

<sup>13</sup>Examples are Portugal (2002) or Spain (2003).

### *3.3 The Dichotomous Roles of Governments in the Telecommunication Sector*

shares in the incumbent provider to alleviate the challenge of governmental influence on the sector development. However, in multiple cases, such as France before 2001 or the Czech Republic even in 2008, the EC still expresses concerns about an adequate implementation of separation.

Governments typically use control rights to follow sector-related or macroeconomic aims such as infrastructure provision of adequate quality and infrastructure roll-out to stimulate growth aims also in other sectors. The governmental intention of infrastructure provision deviates from managers' intention as telecommunication providers cannot completely internalize the economic benefits derived from infrastructure provision. Based on control rights, governments are able to influence the decision process for long-term investments directly balancing infrastructure roll-out concerning regional reach and concerning innovative technological infrastructure provision. Governments are aware of the capability of telecommunication infrastructure as an instrument for attracting high-potential companies in international competition with other countries, also within the EU. Thus, in contrast to the management of infrastructure providers, governments balance sector-specific competition aims, i.e. static regulation aims, with macroeconomic aims, which mainly refers to investments to provide a high-quality infrastructure for users.

While the EC cannot restrict a national government's macroeconomic strategy (even if this strategy causes rivalry among EU member states) it intervenes on the sector-level if such a strategy benefits one company over competitors. Such a case recently occurred in Germany, where the national government wanted to provide regulatory holidays to the incumbent, so that it could roll out its very high-speed internet network (VDSL) to selected cities. Consensus exists among providers, Deutsche Telekom and also its competitors, and the government that VDSL will have a positive impact on economic growth as a whole. However, the EC expected a first-mover advantage after the installation of VDSL for the incumbent on the service level due to regulatory holidays. Therefore, it abolished the decision of the German government and brought a case to the European Court of Justice. The court followed the argumentation of the EC and, in December 2009, prohibited the necessary adjustments of the German telecommunication law.

### 3 The National Regulatory Structure

While governments are less interested in maximizing shareholder values, their key interest lies in exercising control rights to follow sector aims and macroeconomic aims. In contrast to managers, governments seek total welfare maximization, which differs from profit maximization due to comprehensive positive externalities of telecommunications on other industries.

#### 3.3.4 State Aid and Active Public Participation

Comparing the situations before and after the liberalization shows that the role of telecommunications has dramatically changed from a sector which provides subordinated support for other sectors to one of the key sectors, if not *the* key sector, for economic growth in all developing and developed countries.<sup>14</sup> While physical infrastructure investments are a requirement not only for the development of the telecommunication sector but for the economy as a whole, infrastructure operators can hardly internalize the positive externalities which they provide to other sectors and households.<sup>15</sup>

State Aid is an instrument to control infrastructure investments from a macroeconomic perspective compensating at least partially for externalities provided by a high-quality infrastructure. It enables governments to install rules which separate infrastructure installation from downstream competition, thus, reducing the potential first-mover challenge repeatedly mentioned in line with vertically integrated providers of an essential facility.

Concerning the alternative instruments, I follow the EC definition of state aid:

"State aid is defined as an advantage in any form whatsoever conferred on a selective basis to undertakings by national public authorities."<sup>16</sup>

Based on this very broad definition, direct financial support, i.e. either monetary support or asset support, and privileges, like tax reductions, or legal burden reductions, like regulatory holidays, have to be distinguished.<sup>17</sup>

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<sup>14</sup>Röller and Waverman (2001) and also subsequent studies by Waverman find telecommunications and, in particular, broadband to be a key driver of economic growth.

<sup>15</sup>The impact of service competition and the impact of derived demand for infrastructure is considered in Chapter 4.

<sup>16</sup>[http://ec.europa.eu/competition/state\\_aid/overview/index\\_en.html](http://ec.europa.eu/competition/state_aid/overview/index_en.html)

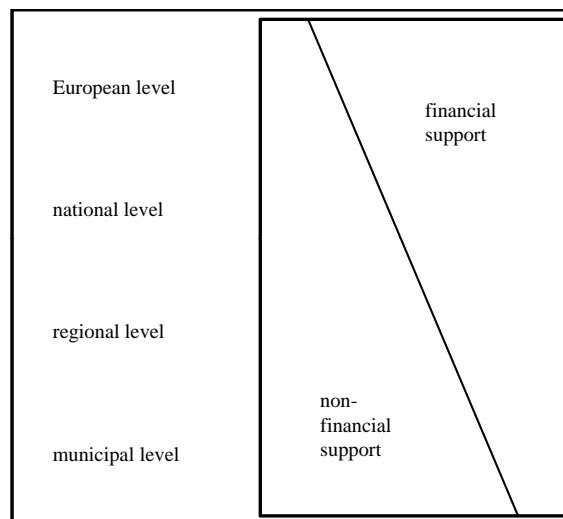
<sup>17</sup>An overview of state aid decisions since 2000 is provided in Table A.8 in Appendix A.2.

### 3.3 The Dichotomous Roles of Governments in the Telecommunication Sector

Both the EU and national authorities provide public aid in telecommunication markets either to expand infrastructure quality in less lucrative regions or to increase infrastructure quality in economic key regions. Moreover, also regional and municipal authorities support infrastructure investments. While European and national aid are mainly monetary grants for infrastructure roll-out, on the lower administrative level, various additional forms of public support are in place, which even include public private partnerships (PPP) with public authorities involved in administrative and control decision processes of the network provider (comprehensively in Sweden and France).

Two types of public aid have to be considered separately, which are financial and non-financial support.

Figure 3.2: Financial versus Non-Financial State Aid



#### Financial Support

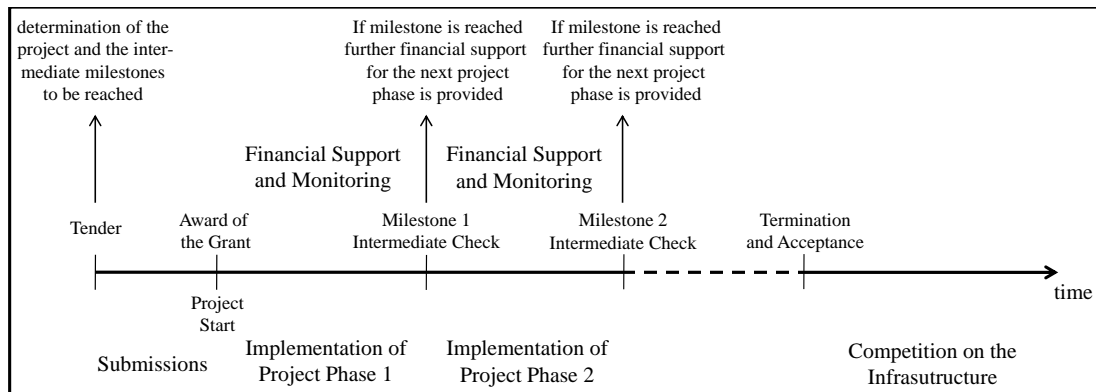
European authorities provide mainly financial support for network operators. In doing so, they assist the infrastructure roll-out in less densely populated areas and in less developed countries. Financial support comprises a pre-determined, mostly fixed amount for a particular project or part of a project. As a common level of infrastructure quality facilitates the integration of multiple national markets and the provision of similar services across all member states, the EU has a strong interest to reduce quality differences in

### *3 The National Regulatory Structure*

single countries and across countries. A high infrastructure-quality level across all member states provides a major advantage for attracting companies with an international focus as a high quality telecommunication infrastructure complements the existing high quality transportation infrastructure. The combination of both high-quality transportation infrastructure and high-quality telecommunication infrastructure are key assets for European countries in worldwide competition.

National governments offer both financial support and non-financial support for infrastructure roll-out. Financial grants are used to increase national infrastructure quality as a whole or to reduce the urban-rural differential of infrastructure quality. In consequence, financial grants foster the installation of new transmission technologies like broadband as e.g. in Sweden. Sweden financed the installation of broadband infrastructure to the centers of Swedish cities. While this strongly increased the acceptance of broadband internet by the Swedish population at an early point in time, it also provided a major advantage for the incumbent over new competitors, as it was the only Swedish provider, which could afford the installation task at that time. In combination with the restrictive regulatory policy and, thus, the low level of access competition, the competitive advantage for the incumbent was even stronger. In France, an alternative state aid strategy is in place in line with broadband initiations. Private broadband installation started at Paris and the surroundings of Paris and major cities such as Montpellier or Lyon, while rural areas were not that attractive for the incumbent and other providers. Therefore, municipal administrations supported by the national government addressed the issue funding broadband roll-out based on PPPs. As national and municipal administrations subsequently demanded decision rights and an adequate return on investments in line with local loop access, the EC heavily criticizes national and municipal governments' claims (Implementation Report 2000).

Figure 3.3: Infrastructure Projects Accompanied by Financial Aid



### Non-Financial Support

On the national and the sub-national levels, financial support is accompanied by additional privileges. In contrast to financial support, non-financial approaches are under much more discussion. Although the Access Directive requires non-discriminatory end-to-end user access (Access Directive (2002/19/EC), Article 3(1)), the provision of particular privileges enables infrastructure operators to discriminate between alternative providers depending on the access price. Similar to financial support, privileges enable the beneficiary to refund its investments. However, non-financial support requires a more comprehensive set of rules, which guarantee the installation of an adequate path to competition after the period of privileges while, simultaneously, investors must re-finance their investments.

As already discussed in the previous subsection, VDSL roll-out in Germany is an example for granting specific legal rights to an infrastructure provider. The German national and the Länder-governments have amended the German telecommunication law in the sense that new high-speed transmission technology is excluded from regulation.<sup>18</sup> As described above, the EC suspected a first-mover advantage for the incumbent as it would be able to decide on competitors offering services on the new infrastructure (contradicting Article 8 and other articles of the Framework Directive). However, the first-mover advantage remains a point of discussion as the EC definition does not exclude privileges for single investors from state aid.

<sup>18</sup>Actually, the proposition did not grant the privilege to the incumbent. However, no alternative infrastructure provider was able to benefit from this specific ruling.



### 3 *The National Regulatory Structure*

Moreover, specific legal rules could be used as an instrument to provide investment incentives for single infrastructure providers or a small group of infrastructure providers. But, in difference to most examples known from the past, such rules require a high level of transparency and project knowledge both from monitoring and controlling institutions and from the granted companies.<sup>19</sup> In addition, depending on the complexity of the project, pre-determined rules have to provide strict milestones, which are controlled and, if necessary, enforced by the controlling institutions which should be the regulator. However, transparent rules need not guarantee the success of the project but offer an economically realistic perspective for investments and their refunding.

This aspect is of particular importance with regard to the critical mass effect in social network-based markets. The critical mass describes the number of customers who are necessary for the sustainable existence of a social network. It is assumed that customers attract new customers, e.g. based on "friendship"-programs being locked-in with a particular company due to network size and "friends" being with the same provider. Thus, granting non-financial state aid must take into account the first-mover advantage of a vertically integrated investor as it is a highly relevant aspect of refinancing the project. In consequence, the phase of independent access control by the investor must be kept flexible and has to be controlled very carefully by the regulator. Pre-determined and commonly accepted rules have to be established at the beginning of the project. In particular, the phase of independent access control does not need to cover the total refinancing due to the first-mover advantage of the investor and the installed customer group before competition is allowed.

#### **Comparison of Financial and Non-Financial Support**

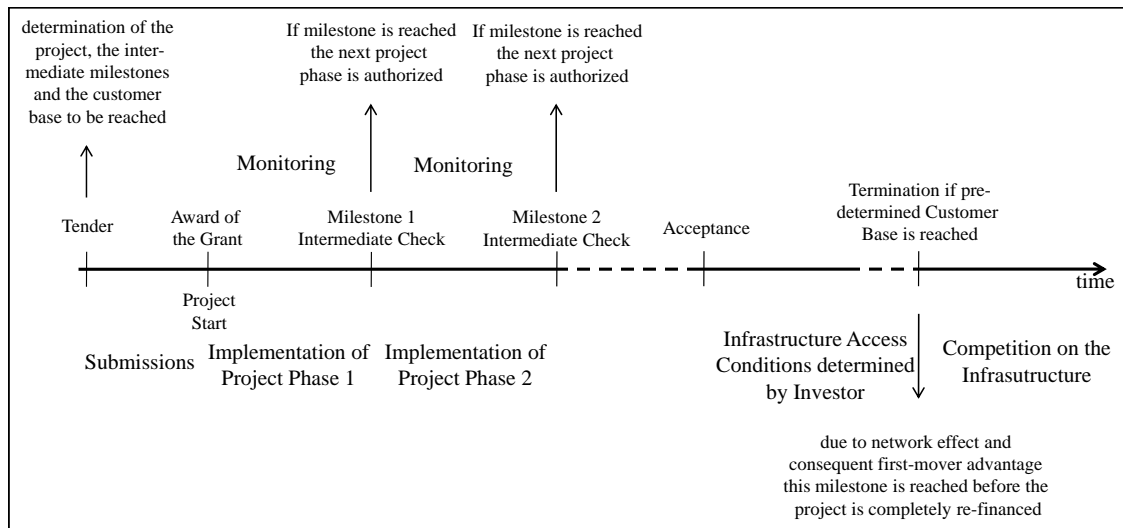
Comparing projects with financial and with non-financial support (Figures 3.3 and 3.4) shows that non-financial aid demands a longer period of project support as the refinancing phase begins after the investment phase(s). In consequence, non-financial support also requires a more complex preparation, as the critical mass aspect has to be

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<sup>19</sup>While these requirements should also accompany projects supported by a financial public grant, they are only implemented in a small number of projects.

### 3.3 The Dichotomous Roles of Governments in the Telecommunication Sector

Figure 3.4: Infrastructure Projects Accompanied by Non-Financial Aid



taken into consideration already in the project preparation phase. Non-financial state aid shifts the balanced consideration of chances and project risks in the direction of the investor as the responsibility for re-financing is with the investor. However, the investor is also informed in much more detail about the status of investments than the provider of a grant and also about the status of the project as a whole. Due to the ex-ante unclear development of the customer size, non-financial support demands also much more flexibility in the post-investment phase. These additional assumptions require a highly structured preparation of non-financial projects. However, adequate preparation and training of NRA employees should already be installed for monitoring public financial aid projects.

#### 3.3.5 Combining Roles to Affect the Integration Process

While I have considered the dichotomous roles of the government separately so far, the common effect of combining multiple strategies should not be ignored, as this could have a much stronger impact on the sector and on market developments and could be used to foster the European integration process even more than simply regulation can achieve. An example of such a strategy is the combination of legal rule settings and public grants to foster investments. Adequate and transparent rules are the pre-condition for a sufficient tender. If lawmakers offer an adequate framework under which conditions such

### *3 The National Regulatory Structure*

tenders could be constructed and also enforced, this would facilitate the installation of a grant and would strongly increase transparency during the implementation phases. Another example in this direction is the provision of an adequate legal system and its enforcement by the national regulator. A stronger proximity of regulators to markets requires also an efficient internal structure, which enables a less bureaucratic and prompt reaction to market changes. The information gained from such a proximity to markets could also run into the long-term oriented provision of a sufficient legal system as is shown in the UK.

On the other hand, governments could also follow the opposite strategy. Insufficient lawmaking and, simultaneously, strategically delaying NRAs' decision powers hamper the integration process.

However, while the EC intends to reduce the influence of national governments on the telecommunication sector, positive examples provide evidence that it could use the long-term interrelationship in the integration process to strengthen the European position as a whole. E.g. coordinating national governments' activities and their roles in the national telecommunication sector could be used to foster the interconnection of national infrastructures forming a pan-European telecommunication infrastructure to broaden the basis for pan-European market integrations.

The telecommunication sector is in the focus of a magnitude of governmental interventions. I have highlighted mainly four key types of interrelationships between public authorities and the sector with a particular focus on the challenges of investments and the installation of competition, which are providing the legal framework for the sector performance, affecting strategic decisions within the sector regulator, ownership participation of the former monopolist and public aid in the context of infrastructure projects. The consideration focuses on problems learned from past cases and provides some introductory discussions based on the literature and EC recommendations. With regard to the legal system and the regulatory structure, entrant companies and the EC repeatedly

mentioned the lack of contemporary and transparent regulatory rules and their implementation. With regard to companies and projects, the major challenge remains the internalization of positive externalities from infrastructure provision on other industries and customers.

## 3.4 Extension: The Third Regulatory Package

In December 2009, the European Parliament introduced the Third Regulatory Package, which has to be implemented to national laws until mid 2011. This new regulatory framework takes up various criticisms brought forward in line with its predecessors and fosters the national implementation process by providing stricter rules. In this extension, I consider the key changes in the light of the current market situations.<sup>20</sup>

### 3.4.1 Infrastructure Investments and Competition

As described above, the current regulatory framework balances the two aims of initiating investments and enforcing competition and leaves the priority decision to national governments and NRAs. National governments implement investment aims with varying efforts, which results in different levels of national infrastructure qualities and infrastructure competition in particular in the local loop.<sup>21</sup> The new regulatory framework attaches more attention to dynamic regulation aims, as the reviews under the current Regulatory Package provided evidence for upcoming competition. Based on the aims of the Lisbon Agenda, the new Regulatory Package further supports innovation aims on the service level by promoting the roll-out of high-quality infrastructure. In consequence, the new regulatory framework demands the installation of regional lead-market projects to foster the international competitiveness of the EU.

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<sup>20</sup>A more detailed consideration of the changes in line with the Third Regulatory Package is provided in Appendix A.2.3. In this extension, I only consider the key changes concerning the discussions of the previous sections.

<sup>21</sup>Please see Figure A.2 in Appendix A.2.3.

### 3 *The National Regulatory Structure*

Turning from balanced competition and investment aims to a stronger focus on high-quality-infrastructure investments, Article 8 of the 2002 Framework Directive on policy objectives and regulatory principles has been comprehensively revised in two directions: The proposal for Directive 2009/140/EC<sup>22</sup>, the amendment of Directive 2002/21/EC, requires national governments and NRAs to appropriately take into account the risk incurred by investors and proposes new forms of co-financing investments which have already been implemented in single member states (adjustment 8h (5d)): In particular, cooperative arrangements between infrastructure providers and service providers foster the internalization of externalities of a high quality infrastructure.

While this adjustment is established to facilitate the integration of positive infrastructure externalities, it can only partially alleviate the existing challenge: Service providers demand high upload rates and are therefore settled in regions with high infrastructure quality, which means urban areas. Thus, service providers are not necessarily interested in supporting the infrastructure roll-out in less-densely populated areas. As returns on infrastructure installation in urban areas are higher and less risky, the integration of service providers into the investment process alleviates the challenge of high quality infrastructure provision in urban areas. However, such an approach increases the urban-rural infrastructure quality differential without cross-regional subsidization.

Besides regional lead-market approaches for fix-line infrastructure quality, the new regulatory framework enhances facility-based local-loop competition by opening more (also denser) radio frequency bands for public usage. Following the communication of 20 March 2006, titled "Bridging the Broadband Gap", the EC explicitly mentions frequency bands to be an adequate and cheaper instrument for providing higher-quality broadband access to less profitable regions. Although having lower transmission capacities than fix-line broadband transmission systems, radio-frequency-based approaches increase the existing level of broadband infrastructure in rural areas at lower costs compared to fix-line infrastructure installation.

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<sup>22</sup>[http://ec.europa.eu/information\\_society/policy/ecomm/doc/tomorrow/reform/better\\_regulation\\_directive/st03677\\_re06.en09.pdf](http://ec.europa.eu/information_society/policy/ecomm/doc/tomorrow/reform/better_regulation_directive/st03677_re06.en09.pdf)

Besides the increase in investment flexibility, the German Monopolies Commission highlights mainly five changes in line with the Third Regulatory Package in its latest Special Opinion on telecommunication markets (Monopolies Commission, 2009), Co-Regulation, Independence of NRAs, Functional Separation, the European Regulatory Body and the Harmonized Implementation of Guidelines. I will shortly discuss them in the light of the previous sections.

### 3.4.2 Co-Regulation

For a better harmonization of regulation in the EU member states the European Parliament introduced a new regulatory stage for national governments and NRAs. Drafts for new market definitions, market analyses and the introduction of new regulatory measures have to be announced to the EC, other NRAs and the BEREC (Body of European Regulators of Electronic Communication).<sup>23</sup> Each of these institutions can provide further suggestions and comments, which have to be taken into account when implementing new measures. The EC and the BEREC can veto draft versions of market definitions and market analyses in coordination with the other if they suspect the proposals not to correspond with European guidelines.

In contrast to the previous regulatory approaches, this new instrument seeks a better coordination of national regulations. However, it increases complexity as it requires NRAs to inform other parties not familiar with the national situation about new regulatory steps and, additionally, it demands NRAs to analyze the regulatory approaches brought forward in other member states. Thus, co-regulation comprehensively increases the workload of NRAs and extends the implementation of regulation to the market. Following the Special Opinion of the Monopolies Commission, this new approach complicates the already complex regulatory system.<sup>24</sup> While co-regulation should foster the European integration process, it extends the national implementation of regulation, which will expectedly reduce regulatory efficiency as a whole as examples in line with the introduction of local loop unbundling have proven in many EU member states.

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<sup>23</sup>More information on the BEREC is provided below and in Appendix A.2.3.

<sup>24</sup>More information on this issue is provided in Chapter 2.

### **3.4.3 Independence of NRAs**

Following the new Framework Directive, national regulatory bodies and the presidential chambers shall become more independent from the national political system. In particular, when implementing European guidelines to national markets, the NRA shall not be allowed to demand for consultative political support and it will also not be allowed to accept such support. Moreover, presidents of NRAs and their vice-presidents must not be dismissed without violating national requirements for their tasks.

These more stringent rules support the recommendations in line with the discussion on NRAs' dependence on national political systems under the Second Regulatory Package. While the current guidelines try to guarantee the independence of decisions by separating the ministries in charge for administrating shares in the regulated incumbent and the NRA, these new rulings additionally require the independence of the NRA as far as possible from any political powers. This new independence reduces the broadly suspected and also observable interference on NRAs. However, it remains to be seen how this stronger sovereignty of NRAs affects regulation and the outcome of national markets in terms of more competition and efficiency.

### **3.4.4 Functional Separation**

Functional separation implies the separation of the network-operating unit and the service unit of a vertically integrated company. Functional separation shall provide non-discriminatory access conditions for service providers compared to the vertically integrated operator, as this provider has a strong incentive to affect service competition based on the access price or the access conditions to its essential input. This type of separation has been introduced in the UK and in Denmark and has been considered as a regulatory option also in other countries already under the Second Regulatory Package. Multiple arguments brought forward in the literature question this approach at the current stage of regulation and market competition. Firstly, functional separation is not sufficiently defined in the Regulatory Package. Examples known from the economic literature hint at the challenges of monitoring a functionally separated company

### *3.4 Extension: The Third Regulatory Package*

(Vickers (1995) for reasons of information asymmetry, Sappington (2006) for reasons of non-price discrimination, and subsequent studies on these topics). Secondly, the analyses of other NRAs after the UK approach and also the considerations in the economic literature (Cave, 2006b; Whalley and Curwen, 2008) show that the complexity of separation and monitoring the separated company might comprehensively increase the workload of NRAs with their current organizational structures. Thirdly, the German Monopolies Commission argues that functional separation is an extensive instrument, which should have been implemented at an earlier stage of the transition process. But it will not foster competition in the current, more developed situation of markets in the integration process.

Following these alternative points of criticisms, it is not clear whether national regulators will actually implement functional separation, in particular in EU-15 member states, which questions the necessity of this instrument as a whole.

#### **3.4.5 The pan-European Regulatory Body**

The BEREC (Body of European Regulators for Electronic Communications) will be a common European regulatory body consisting of the heads of the national regulators, which will support the EC in the adoption of new regulatory measures. In contrast to its predecessor, the ERG, this new institution will not only consult the EC on national issues but it will also have the opportunity to veto national regulatory measures if it suspects them to be insufficient or not in line with European regulatory guidelines.

While its decision powers are more comprehensive than the decision rights of the ERG, the BEREC is a trade-off solution, which leaves key competencies with national regulators and, thus, leaves major sovereignty at the national level. On the one hand, decentralized regulators have a stronger proximity to national and sub-national markets and, therefore, will probably react prompter to market issues in the future. On the other hand, the current form of the BEREC's decision rights with its veto powers complicates the implementation of national regulatory decisions as not only the EC but also the BEREC is allowed to intervene based on the co-regulation approach.



### 3.4.6 Harmonized Implementation of Guidelines

Previous regulatory measures by the EC had to be transposed to national laws taking into account national distinctions. With the new Regulatory Package, the EC is able to order how common regulatory rules have to be implemented to national markets. This stricter ruling reduces national governments' influence in the transposition process and, in particular, also with the implementation of specific regulatory interventions.

Chapter 2 provides evidence that directed European interventions reduce uncertainty in addressed markets in comparison to indirected interventions. However, the adoption of a particular regulatory rule to a group of all member states' markets ignores different stages of competition or infrastructure quality. While this approach is a reasonable attempt for harmonizing international telecommunication markets between member states, ignoring national distinctions might, currently, enhance the acceptance in national markets. Therefore, it does not necessarily foster the integration process as national markets still exhibit major technological and economic differences.

The Third Regulatory Package is to a far extent based on its predecessor regulatory framework. It takes up key aspects of criticisms and provides stricter rules which support the ongoing integration process. Concerning infrastructure provision and competition, the new framework emphasizes the importance of the infrastructure as an enabler of higher-quality services and as a key requirement for other industries. For internalizing comprehensive externalities with infrastructure provision, the new Regulatory Package allows infrastructure providers to take into account the cost of capital as a cost component, which facilitates the internalization of externalities provided by infrastructure investments in access price negotiations. Moreover, the new regulatory framework increases regulatory independence from national governments.

However, it also provides some measures, which require further attention as the effectiveness of these measures is unclear with the current stage of competition in the EU member states (e.g. functional separation) and as they ignore differences between the current stage of competition across EU member states.

## 3.5 Conclusion

I considered the alternative roles of the government in the context of providing a high-quality telecommunication infrastructure and installing competition in infrastructure and service markets. The telecommunication sector is considered to be a key sector for other industries and, therefore, is also a key driver of economic growth. National governments are aware of this relevance of telecommunications and, consequently, seek to influence its development to meet national requirements most effectively. While governmental interventions in the sector facilitate the internalization of externalities by infrastructure providers, governments follow aims on the national level, which do not necessarily correspond to the aims on the European level.

Governments keep strong interrelationships with the telecommunication sector as they provide telecommunication laws and determine the national transposition of European guidelines. However, the transposition process has been repeatedly in the focus of criticisms as competitors and also the EC charge the transposition process to be inefficient and, thus, to benefit providers with larger market shares, mainly former monopolists.

Strong interrelations also exist between national regulators and the government, as national regulators are successor organizations of ministries or administrations when only one telecommunication provider was active in a market with a low level of technological deployment. As organizational structures of regulatory bodies strongly affect market proximity, telecommunication companies criticize the competence of regulators' employees and the decision process as being too slow and ignoring the actual challenges of the markets. By adjusting organizational structures, some regulators reacted to these aspects of criticism and, in doing so, found solutions for securing their knowledge stocks independently from individual employees. The comparisons of these re-organized regulators and "traditional" institutions provides evidence for much more efficiency with the more flexible structure. Therefore, these countries are much less under suspicion of the EC as is proven by the Implementation Reports.

### *3 The National Regulatory Structure*

Besides the jurisdictional relation of governments with the telecommunication sector, governments are also active on the company- and the project level: Most EU member states keep minority stakes of their former monopolists even today, which secures them from unfriendly takeovers. However, governments follow mainly other aims with their participations in telecommunication companies. As telecommunication infrastructure is a key pre-requisite for innovations and investments on the service level and also in other sectors, governments are interested in the provision of a high-quality telecommunication infrastructure. However, infrastructure providers can hardly internalize the increasing externalities provided by their investments. National governments as well as European administrations and sub-national governments reduce the challenge of internalizing investment externalities by providing public support for infrastructure roll-out. While financial aid is the common type of support, non-financial support needs particular attention as it leaves the analysis of investment chances and risks with the (better-informed) investor. Although non-financial support is an accepted type of state aid, the EC criticizes it of being in-transparent, which reduces the field of re-financing investments and, therefore, is an issue to be considered in more detail in future work.

Comparing the alternative roles of the governments provides evidence for a strong inter-relationship of public administrations and governments with national telecommunication markets. Combining the instruments of the alternative roles even increases the power of national governments. While European administrations continuously try to reduce the impact of national governments within the sector and foster market integration mainly with regulatory requirements, the discussion provided here raises the question whether the European integration process could benefit from the strong impact of national governments on the national telecommunication sector.

The latest Regulatory Package takes up key points of criticism and offers new approaches to meet obstacles with its predecessors. However, while competition is to a far extent installed on the service level, efficiency is a key issue to be addressed not only in regulated markets. Moreover, it also has to be addressed in the national regulatory structures in combination with transparency to foster the provision of investment incentives both to increase innovations and to provide a high-quality infrastructure within and across all EU member states.

# 4 Supply and Demand for Telecommunication Infrastructure

## 4.1 Introduction

Telecommunication markets have entered their second fundamental phase of restructuring during the last couple of years. Until the end of the 1990s, telecommunication markets were provider-driven markets with fully integrated monopolistic providers. These providers decided about the quality of services and even the services themselves. As more and more services evolve with the installation of more recent transmission technologies,<sup>1</sup> the profit from infrastructure provision and the profit from service provision continuously diverge. Simultaneously, the role of service users turned from a passive to an active role as users demand for adequate infrastructure which is necessary for higher-quality services. Moreover, with Web 2.0, users even start to provide services themselves and use peer-to-peer platforms, which requires symmetric or at least higher bandwidth accesses.<sup>2</sup> The demand for high-quality infrastructure increases as physical infrastructure turns from an originally provider-determined to a customer-determined product and infrastructure providers and regulators have to contemplate how to handle this fundamental restructuring. This issue is even more striking when taking into account the steps implemented by the European Parliament in coordination with national governments to install the Third Regulatory Package.<sup>3</sup> It is therefore most relevant to know more about how market structure and service competition influence investments,

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<sup>1</sup>Examples are internet platforms like Ebay, search engines like Google, MMS and mobile internet access.

<sup>2</sup>Examples are video platforms like YouTube or social networks like Facebook.

<sup>3</sup>[http://ec.europa.eu/information\\_society/policy/comm/doc/tomorrow/reform/better\\_regulation\\_directive/st03677\\_re06.en09.pdf](http://ec.europa.eu/information_society/policy/comm/doc/tomorrow/reform/better_regulation_directive/st03677_re06.en09.pdf)

#### *4 Supply and Demand for Telecommunication Infrastructure*

how the transition from one market structure to another affects the supply and, in particular, the demand for infrastructure and how they interact. With this chapter, I want to provide some more insights into these aspects by analyzing the first structural change in telecommunication markets from former monopolistic to competitive markets.

Closed-form models are the standard approach chosen in the literature to explain the impact of service competition on infrastructure provision. However, this approach ignores potential indirect effects of competition on the demand for infrastructure. For taking into account such indirect effects, I estimate an equation system for infrastructure supply and infrastructure demand as recommended in Röller and Waverman (2001). Such a more structural approach separates demand-related impact variables from supply-related ones and considers how competition and other explanatory variables of standard closed-form models affect the supply side or the demand side, respectively.

In doing so, I find service competition increasing infrastructure investments both in fix and in mobile markets. However, competition does not directly affect investments, i.e. I find no or only weakly significant supply-side effects of competition on investments. Instead, competition influences the demand for infrastructure which then affects investments.

Taking into account cross effects between fix and mobile infrastructure markets, I find that higher mobile revenues per customer lead to a lower demand for mobile infrastructure but to a higher demand for fix infrastructure access. On the other hand, no such effect is found the other way round. Similarly, the supply of mobile infrastructure depends on the situation in fix infrastructure markets but not vice versa.

In section 2, a short overview over the literature on investments in telecommunication infrastructure and competition is provided. Section 3 describes the main changes in European telecommunication infrastructure markets and derives three hypotheses, which are either based on the observation of the European situation or which are based on findings in the literature. Section 4 explains the estimation models and introduces the underlying database. In Section 5, estimation results are discussed in more detail. Section 6 concludes the chapter.

## **4.2 Related Studies on Telecommunication Infrastructure Supply and Demand**

Since the liberalization of European telecommunication markets, telecommunication infrastructure is in the focus of an ongoing political debate. In particular with the consideration of open access, the question of adequate infrastructure quantity and quality is a central issue on the agenda of infrastructure providers, politicians and also user associations. Despite the huge political relevance, there is still a very low number of papers addressing the debate from an empirical perspective and nearly no paper analyzes the interplay of infrastructure supply and demand. In this short review, I concentrate on papers, which take up the question of infrastructure provision, and papers, which address the topic of infrastructure demand and customers' choice between alternative infrastructures from an empirical perspective.

The seminal paper of Röller and Waverman (2001) provides the basic estimation framework of this chapter. The authors analyze the impact of infrastructure provision on economic performance measures for a selection of OECD countries. In doing so, they find a significant, non-linear impact of the availability of telecommunication infrastructure on GDP. Moreover, due to network effects in the telecommunication sector, they identify a critical level of telecommunication infrastructure, above which increasing returns on GDP growth exist. While Röller and Waverman consider telecommunication infrastructure as a driver of economic growth, the following papers concentrate on telecommunication market performance itself.

In a cross-country study of multiple African and South American countries, Wallsten (2001) analyzes how infrastructure liberalization and privatization affect investment patterns. He identifies a positive correlation between mainline competition and connection capacity. However, for privatization, no positive effect on competition exists. In a subsequent study, Wallsten takes a closer look at the sequence of privatization and deregulation (Wallsten, 2002) and concludes that the sequence significantly affects the performance of telecommunication markets. If regulation follows privatization, this structure decreases market concentration and market power of the former monopolistic firm more than the other way round.

#### *4 Supply and Demand for Telecommunication Infrastructure*

Henisz and Zelner (2001) also analyze the role of the government on telecommunication market performance. They focus on how countries can close the gap to other countries with a more advanced telecommunication infrastructure in place since, in line with Röller and Waverman (2001), telecommunication infrastructure is assumed to be the central pre-requisite for economic performance. Henisz and Zelner find that governmental interventions to coordinate and support the development are a key aspect, which determines the speed of catching-up.

In contrast to the previous papers, Heimeshoff (2007) uses a data set of developed countries. He considers the main drivers of telecommunication investments, adopting a time series approach for a selection of OECD countries and identifies market concentration as a driver of infrastructure investments. Moreover, Heimeshoff includes an indicator of governmental and democracy drivers (comprising measures for the procedure of government election or alternative types of civil rights) and finds that "more democracy" has a significantly positive impact on investments in telecommunication infrastructure.

The paper of Grajek and Röller (2009) is one of the first studies in which a firm-level data set is employed. Using a new regulatory index, the Plaut Economics Regulatory Index,<sup>4</sup> they analyze the effect of regulation on investments for a database of European telecommunication companies. By controlling for endogeneity of regulation with various instrumental variables, including political variables and levels of regulation in other European countries, they identify a negative effect of regulation on investments.

Besides the consideration of supply-side aspects and infrastructure deployment, a number of papers address a demand-related topic of infrastructure availability, the substitutability between fix-line and mobile services and fix-line and mobile infrastructure. While particularly in developed countries at least basic fix-line infrastructure access is available, the major issue lies on an upcoming new infrastructure and the substitutability between the quality of fix-line and mobile access lines.

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<sup>4</sup>See Zenhäusern et al. (2007) for a more detailed description.

#### 4.2 Related Studies on Telecommunication Infrastructure Supply and Demand

Rodini et al. (2003) apply an empirical analysis for a U.S. household survey, in which they consider access substitutability between mobile access and second fix lines.<sup>5</sup> By estimating cross-price elasticities, they find that both access modes are selected substitutively. Following the authors, substitutability has a strong impact on policies concerning the restructuring of a fix-line network.

In contrast to Rodini et al., Hamilton (2003) considers the role of infrastructure substitutability and complementarity for developing countries. She points out that substitutability and complementarity depend on a country's economic development. Particularly in less developed countries with a lower roll-out of fix-line infrastructure, mobile access is a substitute to fix-line access. In countries with an existing fix-line infrastructure, mobile access could also be complementary to fix access lines. Moreover, in case of a low fix-line roll-out, the introduction of mobile infrastructure increases the competitive pressure on fix-line providers to extend fix-line infrastructure.

To the best of my knowledge, Röller and Waverman (2001) is the only empirical paper which takes into consideration both the supply side and the demand side of infrastructure. Papers based on infrastructure supply on a country-level aggregation mainly consider fix-line and mobile investments in general but ignore differences in supply patterns of the two infrastructures.<sup>6</sup> In contrast, papers on telecommunication demand mainly ignore the challenge of infrastructure availability and investments. I try to close this gap by considering both the supply side and the demand side using an equation system of supply and demand to check, which factors are drivers of supply and/or demand. Moreover, I undertake the analysis for fix-line and mobile markets separately accounting for cross effects between the two infrastructures.

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<sup>5</sup>The authors argue that the first fix-line access is the standard access. Households increase availability either by a second fix-line access or by a cellular phone access. While a second fix-line access is only available at home, it particularly guarantees a higher transmission rate for internet access.

<sup>6</sup>Grajek and Röller (2009) use data on the company level and control for fix-to-mobile differences in their model.



### **4.3 Infrastructure Supply and Demand with Platform Competition**

In European countries, mainly two telecommunication infrastructures are installed which carry, mostly, identical services. While a basic fix-line infrastructure has been available for all households, mobile communication was established during the 1990s and is still on an ongoing growth path today. In consequence, the change from one infrastructure to two infrastructures affects the demand for services provided on the infrastructures and also the demand for infrastructure itself. Simultaneously, new transmission technologies and also new infrastructures were installed to increase capacity and, thus, to increase quality both in fix-line and in mobile markets. While the additional infrastructure capacity enables a higher quantity and a higher quality of services, the initiator for investments is unclear. In particular, the role of service competition for infrastructure investments with two competing access modes is of regulatory relevance due to externalities provided by infrastructure availability.

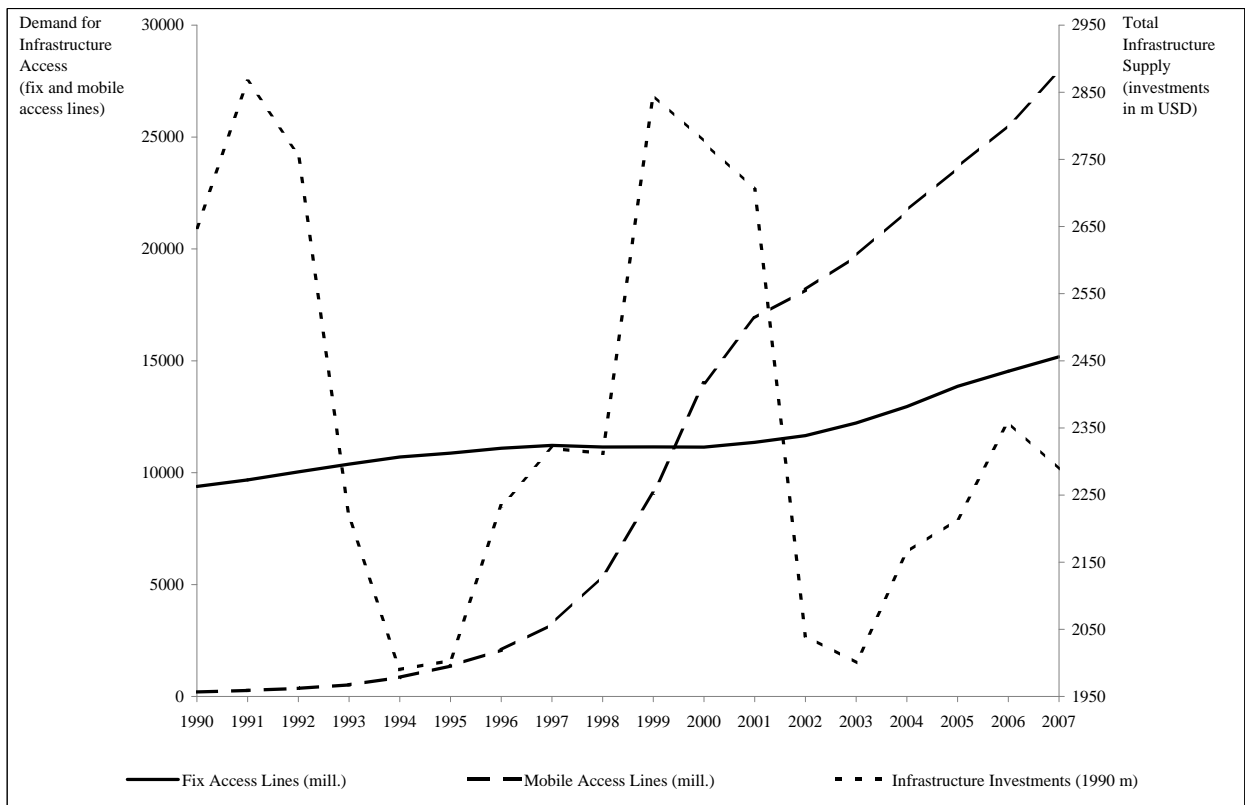
In most economic studies on infrastructure supply, i.e. investments, a closed-form approach is chosen, which assumes demand for infrastructure being independent of other drivers of investments. On the other hand, when analyzing demand aspects like substitutability of infrastructure and how the demand for one infrastructure affects the demand for another infrastructure, the supply side has mainly been ignored. The consideration of both supply and demand simultaneously is particularly relevant when analyzing major structural changes either stemming from comprehensive technological deployments or from substantial changes in market structures.

During the 1990s until 2007, the European telecommunication sector has experienced a major change in terms of market structures from former monopolistic markets to competition. Moreover, the installation of mobile infrastructure and, thus, the availability of mobile services affected also the demand for fix-line infrastructure. As stated in the first proposal of the Second Regulatory Package, the new situation in market structures induced major adjustments in terms of transmission technology such as the introduction

### 4.3 Infrastructure Supply and Demand

of broadband and the switch from GSM to UMTS technology.<sup>7</sup> While closed-form models consider *whether* there exists an effect of such market-structural or technological changes on investments, multi-equation estimation approaches allow to consider *how* this affects the interplay of supply and demand. By employing a more structural estimation approach, we are able to separate key drivers for changes in infrastructure demand from key drivers for changes in supply. Moreover, cross-infrastructure effects can additionally be considered. This provides more detailed insights into how alternative factors work together in situations of structural and also technological changes.

Figure 4.1: Infrastructure Supply and Demand in the EU-15, Norway and Switzerland



Source: Information taken from the OECD Communications Outlooks (2001, 2007, 2009) and from the SourceOECD Telecommunications Database.)

A first impression whether the fundamental changes in ownership and market structures have had an impact on infrastructure supply and demand could be derived from

<sup>7</sup>The technological change is one reason among others for the introduction of the Second Regulatory Package as stated in an EC communication: [http://ec.europa.eu/archives/ISP0/infosoc/telecompolicy/en/com2000-239en.htm#\\_Toc478275739](http://ec.europa.eu/archives/ISP0/infosoc/telecompolicy/en/com2000-239en.htm#_Toc478275739)

#### *4 Supply and Demand for Telecommunication Infrastructure*

Figure 4.1. Total supply across all EU-15 member states, Norway and Switzerland, is represented by total investments in telecommunication infrastructure deflated to 1990 using the Consumer Price Index (CPI). Demand is separated into demand for fix-line access, i.e. the number of standard fix lines, and demand for mobile, i.e. the number of subscribers. Firstly, we do observe two major investment cycles since 1990 which, deflated to 1990, comprise mainly identical investment sizes and comparable structures. On the other hand, the demand for accesses continuously increases with a much stronger rate for mobile access than for fix line access. While fix-line access is an established access type to communication infrastructure, mobile infrastructure is a follower-access type. Mobile infrastructure has been installed at a point in time when most households and companies have had fix accesses. Therefore, mobile providers were in a position where they had to convince customers of fix infrastructure access to complement their availability with an additional mobile access or to substitute fix access by mobile access. Ambiguous explanations exist for the impact of service competition on infrastructure provision. On the one hand, more service competition triggers the provision of more and higher-quality infrastructure as service providers require a high level of infrastructure capacity to distinguish from each other in service competition. Thus, the demand for infrastructure motivates infrastructure operators to invest (an argument brought forward by the EC based on US-EU comparisons). On the other hand, increasing service competition might also have an investment-reducing effect due to too low expected returns on investments. Infrastructure providers comprehensively know service level activities and, thus, the business models of companies demanding infrastructure as an input. As access demand (not infrastructure demand itself) is highly price-elastic, the reduction of regulated infrastructure access prices can have a profit-reducing effect on infrastructure providers. In consequence, tougher service-level competition reduces (regulated) rents which could be extracted by infrastructure providers and, thus, reduces the incentive to invest (Aghion and Howitt, 1992, or Heimeshoff, 2007).

Employing data for EU-15 markets as well as Norway and Switzerland allows for a comparison of a variety of hypotheses under a common regulatory regime and market structural background. Figure 4.1 shows a long-run investment cycle in aggregated total

investments across all countries. The increase in total investments after 1994 slowed down around 1997 but afterwards strongly accelerated until 1999, which is in line with the introduction of competition. Even after the investment increase was interrupted by the burst of the IT bubble, deflated investments did not fall below the level of 1994 anymore due to the technological development.<sup>8</sup> These graphical findings are in line with the interpretation of the EC. Following Commissioner Viviane Reding, a positive effect of service competition on investments should be expected.<sup>9</sup>

**H1:** Upcoming service competition initiates telecommunication infrastructure supply.

Turning to the demand for infrastructure (proxied by the number of access lines in Figure 4.1), mobile subscription follows the expected S-shape relation known from the literature on network-based markets (see e.g. Cabral, 1990; Grajek, 2003). Moreover, the development is of particular interest as, from the standard theoretical approaches, we should have expected a concave functional form after around 1999, but we observe a second acceleration in demand. This new acceleration is driven by technological upgrades, as around 2000/2001, UMTS licences were allocated. The subsequent European-wide upgrade from GSM-based infrastructure to UMTS-based infrastructure was mainly motivated by the (expected) provision of higher-quality services, which demand for mobile "broadband" internet access.<sup>10</sup>

A similar but much weaker increase in demand is found with the fix access curve. While there is a stagnation of growth between 1997 and 2001, the upward orientation continues afterwards, which is also based on the demand for higher-quality services in line with broadband infrastructure. The latest OECD Communications Outlook (2009) describes the increase in fix-line and mobile service quality and the extensive price reductions as the results of upcoming competition.

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<sup>8</sup>Non-deflated investments even increased slowly.

<sup>9</sup>See e.g.

[http://ec.europa.eu/commission\\_barroso/reding/docs/speeches/brussels\\_20070321.pdf](http://ec.europa.eu/commission_barroso/reding/docs/speeches/brussels_20070321.pdf)

<sup>10</sup>Note that UMTS was not the first technology for mobile internet access. Nevertheless, it is the most advanced at the time of its introduction.

#### 4 Supply and Demand for Telecommunication Infrastructure

**H2:** Upcoming service competition increases the (derived) demand for telecommunication infrastructure of adequate quality and, thus, increases infrastructure supply.

While the first two hypotheses consider infrastructure supply and demand separately, I now turn to cross effects of fix-line and mobile infrastructure supply and demand. A central issue, which has been frequently discussed in the literature, is the topic of substitutability between infrastructures. Mobile and fix access lines are considered to be either complements or substitutes with regard to services and with regard to infrastructure itself (Rodini et al., 2003; Hamilton, 2003; Sugolov, 2005; or Plank, 2005). Evidence for both outcomes is found depending on the underlying data set. Until the critical mass for a new substitutive network is reached, this network strongly depends on the already existing network. Therefore, the established network is a complement for the newer alternative and probably also the other way around. Nevertheless, if the newer network has reached its critical mass of users, both networks (might) get substitutes.

In European countries, basic fix-line infrastructure access must be accessible for households at an affordable price due to Directive 1998/10/EC and the subsequent Universal Service Directive (2002/22/EC). Even before the liberalization, national laws already guaranteed access to public telecommunication networks. Therefore, most households had access to fix-line infrastructure already at the beginning of the observation period. In contrast, mobile subscription is not covered by the Universal Service Directive or national laws. Moreover, following Rodini et al. (2003) and the fix-line and the mobile demand development in Figure 4.1, customers take mobile access as a secondary access mode. As fix access has been less expensive, mobile access is no substitute when customers decide about the first fix access. In contrast, a secondary fix access has been a substitute to mobile access during the phase of mobile-infrastructure roll-out.<sup>11</sup>

**H3a:** Due to fix-line availability, customers demand more fix-line access when mobile access is more expensive. However, the demand for mobile access is only weakly affected by lower fix-access prices.

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<sup>11</sup>Please note that due to new contract structures and higher-quality mobile services, fix and mobile accesses have become closer substitutes to each other today than during the observation period.

Turning to the supply side, the technological lag of mobile infrastructure capacity enables fix-line infrastructure upgrade decisions to be independent of mobile infrastructure provision. In contrast, mobile infrastructure is a follower technology and therefore depends on the fix-line infrastructure quality and the access price.

**H3b:** The more fix-line infrastructure is provided and the higher the quality of installed lines/the lower the price for fix-line access, the less mobile infrastructure investments are implemented. In contrast, no reverse effect exists due to a first-mover advantage of fix-line infrastructure capacity.

## 4.4 Empirical Analysis

In this section, I first derive a model to analyze the interrelationship of supply and demand for fix-line and mobile infrastructure. Afterwards, I provide a descriptive consideration of the data and give a short overview of the necessary adjustments of investment data and the resulting pitfalls to be taken into account when interpreting the estimation results.

### 4.4.1 Econometric Model

Two complementary equations are used to characterize supply and demand of telecommunication infrastructure. Supply is determined as infrastructure investments. The higher investments are, the "more" infrastructure is provided or the higher is the capacity of the existing infrastructure. Infrastructure expansions, in particular backbone investments, reduce congestion on the available infrastructure. In consequence, infrastructure investments either lead to an expansion in terms of geographical reach or in terms of quality of the existing infrastructure.

While Röllner and Waverman (2001) concentrate on the impact of telecommunication infrastructure on GDP and, therefore, instrument infrastructure using supply and demand functions, I want to analyze the determinants of infrastructure supply and demand themselves and specify the supply function in more detail using approaches provided in the more recent literature (Henisz and Zellner, 2001; Wallsten, 2001, and Wallsten, 2002;

#### 4 Supply and Demand for Telecommunication Infrastructure

Heimeshoff, 2007). Infrastructure supply is described by the following equation:

$$\begin{aligned} \log(inv_{t,i}) = & \alpha_{t,i}^s + \beta_{rev.acc}^d \log \frac{revenue_{t,i}}{access_{t,i}} + \beta_{acc}^s \log \frac{access_{t,i}}{pop_{t,i}} + \beta_{comp}^s comp_{t,i} \\ & + \log(pop_{t,i})' \beta_{pop}^s + \beta_{pub}^s \log(pub_{t,i}) + \beta_{int.rate}^s \log(int.rate_{t,i}) \\ & + \beta_{time}^s time + country'_{t,i} \beta_{country}^s + \epsilon_{t,i}^s \end{aligned} \quad (4.1)$$

with  $t$  being a year-index and  $i$  being a country-index. Investments  $inv$  are assumed to be a function of revenues per access,  $\frac{revenue}{access}$ , the number of mainlines in operation per household (number of mobile subscribers per capita),  $\frac{access}{pop}$ , entrants' market shares in the fix-line or the mobile market  $comp$  and the following control variables: population characteristics  $pop$  like the population, GDP per capita and the share of urban population as a measure of population concentration, the public ownership share  $pub$ , the costs of capital,  $int.rate$ , trend variables  $time$  and country control variables  $country$ .

Unfortunately, no public information is accessible on the telecommunication capital stock in European countries. It is proposed in the literature to calculate the capital stock based on the number of mainlines, i.e. the number of accesses to the telecommunication infrastructure. However, mainlines are a measure of infrastructure demand as customers ask for the installation. Thus, mainlines are not installed without customers' desire to do so. I therefore refrain from using mainlines as a measure of provided infrastructure and rather apply the share of mainlines in operation per households (mobile subscribers per capita) as a measure of infrastructure demand (see below).<sup>12</sup>

Cadot et al. (2006) use the Perpetual Inventory Method (PIM) to calculate infrastructure stocks. They allocate information on a cross-regional infrastructure stock based on the average past-years investment shares. However, such an approach can hardly be adopted to markets which are subject to comprehensive technological deployments. Moreover, no data are available for the time period before 1990 (even no mainline figures for all EU-15 countries). Thus, a starting level for the European telecommunication capital stock can hardly be calculated.<sup>13</sup>

<sup>12</sup>Moreover, additional criticisms are brought forward in the literature (see e.g. Wallsten, 2001) as mainlines cover only the last-mile infrastructure but do not measure backbone capacity and availability.

<sup>13</sup>Grajek and Röller (2009) employ data on the company level and, therefore, proxy the infrastructure stock based on financial data.

As infrastructure investments tie up capital in the long-run, it is important to control for the long-run costs of capital. I include interest rates based on 10-years government bonds which are expected to have a negative impact on infrastructure supply but no effect on demand.

Usually, infrastructure demand is assumed to be exogenously given in closed-form models. It either enters the estimation equation as a proxy for existing infrastructure or it is ignored. However, taking demand as an exogenous variable neglects the impact of service competition and other variables on demand. Standard approaches in the literature estimate the effect of alternative impact factors on infrastructure provision with closed-form investment models. These models implicitly assume a black-box structure with regard to the interplay of infrastructure supply and demand and ignore any interactions of infrastructure demand characteristics and service competition. By giving a more structural form to demand, I try to disentangle this black box.

Röller and Waverman (2001) express infrastructure demand as the number of mainlines in operation. I adopt this measure for fix-line access and, correspondingly, use the number of mobile subscribers as the measure for mobile infrastructure demand.<sup>14</sup> The dependent demand variable differs from the demand specification in Röller and Waverman (2001) in the sense that they construct demand as the sum of per-capita access and the per-capita waiting list for infrastructure access. I ignore the waiting-list term as it is stated in the OECD Communications Outlook 2001 that the waiting time and, thus, the number of customers waiting for infrastructure availability is negligible for the period since about 1990 (p. 211 and Table 8.1). Moreover, it is stressed that due to this fact most countries have even stopped listing waiting time (Table 8.2).

Using a measure based on the number of mainlines or mobile subscribers for infrastructure demand holds some pitfalls, firstly, as it excludes the individual quantity of usage and, secondly, as it ignores quality differences. However, infrastructure usage and the quality level of the access mode relate to the services provided on the lines and do not

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<sup>14</sup>Röller and Waverman only consider (fix) mainlines as mobile telephony is of no interest for the period of their model.



#### 4 Supply and Demand for Telecommunication Infrastructure

necessarily express the singular demand for access lines.<sup>15</sup>

The demand equation therefore has the following structure:

$$\begin{aligned} \log \frac{access_{t,i}}{pop_{t,i}} &= \alpha_{t,i}^d + \beta_{accpr}^d \log \frac{revenue_{t,i}}{access_{t,i}} + \beta_{acc}^d \log \frac{access_{t-1,i}}{pop_{t-1,i}} + \beta_{comp}^d comp_{t,i} \\ &+ \log(pop_{t,i})' \beta_{pop}^d + \beta_{pub}^d \log(pub_{t,i}) + \beta_{int.rate}^d \log(int.rate_{t,i}) \\ &+ \beta_{time}^d time + country'_{t,i} \beta_{country}^d + \epsilon_{t,i}^d \end{aligned} \quad (4.2)$$

I assume a very similar structure for supply and demand as no information about drivers of infrastructure demand could be found in the literature. By adopting an equation system for supply and demand, I use the variables typically provided in the literature to affect infrastructure investments and consider whether they better explain supply or demand or even both.<sup>16</sup> Simultaneous-estimation methods allow for such a specification as the common variance-covariance matrix accounts for correlations between the error terms as well as endogenous variables and the exogenous variables of the two equations. While infrastructure demand enters the supply equation, I include the one period lagged demand into the demand equation as a customer's decision about infrastructure demand is a singular decision and is not changed every period. Thus, the demand for infrastructure in period  $t$  should strongly depend on infrastructure demand in period  $t - 1$ . I also include an approximation for the relative value of the infrastructure access, which is the total infrastructure revenue per access,  $\frac{revenue}{access}$ , as is done in Röllner and Waverman (2001). Unfortunately, there is no consistent information about access prices due to highly distinct pricing methods across countries and due to repeated adjustments of access price calculations in individual EU member states.

For analyzing whether substitutive effects exist between fix-line and mobile infrastructure, I additionally include mobile revenues per subscriber in the fix-line supply function and fix-line revenues per mainline in the mobile supply function. Similarly, I include the number of mainlines in operation per household in the mobile demand equation and the number of mobile subscribers per capita in the fix-line demand equation.

<sup>15</sup>For the analysis of infrastructure quality differences, alternative measures such as broadband availability or UMTS technology subscriptions could be used. Nevertheless, this is not the aim of the analysis in this chapter.

<sup>16</sup>Thus, the results of my estimations provide more information of how one could specify infrastructure supply and demand.

## 4.4.2 Data Description and Data Adjustments

### Data Sources

I apply data aggregated on the country level for the EU-15 countries as well as Norway and Switzerland between 1990 and 2007. Data are mainly taken from OECD sources, which include information from various editions of the biannual OECD Communications Outlook (1999, 2001, 2009). Additionally, I also use data from the OECD International Regulation Database about regulation and competition and information from SourceOECD and Eurostat on long-run interest rates. Population concentration data is taken from the UNECE website.<sup>17</sup>

### Data Description

Table 4.1 provides an overview of the variables used in the analysis for the first and the last year of the observation period as well as for 1998 as this is the year of the transposition of the EC directives to national laws in most EU member states. All financial variables are deflated using the CPI 1990 and are expressed in US Dollars (USD) for reasons of comparison between countries.

The strong reduction in fix-line infrastructure investments and the simultaneous increase in mobile infrastructure investments is mainly due to the ongoing increase in mobile roll-out during the observation period. While total investments decreased from nearly 2650m USD in 1990 to about 2290m USD in 2007 in a cyclical move, the share dedicated to mobile investments increased.

Concerning the demand for infrastructure access, the aggregated figures correspond to the graphs in Figure 4.1. A weak increase in the demand for fix-line access and a very strong increase in the demand for mobile access during the observation period is observed. Figures on the relative change in demand provide some descriptive impression of the slope of the demand curves. The relative change in fix access lines experienced a weak downward slope between 1993 and 1999 but afterwards continuously increased

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<sup>17</sup><http://www.unece.org/stats>

Table 4.1: Descriptive Statistics

<b>1990</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Min</b>	<b>Max</b>	<b>Obs.</b>
Fix Investments (m)	2601.5	3261.8	442183	10344.0	17
Mobile Investments (m)	47.0	51.9	0	198.4	17
Fix Access/Pop.	0.456	0.114	0.240	0.689	17
Mobile Access/Pop.	0.015	0.018	0	0.054	17
Rel. Change Fix Lines*	3.7	2.6	0.4	11.8	17
Rel. Change Mobile Lines*	29.1	14.0	11.6	53.1	16
Fix Rev./Acc.*	706.9	192.1	453.4	1190.3	14
Mob. Rev./Acc.*	188.8	620.1	5.9	2429.4	15
Population (mill.)	21053.0	22886.1	378.4	62063	17
GDP/Pop.	21235.6	7639.8	7150.9	34363.5	17
Share Urban Population	72.2	12.3	47.9	96.4	17
Long-Run Interest Rate	0.111	0.025	0.065	0.154	15
Fix Market Share Entrant	0.471	1.940	0	8	17
Mobile Market Share Entrant	3.5	10.1	0	37	17
Gov. Share Fix Inc.	93.2	19.3	35	100	17
Gov. Share Mob. Inc.	93.2	19.3	35	100	17
# Fix Prov. > 1	5.9	24.3	0	100	17
# Mob. Prov. > 1	17.6	39.3	0	100	17

\* 1991

<b>1998</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Min</b>	<b>Max</b>	<b>Obs.</b>
Fix Investments (m)	1576.6	1711.1	16.2	4987.6	17
Mobile Investments (m)	735.6	700.3	9.3	2062.5	17
Fix Access/Pop.	0.511	0.079	0.386	0.688	17
Mobile Access/Pop.	0.291	0.116	0.170	0.554	17
Rel. Change Fix Lines	-1.8	6.1	-17.4	5.1	17
Rel. Change Mobile Lines	40.0	10.8	19.1	54.4	17
Fix Rev./Acc.	764.9	254.5	253.9	1405.2	17
Mob. Rev./Acc.	104.5	41.6	45.7	218.3	17
Population (mill.)	22617.7	25579.9	419	82035	17
GDP/Pop.	26162.0	8713.3	11726.4	46181.4	17
Share Urban Population	73.6	11.8	53.1	97.0	17
Long-Run Interest Rate	0.050	0.011	0.030	0.085	16
Fix Market Share Entrant	8.4	16.1	0	63	17
Mobile Market Share Entrant	36.7	18.0	0	66	17
Gov. Share Fix Inc.	56.9	38.5	0	100	17
Gov. Share Mob. Inc.	58.5	39.8	0	100	17
# Fix Prov. > 1	47.1	0.514	0	100	17
# Mob. Prov. > 1	100	0	0	100	17

<b>2007</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Min</b>	<b>Max</b>	<b>Obs.</b>
Fix Investments (m)	820.2	831.3	27.0	2488.2	17
Mobile Investments (m)	1467.8	1446.0	48.3	4178.2	17
Fix Access/Pop.	0.645	0.100	0.440	0.808	17
Mobile Access/Pop.	1.2	0.162	0.902	1.5	17
Rel. Change Fix Lines	2.8	5.8	-7.1	14.6	17
Rel. Change Mobile Lines	7.0	4.0	-4.4	14.4	17
Fix Rev./Acc.	1419.6	712.9	362.9	3235.1	17
Mob. Rev./Acc.	328.5	97.8	185.7	499.3	17
Population (mill.)	23580.2	26341.7	473	82376	17
GDP/Pop.	49593.5	20073.9	21112.1	105065.3	17
Share Urban Population	75.2	11.1	58.9	97.3	17
Long-Run Interest Rate	0.041	0.004	0.029	0.049	16
Fix Market Share Entrant	35.2	10.0	21.2	60	17
Mobile Market Share Entrant	55.3	8.0	41	74	17
Gov. Share Fix Inc.	26.3	28.5	0	100	17
Gov. Share Mob. Inc.	23.4	28.5	0	100	17
# Fix Prov. > 1	100	0	100	100	17
# Mob. Prov. > 1	100	0	100	100	17

at a low rate. Concerning the relative change in the number of mobile subscribers, a strong increase exists which corresponds to the slope of the demand curve as seen in Figure 4.1. Nevertheless, with a higher number of mobile subscribers, the relative change in mobile subscriptions slows down. While fix-line and also mobile revenue per access remained at a nearly constant level or even decreased during the first half of the observation period, both strongly increased with upcoming competition. During the first half of the observation period, incumbents chose prices under weak or no competition. In contrast, upcoming competition increased customers' attention, which increased the demand for services. Moreover, innovative transmission technologies reduced congestion and enabled higher-quality services on the lines. Combining both infrastructure demand and higher-quality service enabled a, in total, higher revenue per access in the second half of the observation period.

Other telecommunication-related variables in Table 4.1 correspond to upcoming competition and privatization. As the access to mobile infrastructure markets has been regulated by licensing from its early beginnings and as multiple licenses have been issued at a very early point in time, the concentration in mobile infrastructure markets has always been lower (or at most as high) as in fix-line markets. Concerning competition in fix-line markets, the 1998 liberalization proves to be much more important as only a few countries had installed fix-line infrastructure competition before this year. Even today, fix-line infrastructure access is provided mostly by one operator in national markets. This operator is obliged to provide access to its infrastructure, to give access for interconnection to its Main Distribution Frame (MDF) or to allow for interconnection in the street cabinets.<sup>18</sup>

In line with the liberalization, governmental ownership of former fix-line incumbents and also of the first mobile operator have been continuously reduced in many countries leading to special governmental control and voting rights, "Golden Shares". The EC regularly intervenes to prevent these control and voting rights as they deter the influence of shareholders in telecommunication companies.

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<sup>18</sup>Nevertheless, this step to infrastructure competition has been a legal issue in most countries for an extended period of time after the liberalization and it is also a major problem for high-quality service provision on the infrastructure.

Table 4.2: Expected Outcomes

Dependent Var.	Fix Infrastructure		Mobile Infrastructure	
	Supply	Demand	Supply	Demand
Revenue/Access	-	0	-	-/0
Access/Population	+		+	
Access/Population (-1)		+		+
Liberalization	+	+	+	+
Market Share Entrants	+	+	+	+
Other Infrastr. Rev./Acc.	+	+	+	0
Other Infrastr. Acc./Pop. (-1)		-		-
Governmental Share	+	0	+/0	0
GDP per population	+/0	+	+/0	+
Population	+	0	+	+/-
Share Urban Population	-	-/0	-	-/0
Long-Run Interest Rate	-	0	-	0

### Expected Estimation Outcomes

Table 4.2 provides an overview of the expected estimation outcomes. In line with Rölller and Waverman (2001), revenues per access are expected to have a negative impact on own demand. As revenues per access mainly correspond to prices for infrastructure access, Rölller and Waverman use this measure as a proxy and therefore expect the standard interrelation of prices and demand. Nevertheless, upcoming competition after 2000 resulted in new services and new pricing structures such as bundle offers of multiple services and infrastructure-access modes, which blur the usually assumed price-demand structure. Figure A.3 in the appendix considers the interrelation of prices and demand expressed by revenue per access and fix and mobile access lines. The figure is a cross-country consideration for 2007. While I find an on average negative relationship for mobile markets ( $R^2 = 0.256$ ), no clear-cut results could be drawn for fix-line markets.<sup>19</sup> In line with the literature on telecommunication liberalization, I expect a negative effect of revenues per access on the demand for infrastructure access as, over the total observation period, the negative price-demand effect should outweigh the blurring effect of service-access-bundling and flat-rate offers introduced in line with more innovative services (Rölller and Waverman, 2001, Model (1), Hassett and Kozlikov, 2002; Hassett et al., 2003).

<sup>19</sup>The positive slope is very low and the  $R^2$  is even below 0.05.

Lagged demand is assumed to have a positive impact on current demand as the decision for a new access mode is a singular decision. Thus, if a customer had infrastructure access in year  $t - 1$  this access is in place also in year  $t$ . Moreover, in countries with a higher demand for infrastructure access also the supply of infrastructure is expected to be higher, which corresponds to the findings in Rölller and Waverman (2001).

The following variables are used as proxies: *Market Share Entrants* as a proxy for competition, *Other Infrastr. Rev./Acc.* as a proxy for cross-infrastructure price effects and *Other Infrastr. Acc./Pop.(-1)* as a proxy for cross-infrastructure demand effects. The remaining assumptions on control variables correspond to the findings from the literature on infrastructure investments and infrastructure demand.

### Data Adjustments

While the other information is available in the relevant specification, fix-line and mobile investments have to be calculated from total investments. Unfortunately, no detailed investment information is publicly available to separate fix-line from mobile investments in European telecommunication markets for the period before the market liberalization. The consideration of a low number of available data points for fix-line infrastructure investments provides indication of how one could separate fix-line from mobile investments. Mainly two approaches for the calculation qualify to be equally valuable methods which are either a measure based on lagged revenues or a measure based on the number of access lines. For mainly technical reasons, which will be discussed in more detail below, I use the approach based on access lines. In doing so, fix-line infrastructure investments are calculated from total investments as the share of fix access lines per total access lines times total investments:

$$fix\text{-line } inv._t = total\text{ investments}_t \frac{fix\text{ access lines}_t}{fix\text{ access lines}_t + mob.\text{ subscribers}_t} \quad (4.3)$$

and mobile investments as total investments weighted by mobile subscription lines:

$$mobile\text{ inv.}_t = total\text{ investments}_t \frac{mob.\text{ subscribers}_t}{fix\text{ access lines}_t + mob.\text{ subscribers}_t} \quad (4.4)$$

Fix-line revenues is a second variable which has to be derived. Nevertheless, this is a minor challenge as mobile revenues and also total revenues are available from the database. Thus, fix-line access revenues are calculated as total telecommunication revenues minus mobile revenues.

## 4.5 Estimation Approaches, Results and Discussion

I first derive the estimation approaches taking into account the results of multivariate specification test.<sup>20</sup> Afterwards, I provide the results and discuss them in more detail.

### Estimation Approaches

Equation system (4.1) and (4.2) is estimated first assuming independence of both equations and then taking into account potential structural dependencies by adopting a simultaneous estimation approach. In the independent estimation approach, the demand equations are estimated using the standard Arellano-Bond method with robust standard errors and restricting the dependent variable lag structure to 1 (Arellano and Bond, 1991). For the investment equation, no lag dependence is expected. The derived investment measures follow a cyclical structure as they are linear transformations of total investments. I estimate the investment equation using a GLS estimator with random effects controlling for country differences and assuming a robust variance-covariance matrix taking into account the Huber-White correction.<sup>21</sup>

In the independent estimation approach,  $\log(\text{access}/\text{pop.})$  is assumed to be exogenous in the supply function as this is the standard model structure to explain investments known from the literature. In contrast, the two-equation estimation takes  $\log(\text{access}/\text{pop.})$  as an endogenous variable in the investment function and instruments  $\log(\text{access}/\text{pop.})$  with its one-period lag and, additionally, with the one-period lag of demand for the

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<sup>20</sup>Further information and results of alternative specification tests are provided in Appendix A.3.

<sup>21</sup>Estimation results are identical to the fixed effects approach except for the constant term.

other infrastructure when considering cross effects. I estimate the equation system using an IV-GMM-based approach as it is proposed in Baum et al. (2003) for panel data. The estimator is a two-step GMM method, in which, firstly, endogenous variables are estimated on all exogenous variables and, afterwards, the second equation is estimated taking into account the estimation results of the first step. In contrast to the standard IV approach, the GMM method is more efficient as it employs the optimal weighting matrix, which is the inverse of an estimate of the covariance matrix of orthogonality conditions (Baum et al., 2003). Thus, the standard IV approach uses one particular weighting matrix out of the set of the alternative GMM weighting matrices.<sup>22, 23</sup>

### Estimation Results and Discussion

Estimation results are provided in Tables 4.3 and 4.4. Columns 1 and 3 show the results of the independent equation estimations. Columns 2 and 4 show the results of the simultaneous estimation approach.

Following **Hypotheses 1 and 2**, a positive effect of service competition both on infrastructure supply and infrastructure demand should exist. Based on observations from other telecommunication markets, the EC expects service competition to provide direct incentives to increase infrastructure availability and quality as infrastructure providers are vertically integrated with service providers. In line with the literature, service level competitors require adequate infrastructure quality to offer their services and to set apart from each other. In consequence, service competition increases the demand for infrastructure.

Competition is found to have a significantly positive impact on the demand for fix-line infrastructure only for the two-equation estimations. In contrast, no direct effect on investments is found in neither of the specification. However, service competition has a significantly positive impact on infrastructure demand and also on infrastructure supply

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<sup>22</sup>Hayashi (2000) provides more detailed information on the construction of the efficient GMM estimator.

<sup>23</sup>I have also tested the results with heteroscedasticity- and autocorrelation-robust standard errors but the estimation results and also their significance levels remain the same.



Table 4.3: Estimation Results – Fix-line Infrastructure

Fix-Line Infrastructure Supply and Demand	log(fix a./pop) A.-Bond (1 a)	log(fix inv.) RE est. (1 b)	log(fix a./pop) 1st stage IV (2 a)	log(fix inv.) 2nd stage IV (2 b)	log(fix a./pop) A.-Bond (3 a)	log(fix inv.) RE est. (3 b)	log(fix a./pop) 1st stage IV (4 a)	log(fix inv.) 2nd stage IV (4 b)
log(fix rev./acc.)	-0.025 (0.023)	-0.318 ** (0.131)	0.011 (0.018)	-0.349 * (0.132)	-0.002 (0.018)	-0.313 ** (0.137)	0.015 (0.018)	-0.446 *** (0.133)
log(mob. rev./subs.)					0.025 * (0.013)	0.027 (0.106)	0.040 *** (0.015)	0.011 (0.099)
fix m. sh. entr.	0.001 (0.000)	0.002 (0.003)	0.001 ** (0.001)	0.001 (0.003)	0.001 (0.000)	0.002 (0.003)	0.001 ** (0.001)	0.001 (0.003)
log(pop.)	0.471 * (0.254)	3.905 ** (1.731)	0.158 (0.224)	3.601 ** (1.695)	0.436 (0.268)	3.949 ** (1.746)	0.168 (0.253)	2.563 (1.680)
log(GDP/pop.)	0.036 * (0.018)	0.476 ** (0.212)	0.048 (0.030)	0.419 ** (0.201)	0.009 (0.025)	0.423 (0.281)	0.014 (0.047)	0.472 * (0.265)
log(share urban pop.)	-0.222 (0.158)	-2.610 (1.672)	-0.510 *** (0.168)	-2.077 (1.574)	-0.102 (0.188)	-2.397 (1.767)	-0.224 (0.185)	-1.601 (1.672)
gov. sh. fix inc.	0.001 *** (0.000)	0.003 ** (0.001)	0.000 (0.000)	0.003 ** (0.001)	0.001 *** (0.000)	0.003 ** (0.001)	0.000 (0.000)	0.002 * (0.001)
log(long-term interest rate)	0.014 (0.044)	0.144 (0.332)	-0.028 (0.042)	0.170 (0.317)	0.012 (0.047)	0.116 (0.342)	-0.051 (0.042)	0.391 (0.320)
log(km2)	-0.613 * (0.372)	0.196 (0.361)	0.045 (0.047)	0.148 (0.354)	-0.597 (0.381)	0.211 (0.371)	0.054 (0.055)	0.106 (0.355)
trend	0.003 (0.003)	-0.067 *** (0.020)	-0.002 (0.003)	-0.078 *** (0.020)	0.004 (0.003)	-0.063 ** (0.026)	0.001 (0.004)	0.076 *** (0.025)
log(fix acc./pop.)		0.366 (0.347)	0.913 * (0.532)			0.341 (0.368)		1.077 *** (0.539)
log(fix acc./pop.) (-1)	0.850 *** (0.079)		0.955 *** (0.085)		0.843 *** (0.076)		0.937 *** (0.077)	
log(mob. subs./pop.) (-1)					0.008 (0.007)		0.006 (0.007)	
constant	--	-49.694 (30.287)	-1.367 (3.854)	-45.669 (29.68)	--	-51.193 * (31.048)	-2.516 (4.303)	-28.899 (30.026)
country dummies included		yes	yes	yes		yes	yes	yes
Chi2 / F (df)	3656.64 (9)	6457.56 (24)	762.69 (24)	237.40 (24)	11384.19 (12)	6124.43 (25)	875.79 (26)	258.57(25)
R2		0.484	0.636			0.472	0.637	
prob. A-Bond test (first order)	0.100				0.016			
prob. A-Bond test (sec. order)	0.862			229.213 (1)	0.547			230.141 (2)
Anderson canon. corr. LR stat.								10.249(1)
Hansen J								
Obs.	223	227	227	242	223	242	227	227

Note: \*\*\*, \*\*, \* represent significance at the 1, 5 and 10 percent significance level, standard errors are displayed in brackets.

Table 4.4: Estimation Results – Mobile Infrastructure

Mobile Infrastructure Supply and Demand	log(m.s./pop.) A.-Bond (1 a)	log(mob. inv.) RE est. (1 b)	log(m.s./pop.) 1st stage IV (2 a)	log(mob. inv.) 2nd stage IV (2 b)	log(m.s./pop.) A.-Bond (3 a)	log(mob. inv.) RE est. (3 b)	log(m.s./pop.) 1st stage IV (4 a)	log(mob. inv.) 2nd stage IV (4 b)
log(fix rev./acc.)					-0.185 ** (0.084)	-0.335 ** (0.138)	-0.013 (0.061)	-0.293 ** (0.133)
log(mob. rev./subs.)	-0.015 *** (0.051)	0.062 * (0.032)	-0.014 (0.096)	-0.078 (0.059)	-0.517 *** (0.094)	-0.082 (0.136)	-0.491 *** (0.074)	-0.472 *** (0.174)
mob. m. sh. entr.	0.008 ** (0.004)	0.007 * (0.004)	0.005 ** (0.002)	0.013 *** (0.004)	0.005 (0.003)	0.007 * (0.004)	0.074 ** (0.002)	0.012 *** (0.004)
log(pop.)	-2.694 * (1.418)	3.357 ** (1.706)	-1.283 (0.962)	4.188 *** (1.625)	-1.484 (1.503)	3.534 * (1.822)	-0.486 (0.883)	4.634 *** (1.799)
log(GDP/pop.)	-0.017 (0.245)	0.225 (0.204)	-0.158 (0.170)	-0.002 (0.204)	0.664 *** (0.156)	0.505 * (0.266)	0.344 *** (0.133)	0.484 * (0.264)
log(share urban pop.)	0.619 (1.291)	-2.056 (1.541)	0.039 (1.020)	-1.331 (1.497)	-1.675 (1.145)	-1.981 (1.735)	-3.148 *** (0.770)	-3.012 * (1.727)
log(long-term interest rate)	-0.027 (0.201)	0.004 (0.337)	0.022 (0.302)	-0.297 (0.357)	-0.150 (0.113)	0.118 (0.350)	-0.100 (0.230)	-0.273 (0.382)
gov. sh. mob. inc.	0.000 (0.001)	0.003 ** (0.001)	0.000 (0.001)	0.004 *** (0.001)	0.000 (0.001)	0.003 ** (0.001)	-0.000 (0.001)	0.004 *** (0.001)
log(km2)	3.495 * (1.906)	0.189 (0.365)	-0.289 (0.232)	0.377 (0.355)	2.338 (1.784)	0.111 (0.395)	-0.13 (0.221)	0.361 (0.401)
trend	-0.005 (0.022)	-0.101 *** (0.020)	0.004 (0.014)	-0.067 *** (0.019)	-0.037 *** (0.013)	-0.092 *** (0.021)	-0.021 * (0.012)	-0.066 *** (0.020)
log(fix acc./pop.) (-1)					0.207 (0.232)		0.210 (0.187)	
log(mob. subs./pop.)		0.972 *** (0.063)		0.743 *** (0.081)		0.917 *** (0.080)		0.589 *** (0.114)
log(mob. subs./pop.) (-1)			0.849 *** (0.049)				0.709 *** (0.048)	
constant		-41.022 (30.730)	24.826 (16.853)	-57.236 * (29.369)		-45.221 (32.192)	21.984 (15.233)	-59.542 * (31.327)
country dummies included		yes	yes	yes		yes	yes	yes
Chi2 / F (df)	11250.04 (10)	9273.37 (24)			34294.93 (12)	7371.42 (25)		
R2			0.7169				0.6716	
prob. A-Bond test (first order)	0.982				0.996			
prob. A-Bond test (sec. order)	0.187				0.164			
Anderson canon. corr. LR stat.				291.505 (2)				252.780 (2)
Hansen J								0.915 (1)
Obs.	215	232	231	231	209	227	227	227

Note: \*\*\*, \*\*, \* represent significance at the 1, 5 and 10 percent significance level, standard errors are displayed in brackets.

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in the mobile estimations.<sup>24</sup> Moreover, the demand coefficients are significantly positive in all simultaneous estimation approaches. In consequence, ignoring the indirect effect of competition on investments deters the conclusions derived from the estimations results: Considering fix-line supply and demand (Table 4.3), the impact of competition on infrastructure investments would have been completely ignored with the single-equation model. Turning to mobile supply and demand, the impact of competition on investments would have been under-estimated without taking into account the indirect effect of competition on the demand variables and, thus, on investments. On the one hand, new entrants offer existing services at significantly lower prices, which initiates price wars à la Bertrand. This is supported by the mobile-demand estimation results as mobile service provision is strongly tied to the infrastructure provider. However, it is not found for fix-line access.<sup>25</sup> On the other hand, advertising and other professional communication channels are used to provide more information to customers about innovative services and forthcoming price reductions and, thus, to increase the interest and the demand for infrastructure. These findings support the discussion in Plank (2005) that upcoming competition on the service level stimulates the demand for infrastructure as service competition forces companies to provide product information to customers. Based on this information, customers demand more services and, consequently, directly and indirectly demand for higher quality infrastructure. Thus, the estimation results support Hypothesis 1 that service competition directly increases investments only partially, for mobile infrastructure but not for fix-line infrastructure. In contrast, the indirect competition effect on investments is found in all simultaneous estimation equations both for fix-line and mobile investments, which is in line with Hypothesis 2.

Cross-effects between infrastructures are taken into account with specifications 3 and 4. Following Rodini et al. (2003), upcoming mobile availability is a substitute for fix-line access. In Europe, fix-line infrastructure has been in place at the time when mobile access became publicly available. Moreover, mobile infrastructure capacity is lagging

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<sup>24</sup>In specification 3a of the mobile estimation approach, the p-value of the competition coefficient is 0.108.

<sup>25</sup>Please see also the plotted cross-country estimations in Figure A.3 in the appendix.

behind fix-line capacity. Therefore, **Hypothesis 3** states that fix-line infrastructure investments are the reference when deciding on mobile infrastructure supply and demand whereas fix-line infrastructure supply and demand are independent from the mobile market situation.

While the demand for one infrastructure is independent from the demand for the other, an ambiguous cross effect exists: mobile revenues per subscriber positively affect fix-line infrastructure demand, whereas fix-line revenues per access line negatively affect mobile infrastructure investments. These findings support the idea of a first-mover advantage of fix-line infrastructure markets over mobile-infrastructure markets: When deciding about an additional access mode, customers compare the prices of the alternative secondary access options. As long as mobile infrastructure is comparably expensive, mobile demand is the less preferable option. Thus, customers choose fix-line access instead of mobile access. In consequence, in countries where mobile subscription is more expensive, customers increase their availability by additional fix-line access modes. This has not been a particular issue for private customers but rather for companies. In contrast, for customers interested in a fix-line infrastructure access, mobile access is no adequate substitute as in all European countries mobile access is a lower-quality access in terms of transfer rates.<sup>26</sup> No significant impact of mobile revenues per subscriber on fix-line infrastructure provision is found. However, a significantly negative effect of fix-line revenue per access line exists on mobile infrastructure supply. As the upgrade of fix-line backbone infrastructure took place at a time when only low-quality services like telephony or short messages could technically be transmitted on the mobile infrastructure, it was a lower-quality substitute to fix-line infrastructure. Moreover, the upgrade of mobile infrastructure for 3G services occurred at a time when similar fix-line broadband quality has already been established. Due to this lag of quality between fix-line and mobile infrastructure, fix-line infrastructure is a stronger substitute to mobile infrastructure than vice versa. Consequently, fix-line infrastructure market revenues affect

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<sup>26</sup>Please note that the observation period covers, to a far extent, the years of introducing mobile communication and upcoming mobile competition. Today, mobile-to-fix substitutability is probably significantly higher than ten years ago.

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mobile infrastructure supply more than the other way around. This finding is strongly in line with Hamilton (2003) but extends her results also to a data set of developed countries. Moreover, the results also support the discussion in Rodini et al. (2003). The estimation results thus confirm Hypothesis 3: As fix-line infrastructure is the primary infrastructure available, mobile infrastructure supply and demand depend on the conditions of fix-line infrastructure availability whereas only weak evidence is found for the opposite direction.

Let us shortly consider the coefficients of the control variables. A significantly positive population effect is found for mobile and also for fix-line investments.<sup>27</sup> Telecommunications is a social network, i.e. the more customers are available in a network, the more traffic is provided on the lines, which requires higher investments. Therefore, the larger the population size, the more infrastructure investments are necessary to cover this higher traffic.

Per capita GDP has a significantly positive effect both on mobile infrastructure demand and on mobile infrastructure supply when controlling for cross-infrastructure effects. In contrast, its impact on fix-line infrastructure demand is, to a far extent, insignificant, whereas it is weakly significantly positive for fix-line infrastructure supply. Following the correlation matrix provided in Table A.9 in the appendix a significantly negative correlation exists between per-capita GDP and mobile demand (-0.73). Dropping per-capita GDP in the demand equation changes the remaining coefficients only slightly. However, the coefficient of the GDP variable can hardly be interpreted due to these cross-effects. Governmental ownership of infrastructure providers has a significantly positive impact on investments. While it is found to have a positive effect also on demand for fix-line infrastructure for the separate estimations (Columns 1a and 3a), this effect vanishes with the system estimations. In contrast to profit-maximization aims, governments follow macroeconomic aims with the telecommunication sector. As investments provide a strong positive externality also on other sectors, which cannot be internalized by the

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<sup>27</sup>Only in the cross-infrastructure estimation, this effect turns weakly insignificant (p-value = 0.127).

investors, they would under-invest from a macroeconomic perspective.<sup>28</sup> In contrast, governmental participation forces infrastructure providers to increase investments above the level optimally from the single company perspective.

Long-term interest rates are used as a measure for the costs of capital as infrastructure investments are very long-term oriented. However, I find no significant impact of interest rates on investments. As the correlation analysis provides evidence for strong correlations between interest rates and other explanatory variables, I excluded interest rates in other estimation specifications not presented here. However, results remained very similar. Even significance levels did not change.

In a nutshell, I find service competition to increase infrastructure investments, which is in line with the literature. However, in particular for fix-line infrastructure, the competition-impact is not a direct driver of investments. Service competition increases the demand for infrastructure and, subsequently, induces an increase in infrastructure supply. In contrast to the EC's expectations, these findings provide first evidence that it is not necessarily competitive pressure which motivates providers to invest. Moreover, there must be a sufficient (derived) demand for infrastructure.

With regard to cross-infrastructure effects, I find that mobile infrastructure supply and demand strongly depend on the revenue per access. On the one hand, customers prefer a secondary fix-line access as long as mobile access prices are too high. On the other hand, mobile infrastructure supply benefits from tougher fix-line infrastructure competition. However, no reciprocal effects exist. These findings strongly demand the consideration of both demand and supply and, in particular, cross-infrastructure interrelationships when analyzing telecommunication infrastructure investments with competing platforms. While I have focused on a period of comprehensive technological improvements in fix-line transmissions and the roll-out of basic and higher-capacity mobile infrastructure, these issues become even more relevant for fix-line and mobile broadband analyses as more and more services could be used on both infrastructures substitutively.

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<sup>28</sup>Please see also Cave (2006a) and the cited literature.

## 4.6 Conclusion and Limitations

Infrastructure availability and adequate quality are the central pre-requisites for higher-value telecommunication services. In this chapter, I considered the driving impact factors of fix-line and mobile telephony infrastructure investments. In contrast to closed-form approaches, which are usually taken in the literature, I separated infrastructure supply from demand. In doing so, it can be analyzed *how* service competition affects investments. The analysis is implemented for mobile and fix-line infrastructure separately so that I can distinguish and compare the results across competitive infrastructures.

As in previous works, I find a significantly positive effect of upcoming service competition on infrastructure expansion. However, upcoming service competition does not only directly influence investments, but it particularly increases the demand for infrastructure which, subsequently, initiates investments. During the transition process of the liberalization, service market entrants stimulate the demand for new services and, as a precondition, the demand for infrastructure of higher quality. This "demand pull" is found for both established fix-line infrastructure and also mobile infrastructure where competition occurred at an earlier point of the technological development. Therefore, service competition, as a driver of demand, enables and supports the comprehensive technological developments, which we have experienced during the last decade.

A political question arising from these findings is how service providers and customers could be involved in the process of infrastructure roll-out. This is of particular interest as infrastructure operators currently bear the risk of re-funding investments and, simultaneously, provide comprehensive positive externalities for service providers and other industries. With more service competition but only one or two physical infrastructure providers in fix-line markets, the challenges for infrastructure providers continuously aggravate. My results support the proposal in line with the Third Regulatory Package that service providers and customers should be integrated in the financing process of

infrastructure investments.<sup>29</sup> However, the actual way of its implementation is an open point of discussion for future economic research.

In a next step, I have considered whether cross effects exist between mobile demand and fix-line demand and also mobile supply and fix-line supply. While other coefficients remain nearly unaffected, higher mobile prices reduce the demand for mobile infrastructure and, simultaneously, increase the demand for fix-line infrastructure. In contrast, fix-line prices do not affect mobile infrastructure demand. As at each point in time fix-line infrastructure quality is at least as high as mobile infrastructure quality, the decision for (higher quality) fix-line infrastructure access takes place when there is no adequate mobile substitute. In contrast, the decision about mobile access occurs when fix-line infrastructure of similar transmission quality is already available. Therefore, when deciding on a secondary access to increase availability, customers (in particular professional users) choose an additional fix-line access if mobile access is too expensive.<sup>30</sup>

Similarly, the provision of mobile infrastructure depends on the situation in the fix-line market. The higher the market price for fix-line access, the less mobile infrastructure is provided. While mobile network operators derive their investment decision from fix-line market competition, fix-line infrastructure supply is independent as no adequate infrastructure of comparable quality is installed. These results provide evidence that mobile infrastructure is always a secondary infrastructure for service provision following fix-line infrastructure due to the lack of transmission capacity. In contrast, fix-line market competition directly affects the mobile market situation both in terms of supply and in terms of demand.

Opening the black box of closed-form investment models allows us to specify results already known from the literature in more detail and to learn more about the structure behind the findings. In doing so, this chapter provides first evidence that (derived)

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<sup>29</sup>The EC is aware of the drifting apart of service level profits and infrastructure investments and therefore proposes that investment risks should be explicitly taken into account by regulators when obliging local loop access (Directive 2009/140/EC).  
[http://ec.europa.eu/information\\_society/policy/ecomm/doc/tomorrow/reform/better\\_regulation\\_directive/st03677\\_re06.en09.pdf](http://ec.europa.eu/information_society/policy/ecomm/doc/tomorrow/reform/better_regulation_directive/st03677_re06.en09.pdf)

<sup>30</sup>Please note again that I consider infrastructure competition between one established platform and a growing platform. Doing the exercise with current data will provide other results as mobile infrastructure is completely rolled out at least at a basic level in all EU member states today.



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infrastructure demand plays a central role in the roll-out of infrastructure. The situation of Web 2.0 where customers themselves become active information providers and where web-based communication turns more and more to peer-to-peer communication will definitely foster the demand pull of infrastructure.

From the findings of the analysis of upcoming platform competition, fix-line infrastructure should be expected to be the first affected by this development. Dependent on the revenue per mobile customers, mobile investments follow the development.

Some pitfalls of the analysis should not be ignored: I have considered investments on the aggregated level in monetary terms. In consequence, even by controlling for country differences, it cannot be stated that more investments are "better", firstly, as investments also include doubled lines resulting not necessarily in a reduction of congestion and, secondly, as no information about existing infrastructure and its quality is available. Moreover, due to data constraints at the current point in time, I have to accept some drawbacks with the specification of supply and demand, which have been discussed in the previous sections and which leave broader room for follow-up studies using a more structural estimation approach to revise the outcomes of this chapter in the future.

# 5 Mobile Network Interconnection and Investments

## 5.1 Introduction

Interconnection is an ongoing issue for competition and regulation authorities in network-based markets. I address the topic of wholesale-price regulation and investments in European mobile telecommunication markets and analyze how investments affect termination rates and off-net traffic. Following Article 8(2) of the Framework Directive (2002/21/EC) "national regulatory authorities shall promote competition [...] by encouraging efficient investment in infrastructure, and promoting innovation". Very recently, the EC took up this topic again and proposed to implement long-run incremental cost (LRIC) regulation in mobile voice call termination markets (Market 16 following the latest market definition of the EC). LRIC regulation should particularly encourage investment incentives as all providers' termination rates depend on the most efficient infrastructure elements. Nevertheless, the topic of investments with interconnected networks has not been addressed in the empirical literature on network competition. There is only little empirical evidence, focusing either on telecommunication markets as a whole or on the effect of competition on investments.<sup>1</sup> Consequently, we only know from theory how mobile network providers, i.e. network providers in markets with comparably low market concentration, should interact. With this chapter, I want to provide more insights into the issue of investment externalities in mobile markets.

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<sup>1</sup>Central exemptions are Röller and Waverman (2001) or also Grajek and Röller (2009).

I focus on (transportation) cost-reducing/cost-efficiency-increasing infrastructure investments and analyze how regulation affects the impact of investments on mobile network providers' wholesale profits. While quality-increasing investments, as discussed in Fors (2004), Kotakorpi (2006) or Valletti and Cambini (2005), induce a change in customers' calling behavior cost-reducing investments address the supply side. Lower costs enable a provider to offer "more" origination and termination service on its network as both existing facilities can be used more efficiently and the challenge of bottlenecks is mitigated. Note that one cannot easily separate investments in quality from cost-reducing investments. I concentrate on cost-reducing investments due to the measurable direct effect of cost changes on changes in termination rates and draw links to the topic of quality investments where this is possible.

If one provider invests in its network this should also affect termination rates, quantities and, thus, profits of other providers. Firstly, investments in cost reduction lower the own termination rates (see e.g. Armstrong, 2002). As termination rates are costs for competitors one should expect investments also to affect competitors' calls to other networks (see Valletti and Cambini, 2005). Secondly, the cost reduction changes the investor's amount of outgoing traffic because lower retail prices induce customers to increase their demand for outgoing calls.

I consider these hypotheses under alternative pricing schemes (linear and non-linear) and compare the results assuming alternative forms of regulation being in place in European countries. Afterwards, the theoretical findings will be analyzed by adopting data for the EU-15 countries as well as for Norway and Switzerland. I keep the models as close as possible to the standard theoretical literature (among others Armstrong, 1998; Laffont et al., 1998a and b; Carter and Wright, 2003) and adopt the assumptions and approaches provided. This way, comparisons of the empirical outcomes with the theoretical findings are facilitated and, moreover, also comparisons with the results of investment effects expected from the literature are allowed for.

In the theoretical part, I assume a three-step model with asymmetric players, which mainly corresponds to the model in Dewenter and Haucap (2005).<sup>2</sup> In doing so, a positive investment effect on own profits is found but also a positive externality on competitors' off-net profits from incoming calls. While non-linear pricing provides similar results as linear pricing, regulation (as assumed in the literature) ignores network externalities leading to a deterrence of competitors' prices and traffic.

With the empirical model, I find support that investments reduce the investor's termination rate and increase the investor's incoming traffic. As the traffic effect outweighs the effect on termination rates in the investor's short-run profit function, the empirical results correspond to the expectations derived from the theoretical model. Moreover, investments increase competitors' incoming traffic and reduce their termination rates. Replacing the regulation control variables by interaction terms with investments shows that the negative effect on competitors' termination rates is not due to regulation. Combining the empirical findings with the theoretical model the (pure) investment-induced termination rate reduction even outweighs the price-driven traffic increase in the competitors' profit functions.

This chapter is organized as follows: The next section provides an overview of the existing literature on off-net mobile competition (Section 2). Afterwards, I introduce the theoretical model. Hypotheses are derived which will be tested for the EU-15 countries as well as for Norway and Switzerland (Section 3). In Section 4, the estimation approaches are introduced and compared with regard to alternative estimation outcomes. Section 5 provides the estimation results and discusses them in more detail. Section 6 concludes and offers ideas for further extensions.

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<sup>2</sup>I rely on the central assumptions in this paper as, to the best of my knowledge, it is the first paper, which analyzes an issue in mobile network competition from both a theoretical and an empirical perspective.

## 5.2 Literature Review

Alternative aspects of mobile interconnection have been analyzed in an extensive range of literature which is mainly based on the framework of three seminal papers, Armstrong (1998), Laffont et al. (1998a) and Laffont et al. (1998b), hereafter A-LRT. Assuming a symmetric two-operators model, the papers provide insights into multiple fundamental outcomes concerning competition in network-based markets and open a wide range for extending research. Concerning off-net traffic, Laffont et al. (1998a) show that in a common per-unit pricing system the increase in total outgoing traffic corresponds to a reduction in incoming traffic. Thus, one provider's decision to reduce off-net prices is a decision at the margin. Alternatively, allowing for on-net/off-net price discrimination network providers choose higher off-net prices affecting customers' network choice as shown in Laffont et al. (1998b). In consequence, a raising-rivals-costs strategy in the sense of increasing termination rates need not result in a change of retail prices but in a promotion of competition for market shares.

The issue of infrastructure investments in network-based markets has been analyzed in a comparably low number of papers mostly assuming a vertically integrated upstream monopolist competing with one or more downstream entrants. Central results of these papers have been proved to exist also with network competition. Foros (2004) shows for a vertically integrated upstream monopolist and a downstream retailer that the level of quality investments depends on the substitutability of downstream services. The higher the degree of substitutability the lower is the investment incentive for the network provider. Foros assumes investments to take place before the regulation stage. As the investor does not know the implemented regulation in advance the under-investment challenge becomes even stronger with regulation than in the situation with no regulation which negatively affects total welfare. On the other hand, if downstream substitutability is comparably low investments are used to force competitors out of the market. Kotakorpi (2006) also finds support for the under-investment problem with downstream substitutability. Following Kotakorpi, network competition eliminates the foreclosure challenge of the upstream monopoly. Though, the long-run under-investment problem still remains in place.

Cambini and Valletti (2005) adopt the analysis of investment incentives to the framework of network competition by introducing an investment stage to the standard A-LRT model. The central assumption is that investments increase quality but do not affect per-unit costs (as in Foros, 2004; and Kotakorpi, 2006). They show that with asymmetric network size a small firm would benefit from a mark-up of termination rates over costs whereas the larger competitor would lose. With a lower level of substitutability between the services offered by the operators both providers would reduce investments with termination rates above costs. Nevertheless, without regulation competitors would negotiate a termination rate above per-unit costs, which reduces the incentive to invest in quality increase.

I will keep these central findings from theory in mind when analyzing the impact of investment externalities. As there exists nearly no empirical analysis of the theoretical findings I try to provide some more insights into the interplay of competitors in mobile markets by adopting the theoretical findings of investment effects on off-net prices and traffic into an empirical framework.

## 5.3 Theoretical Model

In this section, I derive a theoretical model for short-run profits where I assume market shares as given. I start with the more restricted linear pricing model and show how termination rates and quantities change due to investments in cost-reduction. Then, I compare the results of the linear pricing model with the outcome under two-part tariff pricing. Finally, termination rates are fixed at a constant level due to regulation (i.e. either at per-unit costs/at a constant rate above per-unit costs or at a cost-independent level). I employ a simplified version of the model in Dewenter and Haucap (2005) and use comparative statics to analyze alternative effects of investments on termination rates and traffic in terms of total minutes of usage (MOU).

Consider a market with a countable number of mobile network operators (MNPs)  $i$ ,  $i = 1, \dots, N$ ,  $i \neq -i$ . Customers are of mass 1 and have randomly chosen one MNP. As in Dewenter and Haucap (2005), customers receive the same gross-utility  $a$  from calling but no utility from being called.<sup>3</sup> Calls are assumed to be balanced across customers.

Each customer in network  $i$  demands  $a - b(s_i)p_{i,j} = a - b_i p_{i,j}$  calling minutes to customers in network  $j$ ,  $j = 1, \dots, N$ ,  $i \neq j$ , where  $p_{i,j}$  is the per-minute price for outgoing calls to network  $j$ ,  $b_i$  is a scale parameter for price-elasticity increasing in the investor's market share  $s_i$ ,  $b'(s_i) > 0$ . The larger  $b_i$  the lower is the willingness to pay for one unit of off-net calling. As I will only consider off-net traffic, the on-net/off-net pricing strategies and the utility of being with a particular MNP need not be further specified. Customers only decide on the call length depending on prices. The short-run demand function deviates from the model in Dewenter and Haucap (2005) where the representative off-net demand depends on the average off-net prices weighted by competitors' market shares.<sup>4</sup>

MNPs are active in a calling-party-network-pays regime (cpp regime). The per-minute termination rate  $t_i$  is the wholesale price, which one MNP asks another for terminating a call. The per-unit costs  $c_i$  are identical for call origination and termination (as assumed in A-LRT). Finally, I assume the long-run market to be sufficiently less concentrated. For this setting this means  $s_i < 2 \sum_{-i} s_{-i} \frac{b_{-i}}{b_i}$ .

### 5.3.1 Short-run price choice

With a linear pricing scheme provider  $i$ 's short-run off-net profits from call origination and termination are given by:

$$\begin{aligned} \pi_i(p_{i,j}, t_i) = \sum_j \pi_{i,j}^i + \sum_j \pi_{j,i}^i &= \sum_j ((p_{i,j} - t_j - c_i) s_i s_j (a - b_i p_{i,j})) \\ &+ \sum_j ((t_i - c_i) s_i s_j (a - b_j p_{j,i})) \end{aligned} \quad (5.1)$$

<sup>3</sup>For the analysis of quality investments one could think of identical gross-utilities for customers per provider  $a_i$ .

<sup>4</sup>A more detailed discussion on customers' demand for off-net calls can be found in Dewenter and Haucap (2005) and Hörnig (2007). Nevertheless, by adopting Dewenter and Haucap's assumptions,  $b_i = b_j = b$  and  $p_i = c_i$ , one receives similar results with the model of this chapter.

$\sum_j \pi_{i,j}^i$  are retail profits from outgoing traffic,  $\sum_j \pi_{j,i}^i$  are wholesale profits from incoming traffic. Off-net call prices depend on the terminating network. While termination rates are set equally for all incoming calls, retail prices for off-net calls are chosen dependent on the termination rates of the called network.

Let us assume a three stage game where, firstly, MNPs decide on investments, afterwards they choose termination rates  $t_i$  and then decide on retail off-net prices. Customers choose their amount of off-net communication depending on their provider's retail off-net price. Using backward induction optimum retail prices and termination rates will be derived. With the structure assumed here I follow Dewenter and Haucap and ignore the possible long-run strategy for the termination rate choice. The long-run termination rate choice is the focal subject of many theoretical papers beginning with the seminal work of A-LRT and Gans and King (2001) from a time-independent perspective and with a time-dependent perspective in Höfler (2009).

Deriving (5.1) one gets  $i$ 's profit-maximizing off-net price:

$$p_{i,j} = \frac{a}{2b_i} + \frac{c_i + t_j}{2} \quad (5.2)$$

Please note that provider  $i$  only partially passes through termination rates to its customers.

Replacing prices for off-net calls and deriving the resulting profit function with respect to termination rates yields:

$$t_i = \frac{c_i}{2} + \frac{\sum_j s_j (a - b_j c_j)}{2 \sum_j s_j b_j} \quad (5.3)$$

### 5.3.2 Investments

As I cannot analyze the equilibrium investment behavior of MNPs in the empirical part, I use comparative statics here considering the effect of investments on the investor's termination rate, retail prices and off-net traffic and the externality of investments on competitors' off-net profits. I concentrate on investments in cost-reduction  $k_i$  and assume  $c'_i(k_i) < 0$ . The reasoning behind this assumption is that cost-reducing/cost-efficiency



increasing investments are only implemented if the cost level taking into account depreciation is reduced.

In what follows two alternative investment effects are compared:<sup>5</sup> The **own investment effect** represents the effect of investments on the investor's profits from off-net traffic. As the demand for off-net calls depends on off-net retail prices cost-reducing investments affect the investor's off-net profits both through wholesale and retail prices and through the quantity of incoming and outgoing calls.

With the term **investment externalities** the impact of one provider's investment on another provider's off-net profits from interconnection with the investor is described.

Notational note: In the following the investing network is indexed by  $i$  and  $-i$  is used for all networks except for  $i$  and  $-j$  for all networks except for  $j \neq i$ .

### Own investment effect

Deriving (5.3) with respect to  $k_i$  yields the change in the termination rate for incoming calls on network  $i$ :

$$\frac{\partial t_i}{\partial k_i} = \frac{c'_i(k_i)}{2} < 0 \quad (5.4)$$

As expected for monopoly prices, the termination rate decreases by cost-reduction. From (5.2) we know that the effect of investments on the off-net price  $p_{j,i}$  is  $\frac{1}{2}t'_i(k_i)$ . Thus, the cost-reduction is only partially passed on to customers. The investment increases the amount of traffic from network  $j$  to network  $i$  because the impact on off-net prices is strictly negative.

With lower termination rates a positive effect of investments on own wholesale profits is observed as, firstly, termination rates decrease less severely than costs and as, secondly,  $p_{j,i}$  for any MNP  $j$  also decreases due to the reduction in termination costs:

$$\frac{\partial \sum_j \pi_{j,i}^i}{\partial k_i} = -c'_i(k_i) \frac{s_i}{2} \sum_j \left( s_j \frac{1}{b_j} (a - b_j(t_i + c_j)) \right) > 0 \quad (5.5)$$

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<sup>5</sup>In Appendix A.4.1 a third investment effect will be discussed, which has been ignored in the literature due to the standard assumption of only two competing networks.

The term in brackets is non-negative for both the linear and the two-part tariff model as we will see below.

The calculation of retail profits from the investor's outgoing calls is provided in Appendix A.4.2.

### Investment externalities

The effect of  $i$ 's investments on own outgoing traffic depends on  $i$ 's relative market share. Competitors' termination rates are stronger affected by larger providers' investments as origination costs enter competitors' termination rates weighted by the market share (see equation (5.3)). Thus, competitors choose termination rates to be higher the higher the market share of the investor and the stronger the investment effect on origination costs due to the increase in incoming traffic:

$$\frac{\partial t_j}{\partial k_i} = -c'_i(k_i) \frac{s_i b_i}{2 \sum_{-j} s_{-j} b_{-j}} > 0 \quad (5.6)$$

While the impact of investments on incoming calling minutes to the investor is straight forward, the effect on incoming minutes to competitors' networks,  $\sum_j q_{i,j} = s_i \frac{1}{b_i} \sum_j s_j \frac{a_i - b_i p_{i,j}}{2}$ , is ambiguous. With higher wholesale prices for termination the investor chooses higher retail prices for outgoing calls. On the other hand the efficiency increase reduces origination costs. The total effect therefore depends on whether the efficiency increase outweighs the effect on competitors' termination rates or not. Deriving prices for outgoing calls from the investor's network  $p_{i,j}$  with respect to  $k_i$  yields:

$$\frac{\partial p_{i,j}}{\partial k_i} = -\frac{c'_i(k_i) s_i b_i - 2 \sum_{-j} s_{-j} b_{-j}}{2 \sum_{-j} s_{-j} b_{-j}} \quad (5.7)$$

which is negative as the second term is strictly negative (given the assumption of sufficiently low market concentration). Even though competitors' termination rates increase in  $i$ 's investments, the investor does not pass on this termination rate increase to customers. Moreover, the cost-reduction overcompensates the investment effect on competitors' termination rates.

As competitors' costs of call termination on their own network remain unchanged by  $i$ 's investments competitors' wholesale mark up increases. Additionally, the total duration of incoming calls from the investor's network increases as off-net calls from  $i$  are positively affected by  $i$ 's investments in cost-reduction. Combining these findings the investment externality on competitors' wholesale profits is positive:

$$\begin{aligned} \frac{\partial \pi_{i,j}^j}{\partial k_i} &= -\frac{c'_i(k_i)}{2} s_i s_j \left( \frac{s_i}{2 \sum_{-j} s_{-j} b_{-j}} (a - b_i(c_i + t_j)) \right. \\ &\quad \left. + (t_j - c_j) \left( 1 - \frac{s_i}{2 \sum_{-j} s_{-j} b_{-j}} \right) \right) > 0 \end{aligned} \quad (5.8)$$

I show in Appendix A.4.2 that the effect on competitors' retail profits is also positive.

In a nutshell, a positive own-wholesale-profit effect exists as the cost reduction raises the price-cost margin and – by reducing competitors' off-net prices – increases the demand for incoming calls. Furthermore, we have identified a positive externality on competitors' wholesale profits: Firstly, with lower off-net retail prices calling minutes from the investor's network increase and, secondly, competitors' termination rates increase with lower origination costs.

### 5.3.3 Comparison to Two-Part Tariffs

Similar investment effects as found with the linear pricing model do not necessarily exist with alternative pricing schemes. One commonly used approach in the literature are two-part tariffs with per-unit prices equal to termination rates plus origination costs (e.g. A-LRT; Wright, 2002; Armstrong, 2002). Furthermore, it is repeatedly assumed that cost-based regulation forces termination rates to be set at per-unit costs of call termination. Valletti and Cambini (2005) also allow for termination rates at a fixed level above marginal costs. With these alternative/additional assumptions about a fixed termination rate investment effects change as follows:

If the retail price for outgoing calls to network  $i$  is fixed at termination rates plus origination costs,  $p_{j,i} = t_i + c_j$ , changes in termination rates are directly passed on to customers' demand choice. Thus, the investor's termination rate reduction increases the demand for outgoing calls to network  $i$ .

Is the change in termination rates completely passed on to the demand for outgoing calls? If this is the case it induces the following change in demand for calls to network  $i$  and for calls from network  $i$  (with unrestricted termination rates):

$$\begin{aligned}\frac{\partial \sum_j q_{j,i}}{\partial k_i} &= c'_i(k_i) \sum_j \frac{\partial q_{j,i}}{\partial p_{j,i}} \frac{\partial p_{j,i}}{\partial c_i} = -\frac{c'_i(k_i)}{2} s_i \sum_j s_j b_j \\ \frac{\partial \sum_j q_{i,j}}{\partial k_i} &= -c'_i(k_i) s_i b_i \sum_j s_j \left(1 - \frac{s_i b_i}{2 \sum_{-j} s_{-j} b_{-j}}\right)\end{aligned}\quad (5.9)$$

Thus, the demand effect is twice the demand effect with linear prices. With termination rates fixed to costs the change in demand is:

$$\begin{aligned}\frac{\partial \sum_j q_{j,i}}{\partial k_i} &= -c'_i(k_i) s_i \sum_j s_j b_j \\ \frac{\partial \sum_j q_{i,j}}{\partial k_i} &= -c'_i(k_i) s_i (1 - s_i) b_i\end{aligned}\quad (5.10)$$

With the additional assumption of termination rates equal to per-minute costs it is four times the effect. This excess demand increase does not change  $j$ 's off-net profit as retail prices are at per-unit costs.

So far, I have ignored the impact on the subscription fee. With a lower per-unit price the subscription fee is set higher dependent on the (expected) increase in consumer surplus. As Peitz (2005) states:

"In a neighborhood around cost-based access prices an increase in the competitor's [entrant's] access price leads to lower subscription fees of any [both] operators."<sup>6</sup>

Taking for example the model of Peitz (2005) one can easily show that the investor's and a competitor's subscription fee rise due to investments. Corresponding results could be derived for the investment effect on own profits from outgoing calls and also for an indirect investment effect on outgoing calls.

In praxi, the traffic-independent subscription fee of two-part tariff schemes cannot be adjusted as fast as the per-unit price. The adjustment delay is due to contract duration with customers and overlapping beginnings of contract periods. As investments do not have a one-shot property but, moreover, are conducted continuously one should either

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<sup>6</sup>Peitz (2005), p. 9. Peitz considers the two-provider case.

Table 5.1: Mobile Regulation in the EU-15, Norway and Switzerland

	cost-based	incentive	cost-based	incentive	cost-based	incentive
	2001		2004		2007	
Austria					X	
Belgium						X
Denmark						X
Finland	X		X		X	
France					X	
Germany					X	
Greece					X	
Ireland					X	
Italy		X		X		X
Netherlands					X	
Norway					X	
Portugal						X
Spain					X	
Sweden		X		X	X	
Switzerland					X	
United Kingdom		X		X		X

Source: Information taken from the Plaut Economics Regulatory Index (Zenhäusern et al., 2007) and alternative regulators' websites

expect ongoing re-adjustments of subscription fees or, alternatively, per-unit prices above per-unit costs as a second-best option. Contract adjustments are not implausible even during the contract period if providers benefit from lower retail prices, for example due to own or competitors' investments.

### 5.3.4 Regulation

With the transposition of the competition enforcing regulation directives to national law in 2004 and 2005, mobile termination markets have been regulated in all EU member states at the latest. Nevertheless, the directives do not specify, which regulation scheme should be adopted. In European countries mainly two alternative regulation schemes have been in place since 2000. Cost-based regulation like LR(A)IC is the most wide-spread approach and is the one, which the EC proposes to be extended for mobile communication markets in a recommendation of 07 May 2009.<sup>7</sup> The alternative

<sup>7</sup><http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/710&format=HTML&aged=0&language=EN&guiLanguage=en>

regulation scheme is incentive regulation meaning either price- or revenue-cap regulation. Table 5.3.4 provides an overview of the alternative regulation approaches being in place in Europe.

Cost-based regulation forces termination rates to be chosen at the cost level or a constant mark-up above costs. With cost-based termination rates, investments in cost reduction are directly passed on to the investor's termination rates. While the investment externalities on incoming calls are higher with cost-based regulation than without regulation the wholesale price-cost margin remains constant. Concerning the effect on profits from outgoing calls to the investor, a stronger reduction in retail prices is observed since the mitigating effect of cost-reduction on optimally chosen termination rates is abolished. The price effect is overcompensated in the competitors' profit functions by a higher demand for outgoing calls.

Please note that LRIC regulation as it is usually defined in the literature is a simplification of the more technical definition given in Laffont and Tirole (2001):

"LRIC=Marginal cost of date-t production of the most efficient technology  $\times$  (Interest rate + Rate of technological progress + Rate of physical depreciation of the equipment)"<sup>8</sup>

If LRIC regulation is introduced in the strict sense competitors were forced to reduce their termination rates in line with an investment. In consequence, this would deter the outcome twice: Firstly, the investor's retail price would decrease more than without regulation and even more than with standard cost-based or incentive regulation as the competitors' termination rate reduction stronger affects the investor's price-cost margin. Secondly, the competitors' wholesale price-cost margin would also be deterred increasing the off-net traffic between competitors. Thus, under LRIC regulation the strategic-instrument character of investments is enhanced in the short run (increasing incoming traffic and reducing competitors' profit margins). In contrast, with standard cost-based regulation direct investment effects vanish as termination rates are unaffected by competitors' investments but are in place with the LRIC form.

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<sup>8</sup>see Laffont and Tirole (2001), p. 151

Price-cap regulation requires an upper bound for termination rates set by the regulator, which is based on a price basket of telecommunication services. Thus, by investing in cost-reduction, MNPs directly gain from a higher wholesale price-cost margin. Nevertheless, the incoming traffic remains unaffected as long as the individually optimum termination rate is higher than the upper bound. The adoption of price-cap regulation to the model results in a stronger investment effect on the wholesale price-cost mark-up than in the absence of regulation as termination rates are fixed. The investment effect on profits from incoming calls is similar to standard cost-based regulation. The wholesale mark-up changes only due to the cost-reduction but not because of an increase in incoming calls. As termination rates are fixed for every provider separately, investment externalities under a price-cap regulation scheme only consist of an increase in traffic. All other variables (competitors' retail prices, termination rates and outgoing traffic) are unaffected by investments. Indirect investment effects vanish as termination rates are independent of competitors' traffic.

Under a two-part tariff pricing scheme with per-unit prices at cost-level we still observe positive investment effects on the traffic from and to the investor. One exception is incoming calls under an incentive regulation scheme because the investor's termination rates are unaffected by the investment. The cost-reduction increases the investor's traffic-dependent profits only for incoming traffic under price-cap regulation as the termination rate level is allowed to be above costs. Similarly, there is a positive externality on competitors' traffic-dependent profit only for incoming traffic under the price-cap scheme.

In a nutshell, regulation is expected to introduce a deterrence to investment effects as it fixes price components either to a cost-based level or to an exogenously given price basket. Thus, under cost-based regulation the investment effect on competitors' prices is larger whereas the effect on the investor's prices remains equal to that of the situation without regulation. With incentive regulation the own retail-price effect is equal to the situation without regulation but no effect on competitors' prices exists anymore.

### 5.3.5 Discussion of the theoretical model

As a potential equilibrium situation cannot be analyzed with the data, I only consider the impact of investments on own wholesale profits and the externality on competitors' wholesale profits in the short-run. Thus, I do not fully specify the theoretical model in the sense that I only analyze off-net traffic and ignore on-net effects of investments and the substitutability between on-net and off-net calls.<sup>9</sup> I use comparative statics to analyze the impact of investments and do not further discuss investment costs. In consequence, the strategic investment behavior as it is analyzed in Valletti and Cambini (2005) is ignored here. In doing so, I mainly refrain from the consideration of size effects in terms of market shares and ignore customers' provider choice.

Even with these limitations the theoretical model provides two central results concerning the impact of investments on termination rates and off-net traffic. The results of the own investment effect analysis let expect that investments reduce own termination rates, thus, increasing the demand for calls to the investor both assuming either regulation or the absence of regulation. Please note that the demand increase is induced by the termination rate reduction. Thus, the cost-reduction is only partially passed on to customers with both a linear and a two-part tariff pricing structure.

**H1 (Own investment effect):** Investments reduce own termination rates but affect incoming traffic only through the investor's termination rate choice.

After the analysis of the own investment effects I turned to the effect of investments on competitors' termination rates and competitors' incoming calls. The demand for outgoing calls, i.e. the total incoming calls to competitors, increases in line with cost-reducing investments, as the cost-reduction results in lower retail off-net prices from the investor's network. Due to this demand increase competitors are able to ask for higher termination rates. Taking into account regulation, we should expect either no significant effect on competitors' termination rates or a reduction in termination rates. The impact on the amount of incoming traffic to competitors is still positive.

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<sup>9</sup>The on-net/off-net price differential problematic was first introduced in A-LRT and is the subject of Hörnig (2007).



**H2a (Investment externality without regulation):** Investments increase competitors' termination rates and directly increase the incoming traffic to the competitors' networks.

**H2b (Investment externality with regulation):** Investments either have no effect on competitors' termination rates (standard cost-based regulation, incentive regulation) or reduce competitors' termination rates (LRIC regulation) and directly increase the incoming traffic to the competitors' networks.

As mobile contract conditions could be adjusted only in the long-run, I expect to find these effects independently of the pricing structure. The effect on termination rates might be reduced in the long-run but should still be observed.<sup>10</sup>

## 5.4 Empirical Analysis

In order to test the hypotheses, I employ data for the EU-15, as well as for the Norwegian and the Swiss mobile wholesale markets. I first derive an econometric model, which is closely related to the theoretical model of the previous section. Afterwards, I shortly describe the data and the expected signs of the estimation coefficients. The data selection, the description of some pitfalls with the data and also the way of data adjustments is provided in Appendix A.4.3 and Appendix A.4.4.

### 5.4.1 Econometric Model

Both hypotheses consist of two parts, one concerning price effects and one concerning traffic. It is therefore important to disentangle both effects. Two separate equations are used to explain the effect of investments on termination rates and on incoming traffic. Furthermore, two alternative equation systems are used for the first and for the second hypothesis as two alternative effects of investments are tested.

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<sup>10</sup>Please note that I refrain from hypotheses on off-net profits as due to data availability off-net profits have to be derived from the available variables. Nevertheless, the impact of investments on off-net profits will be further discussed in an extension to Section 5.5.

Dewenter and Haucap (2005) provide a very promising approach for estimating termination rates. They use measures for market concentration and market size and control variables for technology and regulation as well as country and year effects. I adopt this approach and additionally include an investment parameter to get the following equation for the analysis of the own investment effect on termination rates:

$$\begin{aligned} \log(t_{i,l,z}^1) &= \alpha_{l,z}^{t1} + \beta_{inv}^{t1} \log(investment_{i,l,z}) + \beta_s^{t1} \log(s_{i,l,z}) \\ &+ \beta_{msize}^{t1} \log(msize_{l,z}) + \beta_{urbpop}^{t1} \log(share\ upop_{l,z}) \\ &+ regulation'_{i,l,z} \beta_{reg}^{t1} + \beta_{1800}^{t1} GSM1800_{i,l,z} + \varepsilon_{i,l,z}^{t1} \end{aligned} \quad (5.11)$$

where  $i$  is a firm index,  $l$  is a country index and  $z$  is a year index.  $s$  is the individual market share in terms of customers,  $msize$  is the total number of mobile subscribers in a country. The share of urban population  $share\ upop$  is introduced as termination costs are expected to depend on the population concentration. With a higher concentration, termination costs should be lower, thus, negatively affecting termination rates. Similarly to Dewenter and Haucap, I introduce a  $GSM1800$  dummy to control for providers which only offer communication via the higher, more expensive frequency level. As there is more detailed information available about the alternative regulation schemes, I add regulation dummies for cost-based, incentive and asymmetric regulation, instead of the approach provided in Dewenter and Haucap. They also added the Herfindahl-Hirshman-Index (HHI) as a control variable and argue that they have expected to find a significant impact of concentration on termination rates. Nevertheless, the explanatory power of the HHI in their estimations might be reduced due to the high correlation with the market share variables. Because of this issue in the estimation specification and as it is found to have no significant effect on termination rates, I ignore the HHI in my estimation approach.

The equation for the amount of incoming traffic to the investor is specified as follows:

$$\begin{aligned} \log\left(\sum_j q_{j,i,l,z}^1\right) &= \alpha_{l,z}^{q1} + \beta_{inv}^{q1} \log(investment_{i,l,z}) + \beta_t^{q1} \log(t_{i,l,z}) \\ &+ \beta_s^{q1} \log(s_{i,l,z}) + \beta_{msize}^{q1} \log(msize_{l,z}) + \beta_{post}^{q1} post_{i,l,z} \\ &+ \beta_{urbpop}^{q1} \log(share\ upop_{l,z}) + regulation'_{i,l,z} \beta_{reg}^{q1} + \varepsilon_{i,l,z}^{q1} \end{aligned} \quad (5.12)$$

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Besides the variables of the termination rate equation, I include termination rates and a post-paid dummy into the quantity equation. From the theoretical model one should expect a negative coefficient of the termination rate term. Also a positive coefficient of the post-paid term is expected.

Equations (5.11) and (5.12) will be used in line with the first hypothesis on own investment effects.

For the second hypothesis, I aggregate the data with regard to investments. Although it was not necessary to consider multiple investors simultaneously in the theoretical model, it is important to take this aspect into account in the empirical analysis. As an individual investment effect of one provider cannot be isolated from those of others, I use a weighted average measure of investments as an explanatory variable for the analysis of a potential externality. In order to make comparisons with the results of the first equation system easier, I take the perspective of a competitor and consider how aggregated investments affect termination rates and incoming traffic.<sup>11</sup> Thus, I get for the termination rate equation and the incoming traffic equation:

$$\begin{aligned} \log(t_{i,l,z}^2) &= \alpha_{l,z}^{t2} + \beta_{inv}^{t2} \log\left(\sum_j \frac{investment_{j,l,z}}{(N-1)_{l,z}}\right) + \beta_s^{t2} \log(s_{i,l,z}) \\ &+ \beta_{msize}^{t2} \log(msize_{l,z}) + \beta_{urbpop}^{t2} \log(share\ upop_{l,z}) \\ &+ regulation'_{i,l,z} \beta_{reg}^{t2} + \beta_{1800}^{t2} GSM1800_{i,l,z} + \varepsilon_{i,l,z}^{t2} \end{aligned} \quad (5.13)$$

$$\begin{aligned} \log\left(\sum_j q_{j,i,l,z}^2\right) &= \alpha_{l,z}^{q2} + \beta_{inv}^{q2} \log\left(\sum_j \frac{investment_{j,l,z}}{(N-1)_{l,z}}\right) + \beta_t^{q2} \log(t_{i,l,z}) \\ &+ \beta_s^{q2} \log(s_{i,l,z}) + \beta_{msize}^{q2} \log(msize_{l,z}) + \beta_{post}^{q2} post_{i,l,z} \\ &+ \beta_{urbpop}^{q2} \log(share\ upop_{l,z}) + regulation'_{i,l,z} \beta_{reg}^{q2} + \varepsilon_{i,l,z}^{q2} \end{aligned} \quad (5.14)$$

where  $\log\left(\sum_j \frac{investment_{j,l,z}}{(N-1)_{l,z}}\right)$  is the logarithm of the average investment of all MNPs except for  $i$ . All other variables are equal to those of the first empirical model. Due to lags in the data employing a time dependent approach is much more susceptible to outliers due to a strong reduction in observations. I therefore pool the data and use similar estimation approaches as in Dewenter and Haucap (2005).

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<sup>11</sup>Alternatively, one could also take the perspective of an investor and look at how investments affect outgoing traffic and the competitors' termination rates.

### 5.4.2 Data Description and Data Adjustments

Data from multiple sources is employed including information about the fully vertically integrated MNPs in the EU-15 as well as Norway and Switzerland, data about termination regulation and the termination rates, information about individual transmission technology per provider and data about population concentration on a quarterly basis between 2001 and 2007.<sup>12</sup> Unfortunately, due to lags in the data structure I have to ignore Greece and Luxembourg in the estimations. As not all information is provided in the form required for the analysis I adjust the data.<sup>13</sup> The most-relevant adjustment is the calculation of incoming calling minutes. Among other sources, data from the Merrill Lynch European Wireless Matrix is used, which provides only aggregated data on calling minutes and does not distinguish on-net traffic from off-net traffic. Furthermore, it is stated in the data description that due to double counting of incoming and outgoing calls total calling minutes are upward-distorted.<sup>14</sup> I correct the data using standard approaches known from the theoretical literature (e.g. A-LRT). Usually, separating on-net from off-net traffic is done on the basis of market shares assuming a balanced calling scheme. The total off-net traffic originating from MNP  $j$  is calculated as one minus the own market share times the total minutes of usage:

$$q_{j,l,z} = (1 - s_{j,l,z})MOU_{j,l,z}$$

where  $MOU_{j,l,z}$  are the total minutes of usage of MNP  $j$ . The higher the individual market share the more outgoing calls are terminated on the own network.

From these adjusted values, I calculate the quantity of incoming calls to any network  $i$  as

$$\begin{aligned} \sum_j q_{j,i,l,z} &= \sum_j \frac{s_{i,l,z}}{1-s_{j,l,z}} q_{j,l,z} \\ &= s_{i,l,z} \sum_j MOU_{j,l,z} \end{aligned} \tag{5.15}$$

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<sup>12</sup>I appreciate the comprehensive support with data provision by the Deutsche Telekom AG, which enabled the access to non-publicly available information on traffic, company-specific information and termination rates.

<sup>13</sup>The description of raw data adjustments is provided in Appendix A.4.3 and A.4.4.

<sup>14</sup>See the Merrill Lynch European Wireless Matrix 2007, p. 18.

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As in Dewenter and Haucap, information on costs of call termination is proxied with variables like population concentration and a dummy for GSM-1800 technology. The dummy takes the value 1 if the provider offers mobile services only in the frequency band around 1800 MHz. If the provider also offers mobile services in the 900 MHz frequency band or only in this lower frequency band the dummy takes the value of 0.

Many European MNPs are active in multiple countries or are organizationally linked across countries. Thus, one might think of competitive advantages of these providers over competitors in national markets because of economies of scale on the organizational or technical level or because of the opportunity of cross-subsidizing investments. I have controlled for multi-national activities including company dummies and dummies for multi-national activities in the estimation equations and I have used Hausman specification tests for comparing the results of the restricted and the unrestricted models. In doing so, I could identify no significant additional company-specific effect as well as no significant difference between multi-national MNPs and national MNPs.

One outstanding issue in the empirical investment analysis are delays in investment effects. That is why one should use investments in a lagged form (Greenstein, 1997; Friederiszick et al., 2008). I have tested alternative lag lengths also considering cyclical investment effects. In doing so, I could identify a four-period investment cycle. Nevertheless, correcting for cyclical investment effects brings us to no significant deviation to the model where one assumes contemporaneous investment effects. Moreover, with a time-variant approach I get results, which strongly suffer from a lower number of observations.

Table 5.2 provides an overview of the data for the first and the last year of the estimation period. Off-net traffic increases during the observation period by about 50 percent, which is driven by mainly three factors: Firstly, we observe an ongoing increase in the number of mobile users in all countries over the observation period at a decreasing growth rate over time, which means that the saturation point of mobile communication has not been reached yet (see also Figure 4.1 in Chapter 4 and the OECD Communications Outlook 2007, Chapter 4). A second reason might be the change in the contract structure and also in the usage of mobile phones. While in the early 2000s many customers used

Table 5.2: Descriptive Statistics

<b>2001</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Min</b>	<b>Max</b>	<b>Obs.</b>
MOU incoming (mill.)	41.9	26.2	0	132.7	143
termination rate (cent/min.)	0.328	0.339	0.102	1.240	163
capex (mill.)	168.4	216.4	38	931	20
market share	0.301	0.173	0.005	0.713	212
market size (mill.)	17704.7	18072.4	2508.0	56108.0	212
share urban population	0.741	0.113	0.551	0.972	236
post paid (mill. subscr.)*	3154.5	3501.7	283	11770	26
cost regulation	0.068	0.252	0	1	236
price/rev. cap regulation	0.136	0.343	0	1	236
regulation net monopoly	0	0	0	0	236
GSM 1800	0.102	0.303	0	1	236

<b>2007</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Min</b>	<b>Max</b>	<b>Obs.</b>
MOU incoming (mill.)	61.0	30.0	0	166.1	120
termination rate (cent/min.)	0.220	0.251	0.057	0.990	148
capex (mill.)	103.7	80.6	14	379	138
market share	0.293	0.147	0.031	0.625	156
market size (mill.)	30235.2	32120.4	4589	93292.0	153
share urban population	0.753	0.110	0.589	0.973	177
post paid (mill. subscr.)*	3005.4	3691.5	82	15669	156
cost regulation	0.305	0.462	0	1	177
price/rev. cap regulation	0.339	0.475	0	1	177
regulation net monopoly	0.356	0.480	0	1	177
GSM 1800	0.102	0.303	0	1	177

\*2002

mobile phones mainly for short calls or for short messages mobile devices changed their character to organizers with music and photo applications. Thus, mobile devices became more important not only for calling services but, moreover, as a standard companion in particular for younger customers. Besides this change in usability, mobile communication more and more substitutes and, simultaneously, complements fix-line telephony (see also the discussion in Chapter 4). Contract structures, in particular at the end of the observation period, turned from minutes-based pricing to flat rate offers, which allows customers to ignore call length. Before, many customers used their mobile phone only

if no cheaper fix phone was available.<sup>15</sup> Finally, lower off-net costs might be a driver for the increase of traffic as a decrease in calling costs is probably passed on to customers, which is also the standard assumption in theoretical models.

The high 2001 observations of capex might be driven by an outlier group in the data set as in the following years investments between 95 and 120 million Euros have been observed. Thus, the exceptionally high average investment level in 2001 is probably not (only) due to the auctioning of or beauty-contests for UMTS licenses. Moreover, it might be induced by missing data on smaller countries for the year 2001.

Concerning market shares, I find a slight reduction in market concentrations, which is the target of termination regulation. Nevertheless, it is unclear whether the reduction in concentration is driven by tougher regulation or whether the reduction goes only in hand with a reduction in variability, also be seen from the standard deviation.

Table 5.3: Expected Outcomes

Dep. Variable	Own Investment Effect		Investment Externality	
	Term. Rate	MOU inc.	Term. Rate	MOU inc.
termination rate		-		-
capex	-		+/-	+
market share	-	+	-	+
market size		+		+
share urban pop.	-		-	
post paid		+		+
cost regulation	+		+	
price/rev. cap regulation	+		+	
GSM 1800	+		+	

An overview of the expected estimation outcomes is given in Table 5.3. From the theoretical model a negative effect of capex on the investor's termination rate should be expected. A positive effect on the competitors' termination rates should exist in the absence of regulation whereas the effect is zero or negative dependent on the underlying regulation scheme. Concerning the effect on off-net traffic, one should expect a positive effect on the competitors' incoming traffic. Please note that with cost-reducing

<sup>15</sup>See e.g. Ward and Woroch (2004).

investments no (additional) investment effect on the investor's incoming calls should exist as the whole effect on incoming traffic stems from the change in the termination rate due to investments.

Dewenter and Haucap (2005) have shown that larger providers choose lower termination rates than smaller competitors. As this aspect was not explicitly modeled, no proposition could be derived from the theoretical model without further assumptions.

With a higher population concentration less infrastructure must be installed. Thus, maintenance costs and also costs for keeping the network running are expected to be lower, which should be reflected in a lower termination rate.

Regulation effects are expected to be positive with regard to termination rates because of the competition-inducing intention of regulation. Regulation is necessary where prices are not at a competitive level. Thus, in countries with regulation higher prices should be in place, which have to be brought down to a competitive level. The coefficients of regulation dummies should therefore not be interpreted as the effect of regulation on termination rates but as coefficients of control variables due to the pooled estimation setup.

## 5.5 Estimation Approaches, Results and Discussion

### Estimation Approaches

I estimate the equation systems provided in Section 5.4 using two alternative estimation methods as only very little experience in estimating mobile competition models is currently available from the literature. In doing so, I try to provide some more insights into alternative methods, which fit the structure typically assumed in theoretical models.

The first approach is standard generally least squares (GLS) with heteroscedasticity robust standard errors. I estimate incoming traffic and termination rates separately thus ignoring any endogeneity of termination rates on incoming traffic. The alternative



Table 5.4: Estimation Results

<b>log(term. rate)</b>	<b>GLS (1 a)</b>	<b>3SLS (2 a)</b>	<b>GLS (3 a)</b>	<b>3SLS (4 a)</b>	<b>GLS (5 a)</b>	<b>3SLS (6 a)</b>
log(capex)	-0.025 ** (0.012)	-0.047 ** (0.020)			-0.026 * (0.014)	-0.044 ** (0.021)
log(weighted av. capex)			-0.042 *** (0.011)	-0.066 *** (0.023)	-0.035 *** (0.012)	-0.061 *** (0.023)
log(market share)	-0.155 *** (0.014)	-0.147 *** (0.026)	-0.184 *** (0.015)	-0.165 *** (0.026)	-0.173 *** (0.015)	-0.154 *** (0.027)
log(market size)	0.251 *** (0.096)	0.196 (0.170)	0.186 ** (0.089)	0.145 (0.170)	0.229 ** (0.096)	0.192 (0.171)
log(share urban pop.)	-4.679 *** (1.678)	-8.860 ** (4.252)	-3.426 * (2.067)	-7.862 * (4.489)	-3.502 * (2.050)	-7.574 * (4.465)
cost-based regulation	0.138 * (0.075)	0.124 ** (0.053)	0.097 (0.068)	0.123 ** (0.053)	0.101 (0.068)	0.130 ** (0.053)
incentive regulation	0.090 *** (0.025)	0.062 (0.042)	0.094 *** (0.024)	0.053 (0.043)	0.097 *** (0.024)	0.057 (0.043)
netmonopoly reg.	0.009 (0.023)	-0.037 (0.045)	-0.020 (0.022)	-0.051 (0.047)	-0.015 (0.022)	-0.048 (0.047)
GSM 1800	0.103 *** (0.018)	0.109 *** (0.039)	0.103 *** (0.017)	0.124 *** (0.039)	0.094 *** (0.017)	0.115 *** (0.039)
constant	-3.146 *** (0.752)	--	-2.294 *** (0.736)	--	-2.563 *** (0.744)	--
			country dummies included			
			year dummies included			
# Obs.	799	510	731	500	799	500
F (df)	1263.5 (28)	47046.9 (26)	1390.5 (27)	45985.5 (26)	1263.5 (28)	46401.4 (27)
(adj.) R2	0.955	0.949	0.957	0.950	0.955	0.950
<b>log(MOU inc.)</b>	<b>GLS (1 b)</b>	<b>3SLS (2 b)</b>	<b>GLS (3 b)</b>	<b>3SLS (4 b)</b>	<b>GLS (5 b)</b>	<b>3SLS (6 b)</b>
log(capex)	0.009 (0.008)	-0.002 (0.012)			0.005 (0.008)	-0.009 (0.013)
log(weighted av. capex)			0.045 *** (0.012)	0.037 *** (0.014)	0.053 *** (0.009)	0.036 *** (0.014)
log(term. rate)	0.008 (0.015)	-0.203 (0.158)	-0.058 *** (0.022)	-0.248 * (0.147)	0.021 (0.017)	-0.271 * (0.160)
log(market share)	0.969 *** (0.014)	0.937 *** (0.024)	1.237 *** (0.018)	0.940 *** (0.025)	0.985 *** (0.014)	0.940 *** (0.025)
log(market size)	0.122 ** (0.056)	0.137 * (0.074)	-0.190 ** (0.081)	0.131 * (0.076)	0.125 ** (0.064)	0.143 * (0.079)
log(share urban pop.)	-7.302 *** (0.920)	-8.466 *** (1.574)	-9.833 *** (1.380)	-9.336 *** (1.525)	-8.067 *** (1.064)	-9.408 *** (1.587)
post paid	0.000 *** (0.000)	0.000 *** (0.000)	-0.000 ** (0.000)	0.000 *** (0.000)	0.000 *** (0.000)	0.000 *** (0.000)
cost-based regulation	-0.005 (0.018)	0.021 (0.031)	0.049 * (0.026)	0.024 (0.030)	-0.008 (0.020)	0.029 (0.032)
incentive regulation	0.024 (0.018)	0.036 ** (0.021)	0.081 *** (0.021)	0.046 ** (0.021)	0.033 ** (0.016)	0.049 ** (0.022)
netmonopoly reg.	0.060 *** (0.016)	0.050 ** (0.022)	0.099 *** (0.023)	0.062 *** (0.023)	0.077 *** (0.018)	0.062 *** (0.024)
constant	0.382 (0.683)	--	1.769 (1.099)	--	0.062 (0.771)	--
			country dummies included			
			year dummies included			
# Obs.	510	510	500	500	500	500
F (df)	742.2 (26)	955946.2 (27)	740.9 (26)	877385.2 (27)	713.2 (27)	12659.96 (27)
(adj.) R2	0.972	0.965	0.975	0.963	0.975	0.961

Note: \*\*\*, \*\*, \* represent significance at the 1, 5 and 10 percent significance level, standard errors are displayed in brackets.

method is a simultaneous estimation approach (3SLS) where  $\log(\textit{termination rate})$  is assumed to be endogenous. This term is explained with the variables of the termination rates equation.<sup>16</sup>

### Estimation Results and Discussion

The results of the alternative estimation approaches for own investment effects and foreign investment effects are given in Table 5.4. Firstly, I estimate the investment effects on own termination rates and MOU (columns (1) and (2)), and on competitors' termination rates and MOU (columns (3) and (4)) separately and, afterwards, combine them in one equation system (columns (5) and (6)). By comparing the investment coefficients of the GLS estimations with those of the 3SLS estimations, lower investment coefficients in the termination rate equations and higher coefficients in the traffic equations are found. The deviation of the GLS coefficients from the 3SLS coefficients for investments is driven by ignoring the endogeneity of termination rates in the traffic equation. With higher investments, firstly, the investor's own per-unit costs and, secondly, also the competitors' termination rates are affected. Ignoring the (positive) indirect effect of investments on traffic leads to a larger capex coefficient and a higher termination rate coefficient for the GLS approach.

From the theoretical model two hypotheses are derived: I find a significantly negative **effect of investments on the investor's termination rate**. Depending on the employed estimation model increasing investments by ten percentage points reduces the investor's termination rate for incoming calls by about 0.25 to 0.47 percentage points. Rearranging equation (5.4), the theoretical model predicts that a ten percentage points investment increase results in an increase in cost efficiency of about 0.5 to 0.94 percentage points.

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<sup>16</sup>For a more technical description of the implementation of 3SLS estimation approaches see Cameron and Trivedi (2005) and Cameron and Trivedi (2009).

Table 5.5: Estimation Results including Interaction Terms

<b>3 SLS</b> <b>log(term. rate)</b>	<b>(1 a)</b>	<b>(2 a)</b>	<b>(3 a)</b>	<b>3 SLS</b> <b>log(MOU inc.)</b>	<b>(1 b)</b>	<b>(2 b)</b>	<b>(3 b)</b>
log(capex)	-0.068 * (0.035)	-0.021 (0.015)	-0.049 * (0.028)	log(capex)	0.002 (0.012)	-0.007 (0.011)	-0.008 (0.015)
log(weighted av. capex)	-0.086 ** (0.039)	-0.035 (0.016)	-0.055 * (0.030)	log(weighted av. capex)	0.040 *** (0.014)	0.025 ** (0.012)	0.034 ** (0.016)
log(market share)	-0.155 *** (0.035)	-0.119 *** (0.015)	-0.148 *** (0.027)	log(term. rate)	-0.380 *** (0.130)	-0.150 *** (0.045)	-0.252 (0.156)
log(market size)	0.702 *** (0.270)	-0.032 (0.091)	0.171 (0.171)	log(market share)	0.939 *** (0.020)	0.928 *** (0.018)	0.944 *** (0.025)
log(share urban pop.)	19.534 ** (9.028)	-14.156 *** (2.292)	-8.646 * (4.424)	log(market size)	-0.004 (0.075)	0.333 *** (0.071)	0.120 (0.078)
cb. reg. x log(capex)	-0.086 ** (0.062)	-0.074 (0.053)	-0.074 (0.053)	log(share urban pop.)	-10.987 *** (1.767)	-5.712 *** (2.143)	-9.042 *** (1.582)
inc. reg. x log(capex)	0.037 (0.059)	-0.002 (0.018)	0.014 (0.035)	post paid	0.000 *** (0.000)	0.000 *** (0.000)	0.000 *** (0.000)
netm. reg. x log(capex)	0.108 * (0.061)	0.052 ** (0.025)	0.071 (0.049)	cb. reg. x log(capex)	-0.028 (0.019)	-0.028 (0.019)	-0.020 (0.027)
cb. reg. x log(weighted av. capex)	0.008 (0.018)	0.008 (0.018)	0.079 (0.053)	inc. reg. x log(capex)	-0.004 (0.015)	-0.004 (0.015)	0.002 (0.016)
inc. reg. x log(weighted av. capex)	-0.048 (0.061)	-0.078 *** (0.026)	-0.092 (0.050)	netm. reg. x log(capex)	0.015 (0.021)	-0.016 (0.017)	0.012 (0.025)
netm. reg. x log(weighted av. capex)	0.239 *** (0.066)	0.109 *** (0.020)	0.122 *** (0.039)	cb. reg. x log(weighted av. capex)	0.014 (0.015)	0.023 (0.019)	0.019 (0.027)
GSM 1800	-27.266 *** (9.066)	--	--	inc. reg. x log(weighted av. capex)	-0.007 (0.023)	0.016 (0.018)	-0.000 (0.027)
constant	--	--	--	constant	1.646 ** (0.685)	--	-0.944 * (1.219)
						country dummies included	
						year dummies included	
# Obs.	318	421	500	# Obs.	500	318	421
Chi2 (df)	3672.04 (26)	145092.42 (27)	46628.15 (30)	Chi2 (df)	12866.44 (30)	1050000 (28)	12571.74 (27)
"R2"	0.920	0.988	0.951	"R2"	0.963	0.983	0.963

Note: \*\*\*, \*\*, \* represent significance at the 1, 5 and 10 percent significance level, standard errors are displayed in brackets.

Moreover, concerning the direct **impact on incoming traffic** no significant coefficients could be identified, which corresponds to the results of the theoretical model. Nevertheless, investments indirectly affect traffic as at least the coefficients of the combined estimation approach in column (6b) provides evidence for a negative termination rate coefficient. I come back to this finding when calculating the effect of investments on the investor's short-run profits. So far, the estimation results confirm the first hypothesis concerning own investment effects.

With regard to the second hypothesis, we observe a decrease in **termination rates** and an increase in **incoming traffic to competitors** due to investments. While the positive investment effect on traffic is in line with the outcome of the theoretical model, following theory, a significantly negative effect on competitors' termination rates was only identified in line with LRIC regulation.

A more detailed analysis of alternative investment effects due to regulation schemes requires the consideration of interactions between investments and regulation. Table 5.5 provides the extension of the estimations above where I have replaced the regulation dummies by their interaction terms with investments employing the 3SLS estimation method. Columns (1) and (2) are the results where either cost-based or incentive regulation are compared to "no regulation", i.e. I exclude the other regulation scheme from the observations. In column (3), I keep both regulation schemes in the data. We again find support for the first hypothesis on the investor's own termination rates and incoming traffic. Moreover, also the effect on incoming traffic to competitors' networks is positive. Nevertheless, no evidence could be found concerning the expected impact on competitors' termination rates. While the direct common investment effect is in the range of the previous estimations, particularly the interaction term is found to be positive and even (weakly) significant for the first approach.

Thus, the estimation results support the second hypothesis (investment externalities) with regard to the quantity of incoming traffic effect. Concerning the effect on termination rates, the results raise the question whether regulation indeed affects MNPs' investment strategies. The theoretical model tells us that with no regulation investments

should have a positive effect on competitors' termination rates due to a higher demand for incoming traffic to a monopolistic network market. Even with regulation, we should either observe no investment externality on competitors' termination rates (incentive regulation, standard cost-based regulation) or a negative effect (LRIC regulation). This is why an under-investment problem is often identified in the literature with regulation uncertainty or with network competition.<sup>17</sup>

As competitors reduce their termination rates in line with another provider's investments independent of the existing regulation scheme this strategy must be in the competitors' intention to maximize profits either in the short run or the long run. While I have no data on long-run investment effects I will consider the short-run effect of investments on profits in the extension to this section.

A number of control variables are included without developing explicit a-priori hypotheses. Hence, the discussion of their estimation results is either based on the results of other papers or is explorative in nature. We find a significantly negative market share coefficient for termination rates, which is more or less in the range of Dewenter and Hauscap's findings, and a positive coefficient for the traffic equations. If the market share of a provider is one percentage point higher its incoming traffic is between 0.93 percentage points (with the 3SLS approach) and about 1.24 percentage points higher (for the direct investment estimation using GLS). Note that these high coefficients are probably mainly due to the way of constructing the dependent variable  $\log(MOU\ inc.)$  as this variable depends strongly on the MNP's market share. Therefore, one should not put too much weight on the  $\log(\text{market share})$  coefficient. Similarly, a highly significant effect is found for the share of urban population.

In the discussion of a common regulation-investment effect, I ignored the alternative types of regulation as control variables. Regulation has an ambiguous effect on termination rates and off-net traffic: While in cost-based regulated countries termination rates are about 12.3 percentage points higher no significant effect of incentive regulation is found. Following standard textbooks like Laffont and Tirole (2001), providers have no

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<sup>17</sup>Please see also the discussion on the under-investment problem provided in Chapters 3 and 4.

incentive to reduce prices under cost-based regulation as such a reduction would only reduce costs but would not change the price-cost margin. In contrast, in countries with incentive regulation off-net traffic is significantly higher.

To sum up, I analyzed the results of the theoretical model using alternative estimation approaches. A negative effect of investments on own termination rates and no significant effect of investments on incoming traffic are found, which means that the first hypothesis cannot be rejected. Moreover, the estimations support the assumption in the theoretical model that investments in mobile infrastructure are mainly cost-related. With regard to the second hypothesis that investments positively affect competitors' termination rates and also increase competitors' incoming traffic the outcome is ambiguous: While competitors reduce termination rates due to other MNPs' investments their incoming traffic rises. In the following extension, the empirical findings will be replaced into the wholesale profit functions and I will consider how investments affect the investor's and the competitors' wholesale profits. In doing so, I particularly check whether competitors' termination rate reduction is profit-increasing even in the short run.

## Extension: Calculation of the Investment Effect on Profits

By adopting the estimation results to the theoretical model, I calculate the effect of investments on wholesale profits. I do this exercise only for the 3SLS results due to the restrictions of the GLS approach. As the per-unit costs of call termination are very small, I fix them to zero. The change in profits is independent of the underlying retail market pricing scheme meaning that the traffic-dependent change in profits is identical whether I consider linear retail pricing or non-linear retail pricing.

The investor's absolute change in profits from incoming calls due to investments is given by equation (5.5). Rewriting this equation yields:

$$\frac{\partial \pi_{j,i}^i}{\partial k_i} = \frac{\partial (t_i - c_i)}{\partial k_i} \sum_j q_{j,i} + (t_i - c_i) \frac{\partial \sum_j q_{j,i}}{\partial k_i} \quad (5.16)$$

## 5 Mobile Network Interconnection and Investments

Dividing (5.16) by profits per investment yields the relative profit change:

$$\frac{\partial \pi_{j,i}^i}{\partial k_i} \frac{k_i}{\pi_{j,i}^i} = \frac{\partial(t_i - c_i)}{\partial k_i} \frac{k_i}{t_i} + \frac{\partial \sum_j q_{j,i}}{\partial k_i} \frac{k_i}{\sum_j q_{j,i}} \quad (5.17)$$

In Table 5.4 both coefficients  $\beta_{inv}^{q1}$  and  $\beta_t^{q1}$  are not significantly different from zero in the traffic equation whereas  $\beta_{inv}^{t1}$  is weakly significant in Table 5.5. Note that the quantity change is the sum of the cost-related quantity change and the termination rate-related quantity change. Moreover, we know from the derivative of own termination rates to investments that the change in termination rates is half the change in per-unit costs. Thus, equation (5.17) changes to:

$$\begin{aligned} \frac{\partial \pi_{j,i}^i}{\partial k_i} \frac{k_i}{\pi_{j,i}^i} &= -\frac{\partial t_i}{\partial k_i} \frac{k_i}{t_i} + \frac{\partial \sum_j q_{j,i}}{\partial t_i} \frac{t_i}{\sum_j q_{j,i}} \frac{\partial t_i}{\partial k_i} \frac{k_i}{t_i} \\ &= -\beta_{inv}^{t1} + \beta_{t1}^{q1} \beta_{inv}^{t1} \end{aligned} \quad (5.18)$$

Similarly, one has to add the significant regulation coefficients of Table 5.5 for the investment effect on own profits.<sup>18</sup> Doubling investments increases short-run profits from incoming traffic by about 4.7 to 6.8 percentage points (when including interaction terms). Similarly, the relative investment externality on competitors' profits is calculated. The relative profit change due to a one-percent change in investments is given by:

$$\frac{\partial \sum_{-j} \pi_{-j,j}^j}{\partial k_i} \frac{k_i}{\sum_{-j} \pi_{-j,j}^j} = \frac{\partial t_j}{\partial k_i} \frac{k_i}{t_j} + \frac{\partial \sum_{-j} q_{-j,j}}{\partial k_i} \frac{k_i}{\sum_{-j} q_{-j,j}} \quad (5.19)$$

Rewriting equation (5.19) yields:

$$\begin{aligned} \frac{\partial \sum_{-j} \pi_{-j,j}^j}{\partial k_i} \frac{k_i}{\sum_{-j} \pi_{-j,j}^j} &= \frac{\partial t_j}{\partial k_i} \frac{k_i}{t_j} + \frac{\partial \sum_{-j} q_{-j,j}}{\partial c_i} c_i'(k_i) \frac{k_i}{\sum_{-j} q_{-j,j}} + \frac{\partial \sum_{-j} q_{-j,j}}{\partial t_j} \frac{t_j}{\sum_{-j} q_{-j,j}} \frac{\partial t_j}{\partial k_i} \frac{k_i}{t_j} \\ &= \beta_{inv}^{t2} + \beta_{inv}^{q2} + \beta_t^{q2} \beta_{inv}^{t2} \end{aligned} \quad (5.20)$$

By replacing the coefficients with the estimation results in Tables 5.4 and 5.5, we find that the competitors' wholesale profit changes by -1.2 and -2 percentage points, respectively. While there exists a strong impact of investments on termination rates and also on traffic the impact on profits is close to zero. In contrast to no investment effect on the investor's

<sup>18</sup>I only consider the common estimation approach in columns (3) as this is the corresponding estimation approach to Table 5.4.

own incoming traffic, the increase in incoming traffic to competitors is relatively large and, thus, reduces the negative effect on wholesale prices in the competitors' profit function. Thus, at least in the short-run, the effect on incoming traffic cannot outweigh the reduction in termination rates.

With these calculations the question still remains why competitors reduce termination rates if they are not obliged to do so. One admittedly speculative consideration might be the following: The players in a market know the competition-driving variables of the market, which are in particular prices (on the retail and the wholesale level) and traffic. Moreover, as they are in a repeated game, they have experience in the impact of investments on these variables, they know their competitors and, due to legal obligations and sunk investment costs, they know that their competitors will remain the same in the future. Since an investor is able to extract higher rents based on its current market share and its customers' calling behavior (without gaining market shares in the short-run) and since competitors lose only little by reducing termination rates, we probably observe a tit-for-tat game among the MNPs. Therefore, providers refrain from increasing their wholesale prices expecting competitors to do the same. Additionally taking into account multi-market activities, providers probably compete tougher where it is more profitable and spare themselves where they gain less.

In a nutshell, the consideration of wholesale profits provides more insights into the change in the wholesale price-cost margin and the change in quantities due to investments. By adopting the estimation results to the theoretical model, we find a positive own-profit effect as investments increase the investor's wholesale price-cost margin and the incoming traffic. On the other hand, we cannot identify a positive effect on competitors' profits. Moreover, the investment effect on competitors' profits is close to zero as the (direct and the indirect) investment effect on traffic compensates for the termination-rate reduction.



## 5.6 Concluding Remarks and Limitations

Investments in competing networks is an ongoing issue in network-based markets because of mainly two reasons: Firstly, investments are implemented to increase the investor's market share and, thus, particularly revenue. Nevertheless, the service provided depends on the users, which means that a provider is *ceteris paribus* attractive only because of a larger customer base. Secondly, investments directly affect the traffic to competitors' networks. (Retail and wholesale) Prices are altered and off-net traffic changes. With this chapter, I wanted to provide more insights into these two aspects of investments in mobile infrastructure under the alternative European regulation schemes.

Starting with a theoretical model, I showed that under a linear pricing scheme investments should increase both own and competitors' short-run wholesale profits from traffic between the investor and any competitor. I extended the analysis to non-linear retail pricing and find mainly similar results. Afterwards, I compared the outcomes to the usual cost-based and incentive regulation approaches known from the literature: While own termination rates decrease in line with investments, competitors' termination rates should either increase (in the absence of regulation), remain unaffected (with incentive regulation and standard cost-based regulation) or decrease (with LRIC regulation). Concerning traffic, both traffic to the investor and from the investor increase.

These findings are tested employing data for European mobile markets. With regard to own investment effects, I indeed find support for a termination rate reduction. Moreover, with lower termination rates also the amount of incoming traffic to the investor's network is increased. By replacing the empirical findings into the theoretical model, one gets the effect of investments on the investor's wholesale profits, which raises by about 4.7 to 6.7 percentage points by doubling investments.

Concerning the effect on competitors' profits, the amount of incoming traffic also increases, whereas termination rates decrease (as expected only in line with LRIC regulation). I therefore replace the regulation parameters in the estimation equations by their interaction terms with investments. In doing so, a weak, mostly insignificant, additional effect on termination rates is identified.

Since regulation is found to have only a minor impact on the investment effect on termination rates and off-net traffic, it is concluded that the findings are probably due to competitors' strategic reactions. Combining the empirical findings with the theoretical model the following results are derived: While the impact of investments on competitors' termination rates and traffic is not negligible only a small investment externality on competitors' profits could be identified. In particular, the direct investment effect on incoming traffic compensates for the reduction in termination rates in the competitors' profit function.

These findings raise the question whether MNPs probably behave as in a tit-for-tat game: While a competitor loses only little in the short-run the investor is able to get a positive return on its investments from incoming traffic and, in particular, also from its own customers (because of a higher retail price-cost margin and more outgoing traffic). As all MNPs invest continuously each of them gains from the others' reluctance.<sup>19</sup>

Note that the analysis is based on some central limitations, which are mainly due to the challenge with data availability: Firstly, I only consider the short-term effect of investments on termination rates and off-net traffic. In doing so, I ignore investment costs and their depreciation over time, which also enter the per-unit costs. Nevertheless, one could easily correct the per-unit costs in the theoretical model but the central results will remain unchanged. Secondly, I assume market shares to be constant. A more comprehensive estimation approach should take into account the time dependence. Due to lags in the data set I refrain from such an approach and only control for time effects. Finally, more detailed cost information would strongly improve the analysis of the price-cost margin and, thus, the analysis of off-net profits.

Even with these limitations the findings provide more insights into the strategic interplay between MNPs in line with regulation and investments. Concerning the recommendation by the EC in May 2009 that LRIC regulation should be implemented in the market for wholesale voice call termination (Market 16) in all EU member states, I find that the type of regulation has only a minor impact on investment effects.

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<sup>19</sup>Strategic interaction in mobile termination markets is also analyzed in Höfler (2009).



## 6 Summary and Policy Conclusions

Telecommunications has become one of the key sectors in the European economy since its liberalization at the end of the 1990s. The transformation from national monopolies to an integrated European market with a competitive structure is still an ongoing process. This process is accompanied by external and sector-specific influences, which are driven by the worldwide development of telecommunication services, and others, which are mainly due to the European regulatory system. While service markets became highly competitive and service companies, as a whole, benefit from technological improvements of the infrastructure after the liberalization, infrastructure operators can increasingly internalize externalities provided by their infrastructure investments. The drifting apart of the service level situation and the physical infrastructure situation is mainly attributed to the better exploitation of infrastructure capacities by improvements of transmission technologies and the development of highly innovative services. However, European regulation mainly ignores the challenge for infrastructure providers.

Before analyzing the situation in regulated markets, it is crucial to know the regulatory system and how companies deal with changes in regulation. The European regulatory system is a two-stage system where, on the higher stage, the European Parliament in cooperation with the EC and national governments determines the regulatory framework for all EU member states. On the lower stage, national governments adopt these guidelines to national laws taking into account national distinctions. Besides, the EC intervenes in telecommunication markets if it suspects the situation not to be in line with pan-European guidelines and not to reach such a status without further interventions.

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In Chapter 2, three types of EC interventions are compared to each other based on their impact on affected companies. They comprise (1) actions, which address a particular group of markets across all member states, so-called cross-market interventions, (2) actions, which focus on a particular country, so-called country-addressing interventions, and (3) actions on a company's (or a group of companies') behavior in a market, so-called company-specific interventions. While the first two types require the adoption to national laws and, in this way, enable national adjustments, the last type directly addresses individual companies. The comparison of the alternative types of interventions provides evidence that companies are expected to act in line with the EC intention: As indirect interventions (the first two types) are implemented to increase competition or efficiency in the addressed markets as a whole, also the net present value of the affected companies increases on average in these markets. On the other hand, addressing individual companies to prevent them from exercising SMP reduces their net present value. However, such an action does not affect other companies in that market. These findings show that the EC effectively uses concerted actions to control markets also in the short term if it suspects markets not to move to the desired stage. Moreover, country-addressing interventions follow similar market aims as company-addressing actions. While the reactions to such actions are in line with the expectations, they do not significantly differ in absolute terms. In contrast, indirected interventions cause much higher volatilities in reactions, which shows that the transposition to national laws provides additional uncertainty to markets.

On the lower stage, national governments follow own aims with national telecommunication markets, which are not necessarily in line with the guidelines of the European stage. While actions of European institutions seek telecommunication markets to converge and, finally, to integrate to a common European telecommunication market, national governments take into account national and sub-national challenges when implementing European guidelines and regulations to their national market conditions. The availability of high-quality telecommunication infrastructure has become one key instrument to

guarantee economic growth.<sup>1</sup> National governments are therefore highly interested in controlling telecommunication infrastructure provision and monitoring service provision. In consequence, national and also sub-national governments are multiply engaged in the telecommunication sector. Firstly, they determine the legal framework for the development of markets, competition and infrastructure investments. Moreover, governments still have a comprehensive impact on national regulators as they elect the members of the presidential chamber. Secondly, governments also actively influence the development of the telecommunication sector based on public ownership of telecommunication companies and by supporting infrastructure projects with public aid. A consideration of the alternative roles of governments in national telecommunication sectors is provided in Chapter 3. It is shown that governments could systematically combine their alternative instruments either to foster the pan-European integration process or to alleviate the European impact on their national telecommunication sector. The EC seeks to reduce the impact of national governments in national telecommunication sectors to increase competition and efficiency. However, it could probably also use the close proximity of governments to their national telecommunication sector for the pan-European integration process, which requires transparent mechanisms further to reduce individual national aims.

While Chapters 2 and 3 highlight aspects of the European regulatory system and their impact on affected markets and companies, Chapters 4 and 5 provide more insights into the development of markets and companies' strategies under the given regulatory structure. Since the liberalization and subsequent technological improvements of transmission systems, innovations on the service level turned the role of customers and telecommunication users in other industries from a passive, telecommunications-using position, to an active, information-providing position. On the other hand, infrastructure providers can decreasingly internalize the positive externalities of infrastructure installation. Chapter 4 analyzes how structural changes and upcoming competition on the service level

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<sup>1</sup>Following estimations by the EC, the telecommunication sector determined, directly and indirectly, about 40 percent of Europe's 2007 overall growth. Please see the introductory statement.

## *6 Summary and Policy Conclusions*

affect infrastructure provision. It is shown, both for fix-line markets and for mobile markets, that service competition does not only directly increase infrastructure investments. Moreover, service competition much more increases the demand for infrastructure, which, subsequently, increases infrastructure provision. These findings support infrastructure providers' demand for a stronger integration of service providers and customers into the process of infrastructure roll-out as investments follow a "demand pull". Even the consideration of the interrelationship between fix-line and mobile infrastructure also supports these findings. Moreover, this extension provides evidence that mobile infrastructure supply and demand are derived from fix-line infrastructure supply and demand. In consequence, companies and customers assume fix-line infrastructure to be the standard access mode whereas mobile infrastructure is the additional access mode, which provides a first-mover advantage for fix-line infrastructure.

Chapter 5 considers investment decisions under infrastructure competition with infrastructures of identical quality. In most European countries, fix-line infrastructure is a monopolistic market on the local loop level. In contrast, mobile infrastructure is provided by three to four fully vertically integrated mobile network operators. While they compete for customers, customers are locked-in after they have chosen a contract with one operator who is their monopolistic provider for telecommunication services after the provider decision. Therefore, the price for the access to customers, the termination rate, is regulated. However, as investments increase infrastructure quality and/or increase efficiency, they directly affect retail prices and also cost-oriented termination rates and, thus, have an impact on the traffic between an investor's and its competitors' networks. Chapter 5 shows that mobile network operators take into account competitors' investments when choosing termination charges. However, the negative investment externality on competitors' profits from off-net traffic is much weaker than the positive impact on the investor's profits. As the negative termination rate adjustment is not caused by regulation, it might be mainly due to strategic interactions of competitors.

In contrast to other telecommunication markets, only a smaller number of studies concentrates on the specific European situation from an empirical perspective. In consequence, most policy implications are either derived by observing the situation in non-European markets or stem from economic theory. With this thesis, I try to bridge this gap. The considerations of the previous chapters provide new information, which regard the particular situation with the European regulatory system. On the one hand, these findings support theoretical evidence and show similarities with studies on non-European markets. On the other hand, the analyses offer new insights into distinctions of the European market situation, which have not been considered so far. Overall, the main policy recommendations can be summarized as follows:

- The EC disposes a set of multiple instruments besides Regulatory Packages to affect telecommunication markets both on the pan-European level as well as on the national level. The implementation of these instruments is found to reach its intended aims as the net present value of affected companies reacts in the expected direction. However, the EC disposes two instruments, country-addressing interventions and company-specific interventions, which have been implemented in the past to reach similar aims. As company-specific interventions result in a faster adjustment of strategic behavior and, therefore, turn to a faster adjustment of the market situation in the intended direction, directed interventions are found to be more efficient than country-addressing actions from an economic perspective. Thus, the EC is able to adjust national markets on its own initiative without taking into account national governments' aims (and the installed national legal system), which reduces the administrative complexity and, consequently, uncertainty in the regulatory process.
- Turning to the national situation, national governments can combine their alternative roles in the telecommunication sector to reach state-specific aims. While the EC tries to reduce the influence of national governments in the telecommunication sector, a key question for the EC must be how the interrelationship between national governments and the sector could be used and controlled to reach



pan-European aims. This is of particular interest in line with financing infrastructure investments to enhance the European position in world-wide competition. While the pan-European approach considers telecommunications as an independent sector, investments (and also innovations) in telecommunications comprehensively affect other industries and customers' habits. Therefore, my findings provide evidence that financing necessary infrastructure investments requires a macroeconomic consideration, which takes into account the externalities of installed infrastructure. An integrated approach, which could be established on the existing interrelationships of public administrations and the telecommunication sector, could be used to install new models for re-financing important infrastructure provision and, simultaneously, to improve overall infrastructure connectivity and quality in Europe.

- Customers use alternative telecommunication infrastructures. These infrastructures are only partially substitutive. However, investments in one infrastructure affect the usage behavior of customers. In consequence, also the traffic between alternative infrastructures changes due to adjustments in infrastructure quality caused by investments. Regulation ignores the effect of investments on the change in usage patterns and, thus, deters investments and also investment externalities. While regulation should foster competition and provide investment incentives, standard cost-based approaches only partially take into account non-monetary effects of investments (if at all). This is a key challenge especially in markets, which rely on (social) networks and corresponding network effects. The findings provided in Chapter 5 demand a much more flexible regulation scheme, which also takes into account investment externalities. In contrast to the current regulation scheme, such an approach should not only guide investments with a long-term perspective but must also consider effects resulting from investments and, thus, must have implemented much more flexible reverse loops.

- Infrastructure provision requires a long-term perspective as investments amortize over a very long period of time and as the availability of high-quality infrastructure comprehensively spills over to the development of other industries. In consequence, infrastructure providers demand a highly transparent legal framework, which enables a long-lasting foresight of the development of returns. Such a long-lasting, transparent perspective is provided by the Regulatory Packages on the European stage. However, the adoption to national laws requires a very strict implementation. As previous telecommunication laws left broad room for interpretation, they created a comprehensive workload for regulators and courts in most EU member states, which has hampered transparency and, thus, investments. Governments must learn from these negative experiences in the past for the transposition of the Third Regulatory Package. In consequence, forthcoming adjustments in telecommunication laws should be implemented with a minimum level of interpretative freedom to foster necessary infrastructure investments. Due to the key role of telecommunications for other industries, this is a central pre-requisite to accelerate growth after the economic crisis.

While these policy conclusions are based on the current legal and regulatory system installed in the EU, changes in the political system and also in the telecommunication sector should be taken into account when implementing them in line with the new Regulatory Package as telecommunications is a market of ongoing comprehensive technological changes and innovations.



# Bibliography

- AGHION, P., AND P. HOWITT (1992): "A Model of Growth Through Creative Destruction," *Econometrica*, 60, 323–351.
- ARELLANO, M., AND S. BOND (1991): "Some Test of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations," *Review of Economic Studies*, 58, 277–297.
- ARMSTRONG, M. (1998): "Network Interconnection in Telecommunications," *Economic Journal*, 108(448), 545–64.
- (2002): "The Theory of Access Pricing and Interconnection," *The Handbook of Telecommunications Economic*, 1.
- BAUER, J., AND E. BOHLIN (2007): "From Static to Dynamic Regulation Recent Developments in U.S. Telecommunications Policy," *Working Paper*, pp. 1–29.
- BAUM, C., M. E. SCHAFFER, AND S. STILLMAN (2003): "Instrumental variables and GMM: Estimation and Testing," *Working Paper*, (545), 1–32.
- BEL, G., AND F. TRILLAS (2005): "Privatization, Corporate Control and Regulatory Reform: The case of Telefonica," *Working Paper*, pp. 1–25.
- BINDER, J. J. (1985): "Measuring the Effects of Regulation with Stock Price Data," *The RAND Journal of Economics*, 16(2), 167–183.
- BITTLINGMAYER, G., AND T. W. HAZLETT (2002): "Financial Effects of Broadband Regulation," *Working Paper*, pp. 1–29.
- BLUNDELL, R., AND S. BOND (1998): "Initial Conditions and Moment Restrictions in Dynamic Panel-Data Models," *Journal of Econometrics*, 87, 115–143.
- BOLLERSLEV, T. (1986): "Generalised Autoregressive Conditional Heteroskedasticity," *Journal of Econometrics*, 31, 307–327.
- (2008): "Glossary to ARCH (GARCH)," *CREATES Research Paper*, (49), 1–46.
- BROOS, L. C., M. A. HELDEWEG, AND R. A. WESSEL (2009): "European Organization of Telecom Regulators and the Impact on the Pace of Telecom Innovations: Is EU Modesty Hampering Innovation in Telecom? Think Global, Act Local...", *Working Paper*, pp. 1–18.

## Bibliography

- CABRAL, L. M. (1990): "On the Adoption of Innovations with 'Network' Externalities," *Mathematical Social Sciences*, 19, 299–308.
- CADOT, O., L.-H. RÖLLER, AND A. STEPHAN (2006): "Contribution to Productivity or Pork Barrel? The two Faces of Infrastructure Investment," *Journal of Public Economics*, 90(6-7), 1133–1153.
- CAMERON, A. C., AND P. K. TRIVEDI (2005): *Microeconometrics – Methods and Applications*. Cambridge.
- (2009): *Microeconometrics Using Stata*. Stata Press.
- CAMPBELL, J. Y., A. W. LO, AND A. C. MACKINLAY (1997): *The Econometrics of Financial Markets*. Princeton University Press, Princeton, New Jersey, 2 edn.
- CARTER, M., AND J. WRIGHT (2003): "Asymmetric Network Interconnection," *Review of Industrial Organization*, 22(1), 27–46.
- CAVE, M. (2006a): "Encouraging Infrastructure Competition via the Ladder of Investment," *Telecommunications Policy*, 30(3-4), 223–237.
- (2006b): "Six Degrees of Separation: Operational Separation as a Remedy in European Telecommunications Regulation," *Communications & Strategies*, (64), 89–103.
- (2009): *Regulating Telecommunications in Europe: Present and Future in Internet Policy and Economics*. Springer US, 1 edn.
- DE BIJL, P. W., AND M. PEITZ (2005): "Local Loop Unbundling in Europe: Experience, Prospects and Policy Challenges," *Communications & Strategies*, (57), 33–57.
- DEWENTER, R., AND J. HAUCAP (2005): "The Effects of Regulating Mobile Termination Rates for Asymmetric Networks," *European Journal of Law and Economics*, 20(2), 185–197.
- DUSO, T., K. GUGLER, AND B. YURTOGLU (2010): "Is the Event Study Methodology Useful for Merger Analysis? A Comparison of Stock Market and Accounting Data," *International Review of Law and Economics*, forthcoming, 1–22.
- DUSO, T., D. NEVEN, AND L.-H. RÖLLER (2007): "The Political Economy of European Merger Control: Evidence Using Stock Market Data," *Journal of Law and Economics*, 50(3), 455–489.
- DUSO, T., AND L.-H. RÖLLER (2003): "Endogenous Deregulation: Evidence from OECD Countries," *Economic Letters*, 81, 67–71.
- ECKBO, B. E. (1983): "Horizontal Mergers, Collusion and Stakeholder Wealth," *Journal of Financial Economics*, 11, 241–273.

- ECKBO, B. E., AND P. WIER (1985): "Anti-Merger Policy under the Hart-Scott-Rodino Act: A Reexamination of the Market Power Hypothesis," *Journal of Law and Economics*, 28, 119–149.
- EHRMANN, T., M. MIETZNER, AND A. SÜRMAN (2005): "The Effect of Regulatory Announcements on Daily Stock Returns in the German Telecommunication Market – Evidence from an Event-Study Approach," *Working Paper*, pp. 1–30.
- ENGLE, R. F. (1982): "Autoregressive Conditional Heteroscedasticity with Estimates of Variance of United Kingdom Inflation," *Econometrica*, 50, 987–1008.
- (2001): "GARCH 101: The Use of ARCH/GARCH Models in Applied Econometrics," *Journal of Economic Perspectives*, 15(4), 157–168.
- EUROPEAN COMMISSION (1997): "Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions on the Implementation of the Telecommunications Regulatory Package," pp. 1–26.
- (2000a): "Europe's Liberalised Telecommunications Market – A Guide to the Rules of the Game," *Commission Staff Working Document*, pp. 1–60.
- (2000b): "Sixth Report on the Implementation of the Telecommunications Regulatory Package," pp. 1–42.
- (2001): "Seventh Report on the Implementation of the Telecommunications Regulatory Package," pp. 1–29.
- (2009): "Fourteenth Report on the Implementation of the Telecommunications Regulatory Package – 2008," pp. 1–18.
- EUROPEAN COMPETITION TELECOMMUNICATIONS ASSOCIATION (2008): "Regulatory Scorecard 2008," *ECTA Report*, pp. 1–100.
- EUROPEAN PARLIAMENT (2002a): "Directive 2002/19/EC of the European Parliament and of the Council," pp. 1–14.
- (2002b): "Directive 2002/21/EC of the European Parliament and of the Council," pp. 1–18.
- (2002c): "Directive 2002/58/EC of the European Parliament and of the Council," pp. 1–11.
- (2002d): "Directive 2002/77/EC of the European Parliament and of the Council," pp. 1–6.
- (2009): "Directive 2009/140/EC of the European Parliament and of the Council," pp. 1–108.

## Bibliography

- EUROPEAN REGULATORS GROUP (2007): “ERG Opinion on Functional Separation,” *Working Paper*, pp. 1–14.
- FERENSTEIN, E., AND M. GASOWSKI (2004): “Modelling Stock Returns with AR-GARCH Processes,” *SORT*, 28(1), 55–68.
- FOROS, O. (2004): “strategic Investments with Spillovers, Vertical Integration and Foreclosure in the Broadband Access Market,” *International Journal of Industrial Organization*, 22, 1–24.
- FRIEDERISZICK, H., M. GRAJEK, AND L.-H. RÖLLER (2008): “Analyzing the Relationship between Regulation and Investment in the Telecom Sector,” *ESMT White Paper*, pp. 1–70.
- FRIEDERISZICK, H., AND L.-H. RÖLLER (2007): “Analysing the Relationship between Regulation and Investment in the Telecommunication Sector,” *esmt Working Paper*, pp. 1–24.
- GANS, J. S., AND S. P. KING (2001): “Using ‘Bill-and-Keep’ Interconnection Arrangements to Soften Network Competition,” *Economics Letters*, 71(3), 413–420.
- GRAJEK, M. (2003): “Estimating Network Effects and Compatibility in Mobile Telecommunications,” *CIG Working Papers*, (SP II 2003-26), 1–28.
- GRAJEK, M., AND L.-H. RÖLLER (2009): “Analysing the Relationship between Regulation and Investment in the Telecommunication Sector,” *esmt Working Paper*, pp. 1–57.
- GREENSTEIN, S. (1997): “From Superminis to Supercomputers: Estimating Surplus in the Computing Market,” *The Economics of New Goods*, pp. 329–362.
- GUJARATI, D. (2004): *Basic Econometrics*. McGraw-Hill, 4 edn.
- HAMILTON, J. (2003): “Are Main Lines and Mobile Phones Substitutes or Complements? Evidence from Africa,” *Telecommunications Policy*, 27(1–2), 109–133.
- HASSETT, K. A., Z. IVANOVA, AND L. J. KOTLIKOFF (2003): “Increased Investment, Lower Prices – the Fruits of Past and Future Telecom Competition,” *Working Paper*, pp. 1–126.
- HASSETT, K. A., AND L. J. KOTLIKOFF (2002): “The Role of Competition in Stimulating Telecom Investment,” *Working Paper*, pp. 1–49.
- HAYASHI, F. (2000): *Econometrics*. Princeton University Press.
- HEALD, D. A. (1997): “Public Policy Towards Cross Subsidy,” *Annals of Public and Cooperative Economics*, 68(4), 591–623.

- HEIMESHOFF, U. (2007): “Investment in Telecommunications Markets: Evidence from OECD Countries,” *Working Paper*, pp. 1–29.
- HENISZ, W. J., AND B. A. ZELNER (2001): “The Institutional Environment for Telecommunications Investment,” *Journal of Economics and Management Strategy*, 10(1), 123–147.
- HÖFFLER, F. (2007): “Costs and Benefits from Infrastructure Competition. Estimating Welfare Effects from Broadband Access Competition,” *Telecommunications Policy*, 31(6-7), 401–418.
- (2009): “Mobile Termination and Collusion,” *Journal of Regulatory Economics*, 35(3), 246–274.
- HÖFFLER, F., AND S. KRANZ (2007a): “Legal Unbundling can be a Golden Mean between Vertical Integration and Separation,” *Working Paper*, pp. 1–35.
- (2007b): “Imperfect Legal Unbundling of Monopolistic Bottlenecks,” *Working Paper*, pp. 1–14.
- HÖRNIG, S. (2007): “On-Net and Off-Net Pricing on Asymmetric Telecommunications Networks,” *Information Economics and Policy*, 19(2), 171–188.
- KNIEPS, G. (2003): “Telekommunikationsmärkte zwischen Regulierung und Wettbewerb,” *Regulierung, Wettbewerb und Marktwirtschaft – Regulation, Competition and Market Economy*, pp. 202–220.
- KNIEPS, G. (2007): *Netzökonomie – Grundlagen, Strategien, Wettbewerbspolitik*. Gabler Verlag, GWV Fachverlage, 1 edn.
- KOLE, S. R., AND K. LEHN (1997): “Deregulation, the Evolution of Corporate Governance Structure, and Survival,” *American Economic Review*, 87(2), 421–425.
- KOTAKORPI, K. (2006): “Access Price Regulation, Investment and Entry in Telecommunications,” *International Journal of Industrial Organization*, 24, 1013–1020.
- KROUSE, C. G., AND J. PARK (2003): “Local Exchange Competition and the Telecommunications Act of 1996,” *Information Economics and Policy*, 15(2), 223–241.
- LAFFONT, J.-J., P. REY, AND J. TIROLE (1998a): “Network Competition: I. Overview and Nondiscriminatory Pricing,” *RAND Journal of Economics*, 29(1), 1–37.
- (1998b): “Network Competition: II. Price Competition,” *RAND Journal of Economics*, 29(1), 38–56.
- LAFFONT, J.-J., AND J. TIROLE (2001): *Competition in Telecommunications*. The MIT Press, Cambridge, M.A.



## Bibliography

- LEVIN, A., C.-F. LIN, AND C.-S. J. CHU (2002): “Unit Root Tests in Panel Data: Asymptotic and Finite-Sample Properties,” *Journal of Econometrics*, 108, 1–24.
- LEVY, B., AND P. T. SPILLER (1994): “The Institutional Foundations of Regulatory Commitment: A Comparative Analysis of Telecommunications Regulation,” *Journal of Law, Economics and Organization*, 10(2), 201–246.
- (1996): *Regulations, Institutions, and Commitment: Comparative Studies of Telecommunications*. Cambridge University Press, New York, 13 edn.
- LÜTKEPOHL, H. (2006): *New Introduction to Multiple Time Series Analysis*. Springer, Berlin, 1 edn.
- MCAFEE, R. P., AND M. A. WILLIAMS (1988): “Can Event Studies Detect Anticompetitive Mergers?,” *Economics Letters*, 28(2), 199–203.
- MCKINLAY, A. C. (1997): “Event Studies in Economics and Finance,” *Journal of Economic Literature*, 35(1), 13–39.
- MONOPOLIES COMMISSION (2003): “Telekommunikation und Post 2003: Wettbewerbssintensivierung in der Telekommunikation – Zementierung des Postmonopols,” *Sondergutachten der Monopolkommission gemäß § 81 Abs. 3 Telekommunikationsgesetz und § 44 Postgesetz*, pp. 1–153.
- (2009): “Telekommunikation 2009: Klaren Wettbewerbskurs halten,” *Sondergutachten gemäß §121 Abs. 2 Telekommunikationsgesetz*, pp. 1–104.
- NEUMANN, K.-H. (2003): “Regulierungsentscheidungen und Marktstrukturentwicklung im Telekommunikationsmarkt,” *Regulierung, Wettbewerb und Marktwirtschaft – Regulation, Competition and Market Economy*, pp. 221–232.
- NEVEN, D., AND H. ZENGER (2003): “Ex Post Evaluation of Enforcement: A Principal-Agent Perspective,” *De Economist*, pp. 221–232.
- NICOLETTI, G. (2001): “Regulation in Services: OECD Patterns and Economic Implications,” *OECD Economics Department Working paper*, (287), 1–46.
- NIKOGOSIAN, V., AND T. VEITH (2010): “Non-Price Discrimination in Retail Electricity Markets,” *Working Paper*, pp. 1–23.
- OECD (1999): “OECD Communications Outlook 1999: Information and Communications Technologies,” .
- (2001): “OECD Communications Outlook 2001: Information and Communications Technologies,” .
- (2007): “OECD Communications Outlook 2007: Information and Communications Technologies,” .

- (2009): “OECD Communications Outlook 2009: Information and Communications Technologies,” .
- OFFICER, R. R. (1973): “The Variability of the Market Factor of the New York Stock Exchange,” *The Journal of Business*, 46(3), 434–453.
- PEITZ, M. (2005): “Asymmetric Access Price Regulation in Telecommunications Markets,” *European Economic Review*, 49(2), 341–358.
- PELTZMAN, S. (1976): “Toward a More General Theory of Regulation,” *Journal of Law and Economics*, 19(2), 211–240.
- PERSSON, T., AND G. E. TABELLINI (2000): *Political Economics. Explaining Economic Policy*. The MIT Press, Cambridge, Massachusetts, 1 edn.
- PLANK, K. (2005): “The Emerging WLAN-Infrastructure: Complement or Substitute?,” *Working Paper*, pp. 1–20.
- REY, P. (2002): “Antitrust Policy,” *Working Paper*.
- RODINI, M., M. M. WARD, AND G. A. WOROCH (2003): “Going Mobile: Substitutability between Fixed and Mobile Access,” *Telecommunications Policy*, 27, 457–476.
- RUDOLPH, B., AND L. JOHANNING (2004): “Untersuchung der Aktienkursentwicklung der Deutschen Telekom AG,” *Regulierung und Kapitalmarkt看wertung in der Telekommunikation*, pp. 1–50.
- SALINGER, M. (1992): “Standard Errors in Event Studies,” *Journal of Finance and Quantitative Analysis*, 27(1), 39–53.
- SAPPINGTON, D. E. (2006): “Regulation in Vertically-Related Industries: Myths, Facts, and Policy,” *Review of Industrial Organization*, 28(1), 3–16.
- SARNO, L., AND M. P. TAYLOR (1998): “Real Exchange Rates under the Recent Float: Unequivocal Evidence of Mean Reversion,” *Economics Letters*, 60, 131–137.
- SCHWERT, G. W. (1981): “Using Financial Data to Measure the Effect of Regulation,” *Journal of Law & Economics*, 24(1), 121–158.
- SHLEIFER, A., AND R. W. VISHNI (2003): “Stock Market Driven Acquisitions,” *Journal of Financial Economics*, 70, 295–311.
- STIGLER, G. J. (1961): “The Economics of Information,” *Journal of Political Economy*, 69, 213–225.
- (1971): “The Theory of Economic Regulation,” *Bell Journal of Economics*, 1(2), 3–21.

## Bibliography

- STILLMAN, R. (1983): “Examining Anti-Trust Policy Toward Horizontal Mergers,” *Journal of Financial Economics*, 11, 225–240.
- SUGOLOV, P. (2005): “Are Mobile Phones and Fixed Lines Substitutes or Complements? Evidence from Transition Economies,” *Working Paper*, pp. 1–48.
- TAYLOR, M. P., AND L. SARNO (1998): “The Behavior of Real Exchange Rates During the Post-Bretton Woods Period,” *Journal of International Economics*, 46, 281–312.
- VALLETTI, T., AND C. CAMBINI (2005): “Investments and Network Competition,” *RAND Journal of Economics*, 36, 446–467.
- VAREDA, J. (2007): “Unbundling and Incumbent Investment in Quality Upgrades and Cost Reduction,” *Working Paper*, pp. 1–27.
- VICKERS, J. (1995): “Competition and Regulation in Vertically Related Markets,” *Review of Economic Studies*, 62(1), 1–17.
- VOGELSANG, I. (2003): “The Role of Price Caps in Bringing Competition to Network Industries,” *Regulierung, Wettbewerb und Marktwirtschaft – Regulation, Competition and Market Economy*, pp. 253–269.
- WALLSTEN, S. J. (2001): “An Econometric Analysis of Telecom Competition, Privatization, and Regulation in Africa and Latin America,” *Journal of Industrial Economics*, 49(1), 1–19.
- (2002): “Does Sequencing Matter? Regulation and Privatization in Telecommunications Reforms,” *World Bank Policy Research Working Paper*, 2817, 1–23.
- WARD, M. R., AND G. A. WOROCH (2004): “Usage Substitution between Mobile Telephone and Fixed Line in the U.S.,” *Working Paper*, pp. 1–26.
- WAVERMAN, L., AND L.-H. RÖLLER (2001): “Telecommunications Infrastructure and Economic Development: A Simultaneous Approach,” *American Economic Review*, 91(4), 909–923.
- WEIZSÄCKER, C. C. V. (2008): “Regionalisierung der Regulierung im Bitstromzugangs-Markt,” *Gutachten*, pp. 1–30.
- WHALLEY, J., AND P. CURWEN (2008): “Is Functional Separation BT-Style the Answer?,” *Communications & Strategies*, (71), 145–165.
- WHINSTON, M. (2006): *Lectures on Antitrust Economics*. The MIT Press Ltd., Cambridge, M.A., 1 edn.
- WOOLDRIDGE, J. (2009): *Introductory Econometrics: A Modern Approach*. 4 edn.
- WOOLDRIDGE, J. M. (2002): *Econometric Analysis of Cross Section and Panel Data*. The MIT Press, Cambridge, Massachusetts.

WRIGHT, J. (2002): “Access Pricing under Competition: An Application to Cellular Networks,” *The Journal of Industrial Economics*, 50(3), 289–315.

ZENHÄUSERN, P., H. TELSER, S. VATERLAUS, AND P. MAHLER (2007): “Plaut Economics Regulation Index,” *Discussion Paper*, pp. 1–42.



# Glossary

Telecommunication regulation has brought forward a magnitude of technical terms and abbreviations which will be explained in more detail in this glossary.

## **Backbone:**

Backbone infrastructure describes the infrastructure starting at the MDF connecting local access networks and also data centers. Besides the incumbent, competitors have installed own backbone infrastructure. Therefore, backbone infrastructure is commonly accepted to be not an essential facility in telecommunication networks.

## **Bitstream Access:**

This type of access describes high-speed local loop infrastructure, which has been installed by the incumbent and which allows competitors to offer high-speed services to customers. Competitors thus need no access to customers' copper lines.

## **Cost-Based Regulation:**

Under cost-based regulation the regulator chooses a price (optimally) based on forward-looking costs which corresponds to the discounted costs or a constant rate above them.

## **Critical Mass:**

In network theory the critical mass describes the point where the value of a network (created by the number of users) is just identical to the price for the access to the network. If the network size exceeds the critical mass, the network is sustainable as the value of the network for each participant is higher than the access price. A network collapses if the access price is too high.

## **Dynamic Regulation:**

Dynamic regulation provides incentives for investments. In contrast to static regulation (see below), dynamic regulation does not consider the current stage of competition or efficiency of the market but assumes a long-run competition situation which requires continuous investments in the infrastructure and in innovations.

## **ERG (BEREC):**

The European Regulators Group (ERG) was set up in line with the Second Regulatory Package and comprises the heads of all European NRAs (see below). The ERG consults the EC in line with new regulation measures and informs the EC about current regulatory challenges in EU member states. Moreover, members of the ERG exchange information about their home markets and should consult each other on current issues.

The Body of European Regulators for Electronic Communications (BEREC) will replace the ERG in line with the national transposition of the Third Regulatory Package in June 2010. Members of the ERG become the members of the BEREC, but this new body has more comprising decision and veto rights than its predecessor.

**Golden Shares:**

Golden Shares grant special rights to its owner which are mostly governments. While decision rights usually depend on the number of shares, Golden Shares provide veto rights independent of the concentration of other shares. As it deters decision rights it is unaccepted by the EC.

**GSM:**

The Global System for Mobile Communications (GSM) was the first standard for mobile systems in Europe established in the 1990s. In contrast to predecessor approaches, both signalling and speech channels are digital. Therefore, GSM is also called the second generation of mobile communications (2G).

**Harmonization and Integration:**

The European Integration process seeks to integrate EU member states' telecommunication markets to one European telecommunication market. Integrating markets requires a long-term process which started at the end of the 1980s and is still ongoing. As national telecommunication markets are in differing stages of competition and efficiency, it is necessary to harmonize regulation and market rules. The harmonization of rules and market situation is provided stepwise based on the EU Regulatory Packages (see below). When harmonization has reached a sufficient stage, the EC can finalize the integration process.

**Implementation Reports:**

Implementation Reports provide information about EU member states' telecommunication sector developments with a special focus on upcoming challenges and tasks to be solved during the next years. These reports are published by the EC on a yearly basis and should comment the national implementation of the EU Regulatory Packages and outstanding national issues in preparation of the European-wide integration process.

**Interconnection:**

Interconnection describes the access from one network to another either of competing network providers or also of competitive platforms like fix-line and mobile interconnection. In a broader sense, interconnection also describes the cross-connection of alternative countries' networks in the European-wide integration process as has been discussed in line with the international roaming regulation debate.

**Local Loop Unbundling /Last Mile Competition:**

The local loop (last mile) describes the physical link or circuit which connects the end-user with the network of a provider. While in fix-line networks it describes only the company's part of the network (i.e. not the part in the users' house or, in some countries, apartments), in mobile networks the last mile is the cell around a cell tower and the virtual line between the cell tower and the handset.

**LR(A)IC:**

Long-run (average) incremental cost regulation is a cost-based regulation approach. Following Laffont and Tirole (2001) the LR(A)IC comprises the marginal costs of the production at time  $t$  of the most efficient production technology available multiplied by the cost of capital, a measure for technological progress and the rate of physical depreciation. In contrast to standard cost-based regulation, LR(A)IC comprises not only current but also future costs of the (expectedly) most efficient transmission equipment.

**MDF:**

The Main Distribution Frame connects a customer's subscriber line with the local exchange of a provider's network. Thus, the MDF is the connection point where an incumbent provider and competitors get into physical line contact with customers. The MDF is therefore the other end of the local loop where (digital) signals from and to customers are just unbundled. The other end of the MDF is connected with the DSLAM, the Digital Subscriber Line Access Multiplexer, which combines individual signals for backbone transmission.

**NRA:**

National Regulatory Authority, the national regulator which (primarily) regulates the national telecommunication sector. While this body could be integrated with other sector regulators like the German Bundesnetzagentur, it also fulfils more ex post-regulative tasks as is the case with the British OFCOM which has provided antitrust controls for the telecommunication sector.

**Off-Net Traffic/On-Net Traffic:**

Off-Net Traffic describes the traffic, either voice or data communication, which passes more than one network providers' infrastructure. In contrast, on-net traffic is describes calls and services which originate and terminate on one single network.

**Open Access (Network):**

An open access network is a physical infrastructure, which is shared by multiply providers serving information and data over the infrastructure. These providers commonly install and maintain the infrastructure.

**Price-Cap Regulation:**

Price-Cap Regulation adjusts an operator's wholesale price based on a price basket which reflects inflation in the economy. One common approach is CPI-X or RPI-X regulation where the price cap is calculated based on the Consumer Price Index or the Retail Price Index minus efficiency savings which is increased over time at a pre-determined rate.

**Regulatory Holidays:**

Regulatory Holidays describe a period when no regulation occurs in an industry which should be regulated due to common regulation rules. Regulatory Holidays are thus a measure of non-financial aid. It should have been introduced in line with the installation of VDSL in Germany. However, due to insufficient legal rules it was not allowed by the European Court of Justice.



**Regulatory Package:**

Regulatory Packages are the key instrument in the European regulatory system. In December 2009 the Third Regulatory Package has been published which has to be transposed to EU member states' laws until June 2011. Regulatory Packages consist of multiple directives which aim at a particular regulatory issue. The First Regulatory Package, introduced in 1998, provided the framework for European-wide installation of competition. The Second Regulatory Package was installed in 2002/2003 to continue and foster competition and stabilize the new market situation and to further harmonize EU member states laws and market structures in preparation of the European integration of national markets. The Third Regulatory Package continues the integration process by further adjusting regulation on the national level and providing more decision powers and, thus, independence to national regulators.

**Static Regulation:**

Static Regulation provides regulatory instruments which mainly concentrate on the current market situation but which ignore long-run competition and innovations in markets. It is thus a less effective regulatory approach for (most of the) telecommunication markets as telecommunications is in an ongoing innovative process since the liberalization at the latest. However, static regulation better meets the situation in markets which are much less dynamic in terms of technological and competitive changes.

**Termination Rates:**

Termination Rates or Termination Charges describe the wholesale price which one network provider or service provider has to pay another for using the other's network for terminating a call or a service. As termination is a monopolistic "service" provided by the termination-network operator, it is regulated both in fix-line and in mobile markets. Moreover, termination rates also have to be paid if a call terminates in another country. This termination rate is much higher and currently downward-adjusted since the international roaming decision in 2007 (in particular relevant with mobile roaming).

**Transmission:**

Transmission describes technically sending a signal from one point to another on the lines or based on an air signal from the cell tower to a mobile (or fix-line) device.

**UMTS:**

Universal Mobile Telecommunication System (UMTS) is a mobile communication standard which allows for much higher transmission rates than its predecessor GSM. However, the technology is based on the GSM system and supports 2G services. Due to higher transmission rates, UMTS (also called third generation mobile communication, 3G) enables the transmission of mobile "broadband" services and, thus, allows not only for basic communication services like telephony and SMS but supports mobile internet access. However, due to lower transmission rates it can only partially replace fix-line broadband access.

**VoIP:**

Voice over IP (VoIP) describes a telephony technology which is based on the internet protocol. Thus, voice signals are transmitted via internet infrastructure based on a package-based decomposition. As VoIP enables the transmission of all communication approaches via one common network (based on the IP standard), it reduces transmission costs as a whole. Due to a low acceptance rate, VoIP communication is introduced as a parallel communication technology to the traditional communication infrastructure but will replace standard telephony in the long run.

**Web 2.0:**

Web 2.0 describes a change in internet usage. While information provided on the internet formerly stems from service and information companies and is "consumed" by users, with Web 2.0 users provide information themselves based on communication platforms and information platforms. Thus, the role of customers turns from a passive role to a more active role what comprehensively increases internet traffic as a whole.



# Appendix

## A.1 Appendix to Chapter 2

### A.1.1 Summary News and Companies

The following tables comprise an overview of the selected news (Table A.1) and the companies under scrutiny (Table A.2). Relevant news are taken from the Cullen International database whereas companies are taken from Thomson Financial Datastream and were double-checked with regard to their main business subject and the regional reach.

Table A.1: Selected News

Date	Event
02 Jan. 2000	Unbundling Regulation Scheme published in official journal
22 Mar. 2000	European Commission adopts Recommendation on "best practice" interconnection charges for 2000
30 May 2000	Judgement of the European Court of Justice on the Privatization of Public Enterprises and the use of Golden Shares
13 Jun. 2000	Directive on Local Loop Unbundling published
12 Jul. 2000	Commission adopts the Telecommunications Package
04 Oct. 2000	Telecommunications Council reaches Political Agreement on Unbundling Regulation
26 Oct. 2000	EP Plenary adopts Report on Unbundling of the Local Loop
06 Dec. 2000	Council adopts Unbundling Regulation
10 Jan. 2001	Commission Decision replacing Annex III of the Voice Telephony Directive
06 Apr. 2001	Access and Interconnection Directive
11 Jul. 2001	EP votes in the Lead Committee on the proposed Data Protection Directive
07 Dec. 2001	Council Political Agreement on the proposed Data Protection Directive
14 Feb. 2002	Final Adoption of the Telecom Package
25 Feb. 2002	European Commission phases out Recommendation on Call Termination Charges in Fix-Line Network
05 Jun. 2002	European Court of Justice Ruling on Golden Shares
27 Jun. 2002	Adoption of Data Protection Directive in Electronic Communications Sector
09 Jul. 2002	Commission publishes Guidelines on Market Analysis and the Assessment of Significant Market Power
30 Jul. 2002	Commission establishes European Regulators Group
23 Sep. 2002	Commission Directive on Competition in Electronic Communications Networks
09 May 2003	Council Conclusions on Lawful Interception and Mobile Pre-Paid Cards
14 May 2003	European Court of Justice rulings on the Golden Shares
27 Nov. 2003	IRG publishes Principles of Implementation and Best Practice on Mobile Call Termination Remedies
29 Mar. 2005	European Court of Justice ruling on Failure to transpose the 2003 Regulatory Framework
01 Apr. 2005	European Commission Recommendation on Pricing of Leased Lines Part Circuits
27 Sep. 2005	European Commission Recommendation on Accounting Separation and Cost Accounting
09 Feb. 2006	European Commission proposes new EU Regulation on International Roaming
13 Jul. 2006	European Commission Proposal for EU Regulation on International Roaming
26 Mar. 2007	European Parliament votes on Roaming get underway
07 Jun. 2007	Council gives Green Light to EU Roaming Regulation
18 Jul. 2008	Commission announces Plans to regulate SMS Roaming
24 Sep. 2008	Commission proposes to extend Roaming Regulation to cover SMS and Data
20 Nov. 2008	European Commission proposes to amend the GSM Directive
04 Jan. 2000	Commission Decision on the UK Request for a Deferment of the Implementation of Carrier Pre-Selection
21 Dec. 2000	Tariff Rebalancing: Commission sends Reasoned Opinion to Spain
24 Aug. 2001	Tariff Rebalancing: Commission sends Supplementary Reasoned Opinion to Spain
30 Apr. 2003	Commission approves 3G Mobile Network Sharing Agreement in the UK
16 Jul. 2003	Commission approves 3G Mobile Network Sharing Agreement in Germany
20 Jul. 2006	European Commission prohibits Public Funding of Broadband Project in the Netherlands

Source: Information selected from the Cullen International Database

Selected News (*continued*)

<b>Date</b>	<b>Event</b>
18 May 2000	Commission publishes Vodafone Airtouch/Mannesmann Merger Decision
06 Sep. 2000	Commission clears Hutchison/NTT Docomo/KPN Mobile Joint Venture
21 Dec. 2001	Commission suspects Wanadoo (France) of Abusing its Dominant Position
27 Mar. 2002	Commission suspects KPN of Abusing its Dominant Position for the Termination of Calls on its Mobile Network
08 May 2002	Commission suspects Deutsche Telekom of Abusing its Dominant Position for Wholesale and Retail Local Loop Access
11 Jul. 2002	EC clears Merger between Telia and Sonera subject to conditions
06 Aug. 2002	Commission approves Break Up of Italian Mobile Operator BLU
22 Jan. 2003	Commission decides on State Aid for Mobilcom
05 Feb. 2003	European Commission asks the Netherlands to give up Golden Share in KPN
22 May 2003	Commission fines Deutsche Telekom for Charging Anti-Competitive Tariffs for Access to its Local Network
18 Dec. 2003	European Commission takes the Netherlands to Court on KPN Golden Share
19 Dec. 2003	Commission suspects Telia Sonera (Sweden) of having abused its Dominant Position in the Provision of High-Speed Internet Access
14 Jul. 2004	European Commission conditionally approves Restructuring Aid to Mobilcom
21 Jul. 2004	France Telecom ordered to pay back State Aid
27 Jul. 2004	International Roaming: Commission sends 'Statements of Objections' to O2 and Vodafone
27 Sep. 2004	European Commission clears Acquisition of Orange's Danish Mobile Telephony Business by Telia Sonera
14 Feb. 2005	International Roaming - European Commission sends 'Statements of Objections' to T-Mobile and Vodafone in Germany
15 Nov. 2005	Commission opens In-Depth Investigation into Take-Over of Tele.Ring by T-Mobile Austria
11 Jan. 2006	European Commission approves Acquisition of O2 by Telefonica subject to Conditions
24 Feb. 2006	European Commission opens Abuse of Dominance Investigation against Telefonica
01 May 2006	European Commission and Austrian Regulator approve Acquisition of Tele.Ring by T-Mobile subject to Conditions
05 May 2006	European Court of First Instance annuls Commission Decision on 3G National Roaming between O2 and T-Mobile in Germany
05 Jan. 2007	European Commission Investigation into Funding of Amsterdam Fibre Network
02 Feb. 2007	Court of First Instance upholds Commission in Wanadoo Predation Case
06 Jul. 2007	European Commission fines Telefonica nearly €152m for Abuse of Dominant Position ('Margin Squeeze')
23 Jul. 2007	European Commission approves Acquisition of Tele 2 France by SFR subject to Conditions

Source: Information selected from the Cullen International Database

Table A.2: Selected Companies

ID	Company Name	Fix-line Market	Mobile Market	Listing Date
1	Belgacom	X	X	22 Mar. 2004
2	BT Group	X	X	< 01 Jan. 1999
3	Deutsche Telekom	X	X	< 01 Jan. 1999
4	France Telecom	X	X	< 01 Jan. 1999
5	Hellenic	X	X	< 01 Jan. 1999
6	KPN Kon	X	X	< 01 Jan. 1999
7	Portugal Telecom	X	X	< 01 Jan. 1999
8	Swisscom	X	X	< 01 Jan. 1999
9	TDC	X	X	< 01 Jan. 1999
10	Telecom Italia	X	X	< 01 Jan. 1999
11	Telefonica	X	X	< 01 Jan. 1999
12	Telekom Austria	X	X	21 Nov. 2000
13	Telenor	X	X	05 Dec. 2000
14	Telia Sonera	X	X	14 Jun. 2000
15	Vodafone	X	X	< 01 Jan. 1999
16	3U Holding	X		24 Nov. 1999
17	Acotel	X	X	09 Aug. 2000
18	Adept	X		25 May 2006
19	Thus Group	X	X	05 Jan. 2004
20	Alternative Networks	X	X	17 Feb. 2005
21	Amitelo	X		12 Nov. 2005
22	BNS Telecom	X	X	24 Nov. 2005
23	Buongiorno		X	11 Oct. 2000
24	Cable & Wireless	X		< 01 Jan. 1999
25	Canisp	X		15 Oct. 2003
26	Colt Telecom	X		< 01 Jan. 1999
27	Completel	X		16 Sep. 2002
28	Convisual	X		13 Jan. 2006
29	Drillisch	X	X	< 01 Jan. 1999
30	Ecotel	X	X	29 Mar. 2006
31	Elisa	X	X	02 Jul. 1999
32	Eutelia	X		19 Apr. 2000
33	Tele 2 F	X	X	< 01 Jan. 1999
34	Fastweb	X		27 Mar. 2000
35	Freedom4	X		02 Sep. 2004
36	Getmobile		X	26 Apr. 2006
37	Teleunit	X		26 May 2004
38	Inmarsat	X	X	20 Jun. 2005
39	Jazztel	X		20 Dec. 2000
40	Kcom	X		14 Jul. 2000
41	Keyyo	X		< 01 Jan. 1999
42	KPN Qwest	X		09 Nov. 1999
43	Lannet	X	X	01 Jun. 2004
44	Messaging	X	X	25 May 2006
45	Millicom		X	< 01 Jan. 1999
46	Mobile Streams	X		25 May 2006
47	Mobile Tornado	X	X	25 May 2006
48	Mobistar		X	< 01 Jan. 1999
49	Mobyson		X	< 01 Jan. 1999
50	Netmobile		X	13 Jul 2005
51	Normaction		X	28 Jul. 2005
52	PNC Telecom		X	< 01 Jan. 1999
53	Retelit	X		03 Aug. 2000
54	Satcom		X	15 Jul. 2005
55	Sonaecon	X	X	02 Jun. 2000
56	Spiritel	X	X	11 Mar. 2004
57	Tele 2 SE	X	X	< 01 Jan. 1999

Source: Information taken from the Thomson Financial Database

## A.1.2 Summary Statistics and Tests of Pre-Estimations

Table A.3: Summary Statistics and Test Results of the Iterative Estimation Process (Incumbents)

Incumbents	Technology Index			Telecom Index		
	Mean (Std. Dev.)	Minimum (Share Min.)	Maximum (Share Max.)	Mean (Std. Dev.)	Minimum (Share Min.)	Maximum (Share Max.)
<b>AR</b>						
lag ar	4.414 (1.018)	2 (0.020)	6 (0.197)	4.675 (1.300)	2 (0.018)	7 (0.130)
Chi_sq (df)	80.0 (5.414) (37.2)	17.4	248.1	80.0 (5.675) (36.4)	19.0	245.5
log likelihood	44.1 (46.7)	-176.9	157.5	44.2 (46.5)	-176.3	156.5
<b>(G)ARCH</b>						
lag error_sq (=p)	1.778 (1.985)	0 (0.374)	8 (0.007)	1.791 (1.963)	0 (0.363)	8 (0.005)
lag sigma_sq (=q)	1.534 (1.241)	1 (0.781)	6 (0.042)	1.562 (1.376)	1 (0.780)	8 (0.014)
Chi_sq (df)	0.824 (1.279) (4.367)	0.000	103.4	0.965 (1.496) (3.215)	0.000	37.5
log likelihood	49.5 (45.2)	-169.0	163.8	49.0 (45.5)	-168.4	162.0

Note: lag sigma\_sq = 0 corresponds to an ARCH process, whereas lag sigma\_sq > 0 represents a GARCH process.

lag error\_sq = 0 and lag sigma\_sq = 0 corresponds to the standard assumption of the usual model.



Appendix

Table A.4: Summary Statistics and Test Results of the Iterative Estimation Process (Entrants)

Entrants	Technology Index			Telecom Index		
	Mean (Std. Dev.)	Minimum (Share Min.)	Maximum (Share Max.)	Mean (Std. Dev.)	Minimum (Share Min.)	Maximum (Share Max.)
<b>AR</b>						
lag ar	3.531 (1.852)	0 (0.084)	6 (0.191)	3.833 (2.081)	0 (0.072)	7 (0.134)
Chi_sq (df)	74.9 (91.3)	0.000	1553.6	76.7 (90.9)	0.000	1561.1
log likelihood	42.4 (243.2)	-347.6	830.1	44.3 (246.9)	-339.8	890.4
<b>(G)ARCH</b>						
lag error_sq (=p)	1.999 (2.230)	0 (0.348)	8 (0.023)	2.252 (2.354)	0 (0.328)	8 (0.018)
lag sigma_sq (=q)	2.208 (1.835)	1 (0.625)	6 (0.123)	2.397 (2.194)	1 (0.620)	8 (0.057)
Chi_sq (df)	54635 (2.204) (1974468)	0.000	7.16 exp(07)	463.1 (2.088) (15869)	0.000	617316
log likelihood	54.5 (252.7)	-296.2	1191.8	62.4 (259.9)	-293.8	1289.4

Note: lag sigma\_sq = 0 corresponds to an ARCH process, whereas lag sigma\_sq > 0 represents a GARCH process.  
lag error\_sq = 0 and lag sigma\_sq = 0 corresponds to the standard assumption of the usual model.

## A.1.3 Additional Estimation Results

Table A.5: Estimation Results Cross-Market Estimations

	Technology Index			Telecom Index		
	CAR (3)	CAR (7)	CAR (11)	CAR (3)	CAR (7)	CAR (11)
fix-line	0.0004 (0.0005)	-0.0005 (0.0018)	-0.0012 (0.0030)	0.0003 (0.0005)	-0.0008 (0.0018)	-0.0022 (0.0023)
mobile	0.0001 (0.0006)	0.0022 (0.0021)	0.0017 (0.0036)	0.0000 (0.0001)	0.0020 (0.0021)	0.0011 (0.0036)
# fix-line countries	0.0000 (0.0001)	0.0002 (0.0004)	0.0002 (0.0007)	0.0000 (0.0001)	0.0003 (0.0004)	0.0002 (0.0007)
# mobile countries	-0.0001 (0.0001)	0.0002 (0.0004)	-0.0006 (0.0008)	-0.0001 (0.0001)	0.0003 (0.0004)	-0.0006 (0.0008)
incumbent	0.0002 (0.0005)	0.0010 (0.0016)	0.0022 (0.0028)	0.0002 (0.0005)	0.0013 (0.0016)	0.0027 (0.0028)
foreign fix-line	0.0004 (0.0008)	0.0004 (0.0030)	-0.0015 (0.0051)	0.0006 (0.0008)	0.0004 (0.0031)	-0.0016 (0.0052)
foreign mobile	0.0004 (0.0009)	0.0004 (0.0033)	0.0071 (0.0057)	0.0004 (0.0001)	-0.0004 (0.0033)	0.0055 (0.0057)
constant	-0.0005 (0.0008)	-0.0041 (0.0027)	-0.0022 (0.0045)	-0.0005 (0.0008)	-0.0044 (0.0027)	-0.0021 (0.0045)
# Observations	1177	1177	1177	1182	1182	1182
F-Test (df)	0.24 (7)	0.43 (7)	0.40 (7)	0.25 (7)	0.54 (7)	0.38 (7)
R2	0.0011	0.0026	0.0023	0.0012	0.0033	0.0023
	CAV (3)	CAV (7)	CAV (11)	CAV (3)	CAV (7)	CAV (11)
fix-line	0.0000 (0.0001)	0.0003 (0.0005)	0.0007 (0.0010)	0.0000 (0.0001)	0.0003 (0.0005)	0.0007 (0.0001)
mobile	0.0000 (0.0001)	0.0002 (0.0005)	0.0007 (0.0011)	0.0001 (0.0001)	0.0008 (0.0005)	0.0020 * (0.0010)
# fix-line countries	0.0001 *** (0.0000)	0.0004 *** (0.0001)	0.0008 *** (0.0002)	0.0001 *** (0.0000)	0.0004 *** (0.0001)	0.0008 *** (0.0002)
# mobile countries	-0.0000 (0.0000)	0.0000 (0.0001)	0.0001 (0.0002)	0.0000 (0.0001)	0.0001 (0.0001)	0.0003 (0.0002)
incumbent	-0.0006 *** (0.0001)	-0.0035 *** (0.0004)	-0.0070 *** (0.0008)	0.0000 (0.0000)	-0.0035 *** (0.0004)	-0.0072 *** (0.0008)
foreign fix-line	0.0003 ** (0.0001)	0.0016 ** (0.0008)	0.0031 ** (0.0015)	-0.0006 *** (0.0001)	0.0020 *** (0.0001)	0.0038 ** (0.0015)
foreign mobile	-0.0004 *** (0.0001)	-0.0024 *** (0.0008)	-0.0050 *** (0.0015)	-0.0005 *** (0.0001)	-0.0028 (0.0007)	-0.0061 *** (0.0015)
constant	0.0010 *** (0.0001)	0.0054 *** (0.0001)	0.0104 *** (0.0013)	0.0009 *** (0.0001)	0.0048 *** (0.0006)	0.0094 *** (0.0012)
# Observations	1177	1177	1177	1180	1180	1180
F-Test (df)	15.41 (7)	16.12 (7)	16.65 (7)	15.71 (7)	16.39 (7)	16.53 (7)
R2	0.0720	0.0784	0.0813	0.0804	0.0840	0.0850

Note: \*\*\*, \*\*, \* represent significance at the 1, 5 and 10 percent significance level, standard errors are displayed in brackets.

Table A.6: Estimation Results of Particular Market Events

	Technology Index			Telecom Index		
	CAR (3)	CAR (7)	CAR (11)	CAR (3)	CAR (7)	CAR (11)
fix-line	-0.0024 (0.0020)	-0.0005 (0.0012)	-0.0284 ** (0.0139)	-0.0026 (0.0020)	-0.0087 (0.0077)	-0.0022 ** (0.0140)
mobile	.	.	.	.	.	.
incumbent	-0.0009 (0.0008)	-0.0033 *** (0.0006)	-0.0073 (0.0047)	-0.0009 (0.0008)	-0.0030 (0.0027)	-0.0049 (0.0046)
foreign fix-line	0.0012 (0.0014)	0.0016 (0.0014)	-0.0098 (0.0102)	0.0016 (0.0015)	-0.0011 (0.0060)	-0.0099 (0.0100)
foreign mobile	-0.0019 (0.0016)	-0.0009 (0.0013)	-0.0120 (0.0149)	-0.0017 (0.0015)	-0.0037 (0.0067)	-0.0082 (0.0131)
constant	0.0014 (0.0010)	0.0071 *** (0.0016)	0.0101 (0.0070)	0.0021 (0.0023)	0.0063 (0.0082)	0.0293 ** (0.0147)
country dummies included						
# Observations	386	386	386	393	393	393
F-Test (df)	1.17 (8)	1.13 (8)	1.41 (8)	0.82 (8)	0.89 (8)	1.40 (8)
R2	0.0203	0.0181	0.0272	0.0171	0.0146	0.0285
	CAV (3)	CAV (7)	CAV (11)	CAV (3)	CAV (7)	CAV (11)
fix-line	-0.0002 (0.0002)	-0.0007 (0.0013)	-0.0006 (0.0025)	-0.0002 (0.0002)	-0.0005 (0.0012)	-0.0003 (0.0024)
mobile	.	.	.	.	.	.
incumbent	-0.0006 *** (0.0001)	-0.0032 *** (0.0006)	-0.0065 *** (0.0011)	-0.0006 *** (0.0001)	-0.0033 *** (0.0006)	-0.0068 *** (0.0011)
foreign fix-line	0.0001 (0.0002)	0.0005 (0.0012)	0.0014 (0.0023)	0.0003 (0.0003)	0.0016 (0.0014)	0.0038 (0.0029)
foreign mobile	0.0002 (0.0003)	0.0007 (0.0016)	0.0020 (0.0034)	-0.0001 (0.0003)	-0.0009 (0.0013)	-0.0017 (0.0025)
constant	0.0009 *** (0.0001)	0.0052 *** (0.0007)	0.0105 *** (0.0014)	0.0014 *** (0.0003)	0.0071 *** (0.0016)	0.0140 *** (0.0032)
country dummies included						
# Observations	386	386	386	391	391	391
F-Test (df)	4.52 (8)	5.35 (8)	5.60 (8)	4.32 (8)	5.17 (8)	5.48 (8)
R2	0.0556	0.0640	0.0686	0.0546	0.0671	0.0744

Note: \*\*\*, \*\*, \* represent significance at the 1, 5 and 10 percent significance level, standard errors are displayed in brackets.

Table A.7: Estimation Results of Particular Company Events

	Technology Index			Telecom Index			Technology Index			Telecom Index		
	CAR (3)	CAR (7)	CAR (11)	CAR (3)	CAR (7)	CAR (11)	CAV (3)	CAV (7)	CAV (11)	CAV (3)	CAV (7)	CAV (11)
fix-line	-0.0005 (0.0008)	-0.0075 ** (0.0031)	-0.0154 *** (0.0056)	-0.0008 (0.0008)	-0.0089 *** (0.0030)	-0.0171 *** (0.0055)	-0.0001 (0.0001)	-0.0005 (0.0007)	-0.0006 (0.0015)	-0.0001 (0.0001)	-0.0006 (0.0007)	-0.0009 (0.0015)
mobile	0.0019 ** (0.0008)	0.0042 (0.0030)	0.0048 (0.0052)	0.0017 ** (0.0008)	0.0033 (0.0030)	0.0036 (0.0051)	0.0001 (0.0001)	0.0004 (0.0007)	0.0012 (0.0014)	0.0000 (0.0001)	0.0001 (0.0007)	0.0006 (0.0014)
addressed company	-0.0031 ** (0.0012)	-0.0128 *** (0.0037)	-0.0136 ** (0.0060)	-0.0031 ** (0.0012)	-0.0138 *** (0.0037)	-0.0155 *** (0.0060)	-0.0005 *** (0.0001)	-0.0025 *** (0.0007)	-0.0048 *** (0.0013)	-0.0004 *** (0.0002)	-0.0023 *** (0.0007)	-0.0045 *** (0.0015)
affected comp. (fix-line)	-0.0001 (0.0013)	0.0054 (0.0053)	0.0029 (0.0087)	0.0001 (0.0014)	0.0052 (0.0053)	0.0034 (0.0046)	0.0005 ** (0.0002)	-0.0027 ** (0.0011)	0.0056 ** (0.0022)	0.0005 ** (0.0002)	-0.0028 *** (0.0010)	0.0058 *** (0.0021)
affected comp. (mob)	0.0015 * (0.0008)	0.0012 (0.0025)	0.0018 (0.0044)	0.0013 (0.0008)	0.0017 (0.0026)	0.0018 (0.0085)	-0.0001 (0.0001)	-0.0005 (0.0005)	-0.0012 (0.0011)	-0.0000 (0.0001)	0.0001 (0.0006)	0.0001 (0.0011)
incumbent	0.0004 (0.0005)	0.0002 (0.0018)	0.0070 (0.0031)	0.0005 (0.0005)	0.0008 (0.0018)	0.0034 (0.0046)	-0.0005 *** (0.0001)	-0.0029 *** (0.0004)	-0.0060 *** (0.0008)	-0.0005 *** (0.0001)	-0.0029 *** (0.0004)	-0.0059 *** (0.0008)
foreign fix-line	0.0008 (0.0010)	0.0069 (0.0042)	0.0115 * (0.0070)	0.0009 (0.0010)	0.0068 (0.0042)	0.0115 * (0.0070)	0.0003 ** (0.0002)	0.0018 ** (0.0009)	0.0037 ** (0.0019)	0.0003 * (0.0002)	0.0019 ** (0.0009)	0.0038 ** (0.0018)
foreign mobile	-0.0006 (0.0010)	0.0023 (0.0028)	0.0064 (0.0051)	-0.0003 (0.0010)	0.0028 (0.0027)	0.0070 (0.0051)	-0.0001 (0.0001)	-0.0013 * (0.0007)	-0.0027 * (0.0014)	-0.0003 *** (0.0001)	-0.0021 *** (0.0006)	-0.0043 * (0.0013)
constant	-0.0013 (0.0017)	-0.0062 (0.0074)	-0.0163 (0.0138)	-0.0018 (0.0017)	-0.0059 (0.0074)	-0.0157 (0.0139)	0.0009 *** (0.0003)	0.0051 *** (0.0017)	0.0101 *** (0.0035)	0.0007 ** (0.0003)	0.0044 *** (0.0016)	0.0088 *** (0.0033)
# Observations	848	848	848	862	862	862	848	848	848	860	860	860
F-Test (df)	1.42 (16)	3.85 (16)	4.08 (16)	1.47 (16)	1.47 (16)	1.47 (16)	5.61 (16)	6.55 (16)	6.58 (16)	4.72 (16)	5.44 (16)	5.62 (16)
R2	0.0232	0.0521	0.0523	0.1667	0.1793	0.1468	0.0704	0.0729	0.0747	0.0702	0.0777	0.0774

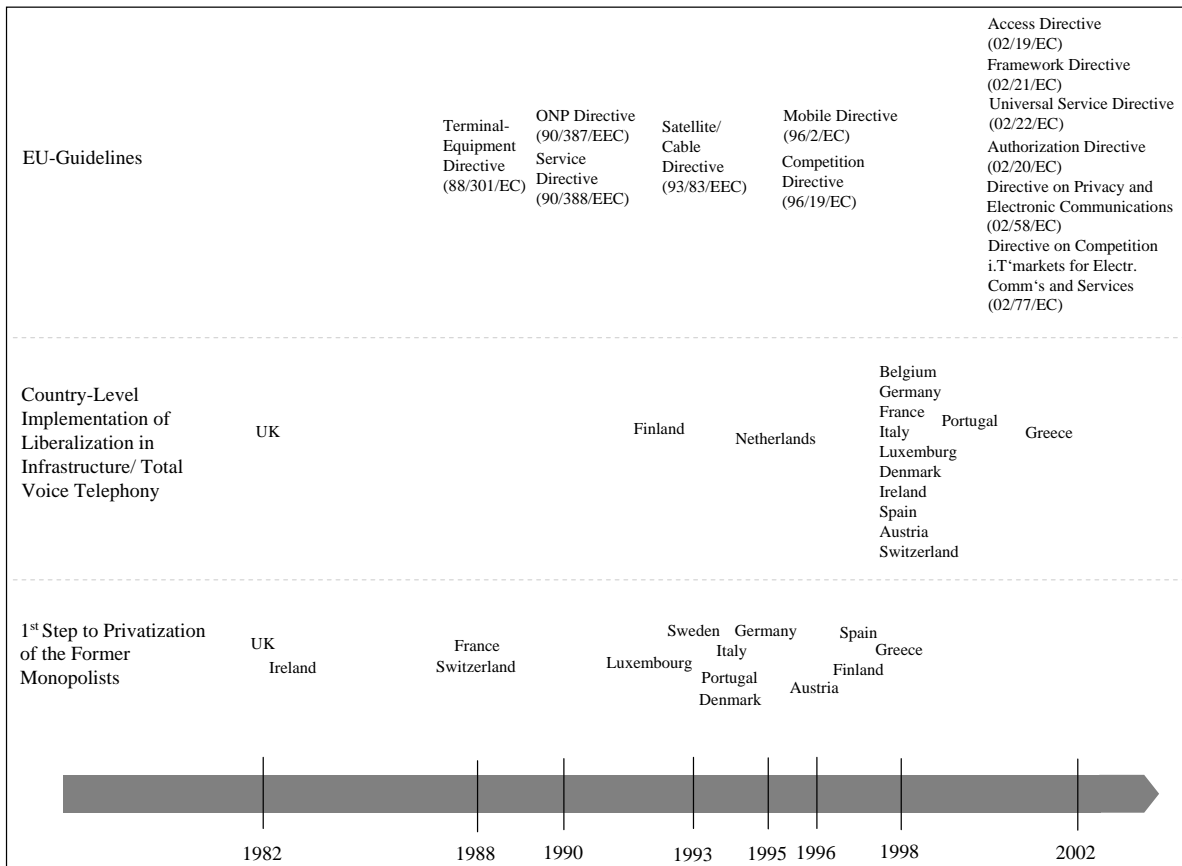
country dummies included

Note: \*\*\*, \*\*, \* represent significance at the 1, 5 and 10 percent significance level, standard errors are displayed in brackets.

## A.2 Appendix to Chapter 3

### A.2.1 Market Access and Privatization

Figure A.1: Steps to Competition on EU-15 Telecommunication Markets



The figure above shows the introduction of the EU Telecommunication Directives. The most important directive was the 1996 Competition Directive which opened both infrastructure and voice transmission markets for competition.

The second line shows the entrance of the first competitor on fix-line telecommunication markets. In most countries, new firms were allowed to enter the markets by the implementation of the EU Competition Directive in national law in 1998.

The last line shows the year when governmental ownership over the former monopolists have been reduced for the first time. As could easily be seen, liberalization always occurred after privatization in the countries under scrutiny.

## A.2.2 Infrastructure Competition and Investments – a Comparison of Performance

Two main reasons exist why one observes European telecommunication markets in alternative stages of competition in different countries: 1) National member states have been at a different competition status when the liberalization of European telecommunications markets was implemented and 2) member states are obliged to adopt the EC directives taking into account national distinctions. Due to these different starting points, the EC has a strong interest in aligning the status of national markets for preparing the integration to one European market. As national governments do not only pursue the European integration policy but follow own national or also individual interests, their actions affect the transposition process and also the national stage of competition.

Figure A.2 displays the relation of DSL- and cable-based broadband access over time (Figure 6.3(a)) and unbundled access lines in relation to the total access lines available for fix-line telecommunication networks (Figure 6.3(b)) over time. The first graph shows a strong bulge for Germany and also for France, whereas the relation in smaller countries is much more balanced, in particular for the Netherlands. Following Cave (2009), a reason for the difference between facility-based competition in larger and smaller countries comes from the availability of cable access. For example, in Germany, cable has been available only in cities and there is still no tendency of cable providers to roll-out networks. Moreover, the German telecommunication incumbent held stakes in regional cable companies until 2003, which might have delayed cable as a medium for internet access as argued by the EC in multiple Implementation Reports. In France, a similar situation is observable, where cable networks are also concentrated in major agglomerations. Following the 2002 Implementation Report, after 2001, investments slowed down in France as the Conseil de la Concurrence, the French competition authority, forced the incumbent to give access to its local loop infrastructure. However, municipal administrations in less densely populated areas arranged with the telecommunication incumbent to join investments based on bilateral agreements. Such new forms of financing DSL roll-out led to an ongoing increase of the gap between DSL and cable usage for broadband access.

Due to the overall availability of low-speed telecommunication networks, a first-mover advantage of DSL infrastructure over cable infrastructure exists, as investment costs are lower for installing adequate transmission technology than for rolling out a new infrastructure. Exceptions are the Netherlands and also the UK where cable is nearly as widely spread as telecommunication infrastructure.

While the last-mile physical infrastructure is commonly agreed to be a monopolistic bottleneck (see e.g. Bauer, 2007, or Knieps, 2007), the access to frequency bands on this infrastructure is particularly relevant for the take-up of local loop competition. Cave's ladder-of-investment model (Cave, 2006a) shows that new competitors enter a market, firstly, getting access to an incumbent's infrastructure by renting or leasing access capacity and, subsequently, building out own infrastructure. Thus, following Cave (2009),

it is important to focus wholesale regulation on a few access elements, and to increase the attractiveness for potential competitors to enter the local market. If they are able to gain sufficient market shares subsequent physical infrastructure investments by new entrants will follow. In a next step, it is therefore necessary to consider how local loop unbundling has been introduced and guaranteed in EU member states.

In its Regulation No. 2887/2000, the EC provides a detailed description about how local loop unbundling should be implemented on the national level, gives detailed information about the elements included at the minimum and provides the date by which infrastructure owners are obliged to provide an offer to competitors, which is 31 December 2000.<sup>2</sup> Figure 6.3(b) shows the local loop unbundling development expressed as the share of unbundled local loops per fix-line access paths. Although local loop unbundling should be implemented to local loops at the earliest point in time when it is feasible, since 2000, local loop unbundling is available only to about one fifth to one fourth of all lines in 2007. As local loop unbundling is the key requirement for providing competitive services to customers, the EC suspects many former monopolists trying to delay the access for new entrants.

### A.2.3 Local Loop Competition - Comparison across EU Member States

Comparing the individual country developments with regard to market opening, the UK is found to be the first country with actual local loop unbundling rules in place already in 1997. However, OFTEL, the UK NRA, decided not to require access to raw copper lines as it suspected competitors delaying the roll-out of own infrastructure otherwise. In line with competition stimulation, the UK NRA required new entrants first to negotiate access prices to collocation points. Only if negotiations failed the NRA would intervene. With regard to services on the lines, the NRA tied the vertically integrated incumbent to allow ADSL provision only if, simultaneously, an adequate wholesale product is available. While the UK market was lagging far behind other countries in terms of competition, after around 2005 a strong catching-up of the local loop unbundling market took place, as the incumbent functionally separated its service units from the infrastructure units. Due to the separation, OFCOM, the successor of OFTEL, decided to relax wholesale line rental regulation as it expected the market to be in a state of competition.

Local loop unbundling has been implemented stepwise in Germany since 1998 based on fully unbundled raw copper, whereas shared access and also sub-loop unbundling (a particular necessity with the fiber-based Opal technology in Eastern Germany) was denied. Concerning interconnection, the EC suspected the German incumbent systematically to delay the availability of a sufficient number of collocation points. Deutsche Telekom offered ADSL services since mid-1999 and competitors were allowed to resale ADSL products from the same point in time.

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<sup>2</sup><http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2000:336:0004:0008:EN:PDF>

In France, the incumbent has offered retail ADSL services since November 1999. However, wholesale offers were not available until an intervention by the French competition authority in 2001, when the incumbent was obliged to unbundle its local loop for full and shared access. Competitors complained about the comprehensive first-mover advantage of the incumbent, in particular, as ADSL was blocked by the incumbent even after the decision. Nevertheless, the courageous intervention by the competition authority resulted in a strong increase in unbundled access lines which is even stronger than in other countries and led to the second highest rate of unbundled lines in the EU-15 (behind Finland).<sup>3</sup>

While local loop unbundling was implemented in the Netherlands in June 2000, about 90 percent of the unbundled lines were provided to a subsidiary of the incumbent. Moreover, until 2001, competitors claimed that the way of providing collocation points circumvented last mile competition as, firstly, too few collocation facilities were offered in major agglomerations and, secondly, the incumbent gave no information about the availability and characteristics of collocation facilities in advance. In consequence, the incumbent and its subsidiary gained a comprehensive first-mover advantage over their ADSL competitors. However, entrants can also use cable providers' infrastructure to get access to customers, but this infrastructure is not covered by the telecommunications regulatory framework.

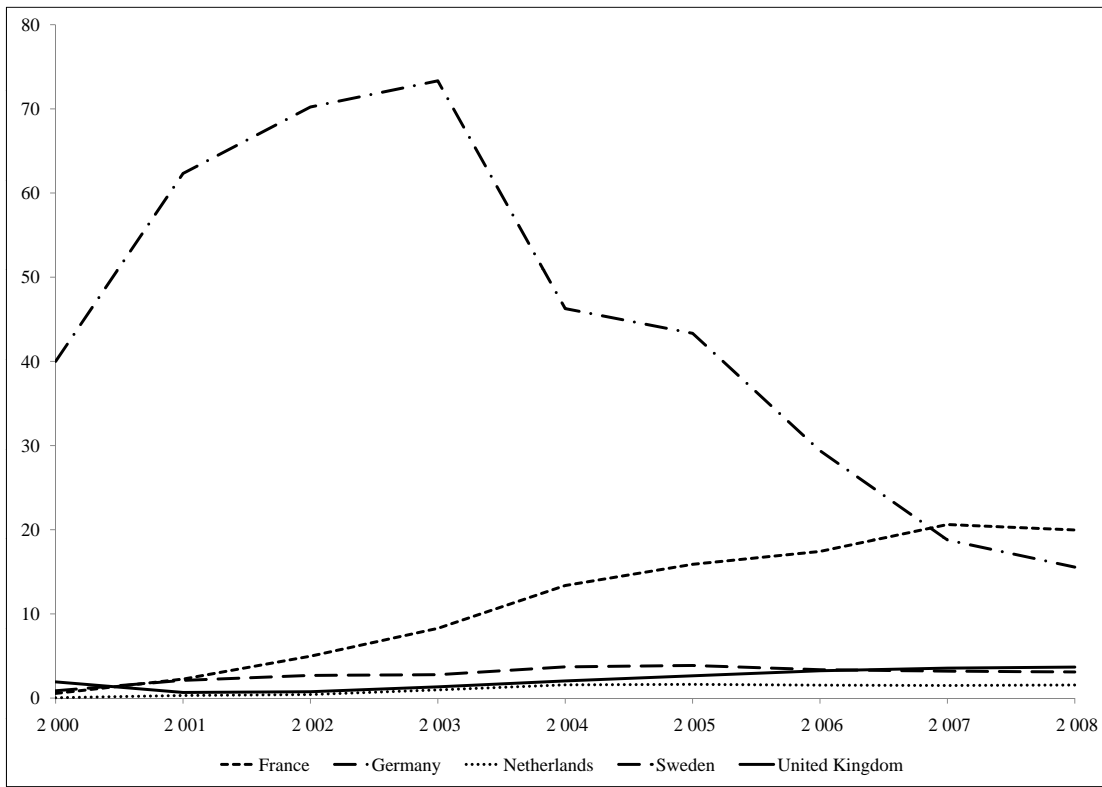
The Swedish incumbent opened its local loop voluntarily by offering local loop access and collocation facilities without national regulatory interventions in March 2000. Thus, competitors were able to negotiate full local loop access or shared access based on bilateral contracts with Telia. However, Telia refrained from providing sub-loop access. Since September 2001, Telia offers a wholesale ADSL product bundle for resale. Following the EC, still too few competition existed in 2001 as the prices claimed by the incumbent were too high both for local loop access and also for the wholesale ADSL offer. As a high market concentration still existed in 2004, PTS, the Swedish NRA, intervened ordering Telia to provide access to the local loop under non-discriminatory conditions to all demanding companies.

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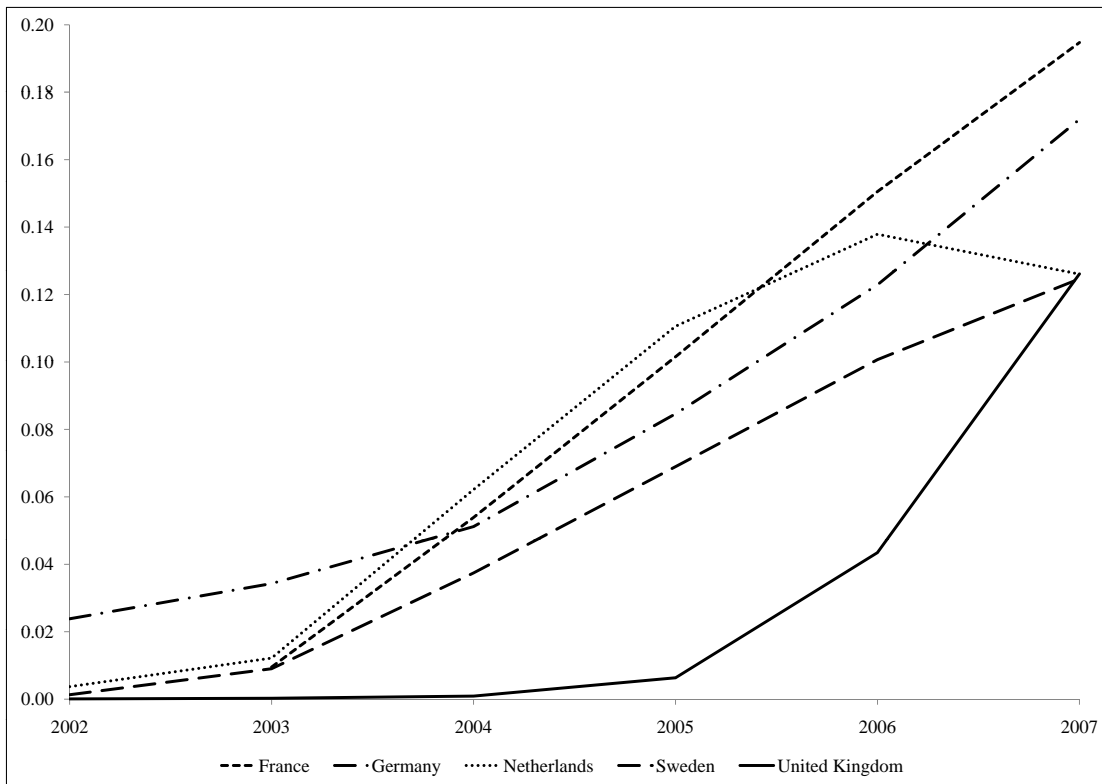
<sup>3</sup>Ranking of the five countries considered here in 2007 (2003 (due to missing information for many countries in 2002)): France: 2 (6), Germany: 3 (2), UK: 5 (14), Netherlands: 6 (5), Sweden: 7 (7).



Figure A.2: Fix-line Access Competition



(a) Facility-Based Competition



(b) Local Loop Access

Source: Data taken from the OECD Communications Outlook 2009

Table A.8: State Aid

Month	Day	Year	Source	Country	Aff. Comp.	Central Information
February	08	2000	The Irish Times	UK		A total of pounds 120 million has been earmarked for grant aid to companies installing broadband fibre-optic communications which, according to Ms O'Rourke, would draw out a total investment of over euros 500 million in bringing bandwidth to regions. The project "E-commerce and Advanced Communications Systems Measure" will receive pounds 150 million, equally split between Exchequer funds and European Rural Development funds. The project will encourage companies to build out rural broadband (high-speed, high bandwidth) networks, and is expected to add up to 150,000 "fibre kilometres" to the State's fibre-optic network (because many individual fibres comprise a fibre-optic cable, a kilometre of cable equals several fibre kilometres).
December	04	2000	Nordic Business Report	SE		Sweden is planning to invest SEK 10bn in a programme to set up a nationwide broadband network which will reach the country's remotest villages, a government official said last week
March	05	2003	The Irish Times	EU		EU Competition Commissioner, Mr Mario Monti, has given the green light for millions of euros of government money to be invested in mobile telephony and high-speed internet access for poorer regions
April	03	2003	The Guardian	UK		When Durham county council's new high-speed network, Durhamnet, is officially launched this spring, it will connect small businesses and homes as well as schools, libraries and council offices. Shropshire and Somerset county councils have similar plans.
June	06	2003	Utility Week	EU		Despite carrying huge debt, the OECD says the telecoms sector doesn't need state aid and telcos should be left to get on with it. The Commission is already investigating whether the French government's credit line to France Telecom breaches state aid rules. Local loop unbundling, recently the subject of a Commission ruling against Deutsche Telekom, is making slow progress. The OECD uses the example of broadband access: 'The pressure of regulators [on local loop unbundling] has eventually improved conditions for competition, and notably helped reduce the prices charged by incumbent operators,' says the report
August	05	2003	M2 Presswire	UK		Department of Trade and Industry (DTI) plans to wire the public sector for broadband unlikely to stimulate new infrastructure investment and may breach European competition rules (pounds 1 billion)
September	09	2003	Telecom Markets	UK		The UK Department of Trade and Industry (DTI) is reviewing how it will award large rural broadband contracts under its Broadband Aggregation Project, in response to concerns that issuing such contracts could breach competition rules
January	12	2004	Telecom Markets	EU	FR, EU	A key legal ruling by the European court of justice in mid-2003 - known as the Almark judgment - illustrated how the SGEI concept can be used as a framework for broadband-network development and an alternative to state aid
January	13	2004	Telecom Markets	UK	BT	In a bid to attract some of the pounds 1 billion (euros 1.4 billion)-plus in UK government funding that has been ringfenced for broadband, BT has upped its efforts to deliver broadband access to remote and rural communities in the UK by trialling fixed wireless technology and slashing the price of one of its wholesale DSL products
April	15	2004	The Times	UK	BT	The Commission is investigating a charge that BT's rates bill is calculated at a rate of 2 per cent of relevant revenues, while rivals pay up to 27 per cent. The complaint, by Viesse Networks, alleges that BT saved more than pounds 1 billion on its rates last year. The company, which provides high-capacity networks for City financial institutions, charges that BT paid rates on its telecoms network equivalent to just pounds 250 million during 2003
October	27	2004	Swedish Business Digest	SE	Terracom	Swedish Terracom To Construct Motala Municipality Broadband Network; Swedish state-owned broadcaster and digital TV provider Terracom signed a contract to construct the broadband network in the municipality of Motala, southern Sweden, it was reported on October 26, 2004.
November	17	2004	European Report	FR, UK		Three publicly-funded broadband Internet access projects in the United Kingdom and France have been approved by the European Commission, in line with the eEurope 2005 action plan. The projects, approved on November 16, have been set up in Scotland, in the East Midlands in England and in the French region of Pyrenees-Atlantique.
December	12	2004	Telecom Markets	EU	FR, EU	The European Commission's green light on November 8 allowing local municipalities to act as a "carrier's carrier" for a rural broadband project in France's Pyrenees-Atlantiques region clarifies state-aid rules for some 130 French rural broadband projects. It also has major implications for projects throughout the European Union
August	09	2004	Swedish Business Digest	SE	TeliaSonera	Swedish TeliaSonera Network Sales AB, a subsidiary of Swedish-Finnish mobile telecoms operator TeliaSonera, signed a Swedish crowns 33 mln (USD 4.3 mln/3.6 mln euro) contract with the municipality of Mark, south western Sweden, to develop broadband infrastructure in the region, it was reported on July 22, 2004
September	17	2004	ZDNet France	FR		L'un des plus ambitieux chantiers publics de réseau télécoms à haut débit est en train de tourner à l'aigre. À Pau, le chantier a 10 mois de retard et il suscite de vives critiques chez certains élus et entrepreneurs. Le projet Pau Broadband Country (PBC) a du plomb dans l'aile. Censé équiper Pau et son agglomération du réseau en fibre optique «le plus large de France», il suscite désormais de vives inquiétudes comme ZDNet a pu le vérifier auprès des entreprises et des élus locaux impliqués.

Source: Information taken from LexisNexis. Note that information could be incomplete due to missing publications in the daily press.

## State Aid (continued)

Month	Day	Year	Source	Country	Aff. Comp.	Central Information
January	28	2005	Utility Week	UK	BT	The European Commission last week launched a probe into alleged state aid for BT in the form of a subsidy on the property tax levied on the company. Why does BT pay tax equivalent to a rental value of pounds 16 per annum per local loop line, but has subsequently charged other operators a rental of pounds 122 per annum for the same line, when both rentals should have been based on fair market values? Paul said that since BT's tax was last assessed in 1995, the discrepancy amounted to pounds 12 billion.
May	11	2005	Total Telecom	FR		The European Commission has approved euros 85 million in government subsidies for a groundbreaking public scheme to provide broadband networks to a rural area of France
June	03	2005	Newsletter DMEurope	UK	DME Ltd.	The European Commission has authorised, under EU state aid rules, a UK subsidy which aims at bridging the digital divide between areas of Wales that currently have broadband communications and those that do not.
October	08	2005	European Report	UK		The European Commission has authorised a state-subsidised project that aims at bridging the "digital divide" in the United Kingdom. Funding is to be provided for the expansion of broadband communications to remote areas in the West Midlands, East Midlands and South West regions, as part of the UK government's Rural Broadband Access Project
October	24	2005	AFX International Focus	NL		The European Commission said it has opened a formal investigation to assess whether public funding for a fibre access network in the Dutch town of Appingedam complies with EC Treaty state aid rules
November	11	2005	Birmingham Post	UK		A team from the Brussels office of Hammonds has secured European Commission clearance for Advantage West Midlands cash backing to provide broadband in rural areas.
March	21	2006	Austria Today	EU		The European Union will provide cash to build high-speed Internet access in the continent's less-developed areas to help set up new businesses and create jobs. Brussels approved several broadband projects last year that received state aid in Britain, Spain, Austria and Ireland.
June	19	2006	The Times (London)	UK	BT	BT faces the imminent threat of a multimillion-pound fine for alleged anti-competitive behaviour over the pricing of its high-speed internet access.
June	25	2006	TT-Magazine	FR		To cap a month of debate about state interest in next generation networks, France's central government said it wants to turn the country into a "digital republic". In Ireland, the Lord Mayor of Dublin is backing a city-wide WiFi network to offer free or low-cost broadband access. Digiweb and Irish Broadband have expressed interest in building the network, estimated to cost -pounds 2
July	19	2006	IP/06/1013	NL		The EC has decided to prohibit, under EC Treaty state aid rules, public funding for the planned construction of a fibre access network in the Dutch town of Appingedam. The project concerns an area already served by broadband networks and the Commission considered that the aid was not necessary to remedy either a market failure or unaffordable prices for broadband
August	08	2006	Total Telecom	DE	DT	The Commission has been notified of Germany's regulatory intent concerning IP bitstream, which include providing IP interface to 73 cities, co-location abilities and providing services in a non-discriminatory manner. According to Clausen, the Commission is now likely to respond by saying that the regulatory conditions also have to apply to the VDSL network
December	21	2006	AFX International Focus	NL		The European Commission said it has opened an in-depth investigation under aid rules into the city of Amsterdam's investment in its glass fibre telecommunications network
December	22	2006	European Report	NL		The European Commission announced that it had opened an in-depth investigation into the investment by the City of Amsterdam in building a glass fibre telecommunications network
May	16	2007	Irish Independent	UK		Ireland's plans for broadband roll-out in metropolitan areas need to be more closely examined to ensure State aid rules are not being broken, Competition Commissioner Neelie Kroes said yesterday
November	10	2008	Global Markets Research Centre DE - Global Insight	Centre DE		News agency Agence Europe reports that the European Commission (EC) has given a green light for the state-aid scheme which would allocate an additional 45 million euro for improving the availability of broadband services in the German countryside; the subsidies in question will target rural areas in the states of Saxony, Lower Saxony, and Bavaria. Commission spokesperson Neelie Kroes was quoted on rural connectivity: "...the Commission is convinced that there is a genuine problem", adding that "without state aid broadband internet access would not be available in those areas"
October	01	2009	EUROpolitics	FR		The European Commission approved, on 30 September, the public co-financing, to the tune of euros 59 million, of the roll-out of a passive, neutral and open broadband network covering the entire French department of Hauts-de-Seine, including the non-profitable areas.
October	07	2009	<a href="http://point-topic.com/content/operatorSource/profiles2/france-broadband-overview.htm">http://point-topic.com/content/operatorSource/profiles2/france-broadband-overview.htm</a>	FR	FT	In 2004, other operators could start marketing broadband services without subscription to a traditional phone service in the exchanges they had unbundled. In 2006, naked bitstream was made available to complete full unbundling outside of LLU areas, which allowed alternative carriers to extend their naked DSL offers nationwide.

Source: Information taken from LexisNexis. Note that information could be incomplete due to missing publications in the daily press.

## Regulation and Competition – the "Better" Regulatory Package?

In 2006, the EC started the revision of the Second Regulatory Package based on the second round of market reviews and published its first proposal for adjustments in 2007 for consultations with interested groups. The second proposal was provided in November 2009, turned effective in December 2009 with its publication in the Official Journal of the EU and has to be implemented to national laws by June 2011. The new guidelines mainly rely on the 2002/2003 framework but extend it with a stronger concentration on European-wide integration of telecommunication markets. Therefore, cross-national harmonization of regulation is even more an issue than in the predecessor package.

In this section, I extend the introductory discussion of Section 5 by providing more insights into the issues raised there and continue the consideration to the context of other issues which are not necessarily the central point of consideration of this paper.

The new regulatory package demands transmission service providers to install measures for a minimum level of infrastructure quality for internet services based on existing transmission infrastructure equipment. With regard to consumer rights, the regulatory package requires net neutrality in the sense that higher-quality services must not deter the quality of other services. In line with this issue, consumers have to be informed about the available infrastructure capacity and the "nature of the service to which they are subscribing".<sup>4</sup> In consequence, consumers have to be informed about traffic management systems and any other limitations which also includes the available (not the maximum) transmission speed.

Besides these changes in contents, attention is given to particular issues which left room for discussions and resulted in comprehensive workload for national courts under the Second Regulatory Framework. The revised rules extend single paragraphs of the 2002/2003 articles in more detail and, thus, reduce the decision space of national governments and regulators. In the following, I consider issues which have been discussed in line with the Second Regulatory Package concerning infrastructure investments and access competition and which change in the new package.

### Regulation and the Regulator

Even before the liberalization, NRAs and the EC have cultivated strong interrelationships to exchange information on current issues with the regulatory implementation on the national level. In line with the the Second Regulatory Package, the EC installed the European Regulators Group (ERG), comprising the heads of the (currently) 27 EU NRAs. This body should exchange information on national market developments and consult the EC with the introduction of new regulatory rules. In contrast to the EC's aim of a common regulatory body, the ERG argues for regulatory sovereignty of national regulators to guarantee the proximity to markets. Thus, the ERG constitutes a counterbalance to the top-down regulation approach fostered by the EC.<sup>5</sup>

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<sup>4</sup><http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/09/491&format=HTML&aged=0&language=EN&guiLanguage=en>

<sup>5</sup>Please see also Chapter 2.

The EC criticizes the role of the ERG as being too weak in the sense that it cannot enforce a consistent application of regulatory rules across all EU member states. Moreover, the EC argues that the magnitude of various national approaches hamper market integration.<sup>6</sup> Due to the strong national sovereignty of regulators and their integral role in national bureaucratic systems, the EC suspects the ERG not to fulfil its aims of sufficiently consulting the process of pan-European regulation. In 2007, the EC therefore proposed mainly three options to replace the ERG under the new European regulatory system.<sup>7</sup> The most comprehensive option was the installation of the Single European Regulatory Authority (SERA) as an EU-wide regulator to replace national institutions which has comprehensive decision powers for both national market interventions and also cross-border interventions. A second option was a European regulator with increased decision powers for national implementations of new regulatory rules. However, the role of national regulators would be reduced only weakly. The last option required a better co-ordination of NRAs in the existing framework of the ERG. Due to losing sovereignties in the telecommunication sector, national governments refused all three options. A compromising solution brought forward by the European Parliament in 2009 is the establishment of the BEREC (Body of European Regulators of Electronic Communication).<sup>8</sup> The BEREC is equipped with more complex regulatory powers than the ERG. In particular, it has veto powers which are similar to the EC to overturn NRA decisions if it suspects national decisions to favor companies with SMP.<sup>9</sup> While the ERG was a reporting and consulting unit to the EC, the BEREC takes over a supervisory role for NRAs. Although it cannot directly intervene to stop governmental activities restricting NRA decisions, the BEREC has the powers to intervene a posteriori.

However, concerns are raised in two directions on the role of the BEREC: Firstly, while more comprehensive decision powers are given to this new regulatory body in comparison to its predecessor, it is unclear whether existing habits will be changed as its members are those of the ERG and as these members still underly the bureaucratic regimes in their home countries. As the BEREC, i.e. the heads of NRAs, should control their own national regulatory bodies, it is unclear how members will implement this ambiguous task.

Secondly, following the argumentation of the German Monopolies Commission (2009), the installation of the BEREC results in a Co-Regulation Regime which even enhances the existing complexity of regulation as the BEREC has to agree on new national regulatory measures. Thus, while the primary intention with the BEREC was the installation of a more powerful regulatory body to accelerate the pan-European integration process, the decision process on the BEREC has mitigated its powers and makes the regulatory process even more complex and, thus, more in-transparent.

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<sup>6</sup><http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2007:0699:FIN:EN:PDF>, p. 2

<sup>7</sup>[http://ec.europa.eu/information\\_society/policy/ecomm/doc/library/proposals/ia\\_en.pdf](http://ec.europa.eu/information_society/policy/ecomm/doc/library/proposals/ia_en.pdf), p. 72ff

<sup>8</sup><http://register.consilium.europa.eu/pdf/en/09/st03/st03675-re01.en09.pdf>

<sup>9</sup>A more detailed description of the BEREC implementation process is provided in Broos et al. (2009).

## Market Integration and Fragmentation

Based on the situation before the liberalization with one monopolist providing country-wide telecommunication services, governments chose also a common country-wide regulation approach. However, since the liberalization, different developments across alternative sub-national markets in all EU member states can be observed, as new entrants focussed on specific regions where they started to provide infrastructure and services. Due to the different status of regions both with regard to technological deployment and with regard to competition, governments and operators chose alternative sub-national strategies to provide infrastructure access. Therefore, the new Regulatory Package also proposes a sub-national market regulation approach as access costs differ across regions, in particular in countries with lower population concentration. Several countries, such as the UK or Austria, already employ sub-national measures to (de)regulate bitstream markets (based on a three-markets classification).

Before regulation could be implemented on a sub-national level, transparent rules had to be established which enable a sub-national market definition and which provide a classification of sub-national competition performance. These rules must be defined on the European level as the Third Regulatory Package proposes sub-national market definitions as a preparation for the pan-European integration. The UK chose sub-national regulation on the level of MDFs as competitors enter regional markets on this level. Following von Weizsäcker (2008), the results of alternative tests for market definitions such as the SSNIP test or the question of collective market dominance support this level of market definition.

An issue raised in sub-national regulation debates is inter-regional subsidization. Following the opponents of sub-national market separations, infrastructure providers use higher profits from urban areas for cross-funding investments in less competitive regions. By separating markets on a sub-national level, competition in more densely-populated areas increases as offers will even better meet customers' characteristics, which reduces profits for cross-funding (Heald, 1997). To overcome this challenge, Knieps (2007) proposes the installation of a universal service fund. Taxes on prices in more densely populated areas are used to cross-fund investments in less lucrative markets where investment projects are auctioned.

In a nutshell, the pan-European integration process requires a complex preparation in advance and cannot be implemented in a one-step approach. As discussed in this subsection, sub-national market separation could accelerate the integration process. As urban areas are much more competitive than rural areas and, thus, could be used to refund investments also in less lucrative regions, it remains to be seen how the integration process is affected by the stage of competition in alternative member states and how national sovereignty affects the process of market definition.

## Functional Separation

Functional separation (or operational separation) has been discussed already in line with the Second Regulatory Package (Section 3.3.2). The European Parliament proposes the functional separation of the network unit from the retail and service unit. In contrast to full (ownership) unbundling and legal unbundling, functional separation only requires the separation of units while the vertical organizational structure of a company remains in place. Thus, functional separation should guarantee a non-discriminatory infrastructure access for the integrated company's service unit and for competitors' demanding access (Cave, 2006b; ERG, 2007). Following Article 13a of Directive 2009/140/EC<sup>10</sup>, functional separation complements NRAs' set of instruments and should be implemented if other measures to install competition fail.

However, the EC provides no final definition of functional (i.e. operational) separation and, thus, also provides no information about how to enforce and monitor functional separation and the separated provider. With (perfect) functional separation, the service unit of a vertically integrated operator competes with other operators on the service market, whereas the network operator provides the essential upstream input but does not discriminate between the own unit and competitors either in terms of access prices or in terms of access conditions (Vickers, 1995). Nevertheless, the infrastructure provider has an incentive to affect service competition if this benefits its own unit. With functional separation and even with legal unbundling, a stricter type of separation, a regulator can only partially monitor and intervene on the behavior of the infrastructure operator. While price discrimination could be monitored and enforced under legal unbundling (not under functional separation) (Höfler and Kranz, 2007a; Cremer et al., 2007), non-price discrimination still remains an option for the infrastructure operator (Höfler and Kranz, 2007b; Nikogosian and Veith, 2010).

Following the Special Opinion of the German Monopolies Commission (2009), functional separation could be a valuable instrument at most shortly after the liberalization to foster competition and, therefore, is expectedly no option for governments and NRAs today. Analyses of the Dutch and the Swedish NRAs come to the same result for their national markets after the introduction of functional separation in the UK and in Denmark before 2007. In consequence, functional separation would be an option which affects competition and infrastructure investments if NRAs could monitor and enforce its strict implementation. However, following the examples in various countries and the discussion in the literature, it will not be employed given the current stage of competition, at least in EU-15 telecommunication markets.

The new regulatory framework further promotes the process of pan-European integration by increasing decision powers of pan-European institutions and also by increasing the independence of NRAs on the national level. The installation of the BEREC as a pan-European regulatory body fosters the integration process. However, due to the executive members of the board and their elections by national governments, the impact of this new European regulatory body on the integration process has to be considered with caution.

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<sup>10</sup>Directive 2002/21/EC replaces the former Framework Directive (2002/21/EC).

With regard to the acceleration of the integration process, the EC has proposed to switch from the existing national regulation pattern to sub-national regulation. In doing so, regulation could be reduced or abolished in regions where markets turn to a competitive stage, whereas regulation could be fostered in less competitive markets. Such an approach bears some challenges in advance in particular for larger countries with a lower population concentration. However, from an economic perspective, it enables providers in sub-national markets with higher concentration to negotiate access without further legal obligations, whereas regulators can concentrate on less-competitive markets. To sum up, the Third Regulatory Package takes up major problems in line with its predecessor. While some pitfalls continue to exist, this new framework enables a further key step to competition and efficiency and, in particular, to the pan-European market integration.

#### **A.2.4 Data and Information Collection**

Data and information for the analysis are collected from multiple sources:

- Data on public ownership (Figure 3.1) is taken from the OECD Regulatory Index.
- Information on local loop competition and facility-based competition (Figure A.2) is provided in the OECD Communications Outlook 2009.
- The EC Implementation Reports provide an overview of national regulation as well as the implementation of EU guidelines and the progress of adoption of the EU Regulatory Packages to national laws. Information on national lawmaking in line with the pan-European steps to market integration (Table 3.1) is taken from the yearly Implementation Reports since 1997.
- State aid information is collected from the newspaper retrieving system LexisNexis, which provides information based on a keyword search.



## A.3 Appendix to Chapter 4

### Stationarity and Specification Tests

The graphs in Figure 4.1 let assume non-stationarity of the demand variables and the investment variables. It is therefore necessary to test for non-stationarity of the dependent variables to select an estimation specification which takes up the potential challenge or to adjust the data set. I have employed a panel Dickey Fuller Test, the Multivariate Augmented-Dickey-Fuller Test (MADF test), as described in Taylor and Sarno (1998) and in Sarno and Taylor (1998) and the Levin-Lin (-Chu) test presented in Levin et al. (2002) for considering non-stationarity of the panel as a whole. The MADF test provides evidence for stationarity of all four time series, investments in fix-line infrastructure, investments in mobile infrastructure and demand for fix-line infrastructure and mobile infrastructure. However, following Sarno and Taylor (1998), the MADF test requires all individual time series of the panel to be stationary. Moreover, the MADF test is criticized as it provides adequate test results only for a long panel data set, i.e. the number of periods should comprehensively exceed the number of countries. In contrast, my data set is a short panel as the number of years ( $t = 18$ ) does not comprehensively exceed the number of countries ( $i = 16$ ). Therefore, I have also employed the Levin-Lin test to compare the results with those of the MADF test but find similar results.<sup>11</sup> As both test specifications reject the null hypothesis of no stationarity, I use the data set without further adjustments for the multivariate time-series estimations.

The Arellano-Bond approach performs a linear dynamic panel-data estimation of the difference in the dependent variable on the differences and the levels of the independent and the lagged dependent variables. Following Arellano and Bond (1991) and Blundell and Bond (1998), it is thus necessary that no higher order correlations exist in the panel data set. The Arellano-Bond test for first- and second-order serial correlation in first-difference residuals are displayed in Tables 4.3 and 4.4.<sup>12</sup> While the first-order tests show ambiguous results, the second-order test results provide evidence that the hypotheses of no higher-order first-difference autocorrelation cannot be rejected. The test of the fix-line specifications rejects the hypothesis of no first-order autocorrelation in contrast to the test of the mobile specifications. While the second-order test of no autocorrelation must not be rejected due to the linearity requirement for the estimation specification, Arellano and Bond (1991) explain that the first-order test results are of minor relevance for employing the dynamic panel-data estimator.

Time-series estimations are prone to the consideration of over-identification in particular if an autocorrelated estimation structure is assumed. I employ Hansen's J test for system estimations and find evidence for over-identification in the fix-line infrastructure estimation approach but not in the mobile-infrastructure estimation approach when analyzing cross-infrastructure effects. Over-identification of an endogenous variable means

<sup>11</sup>While the fix-line infrastructure demand has been found to be non-stationary, the logarithm, which I employ in the econometric analysis, is stationary at the ten percent significance level.

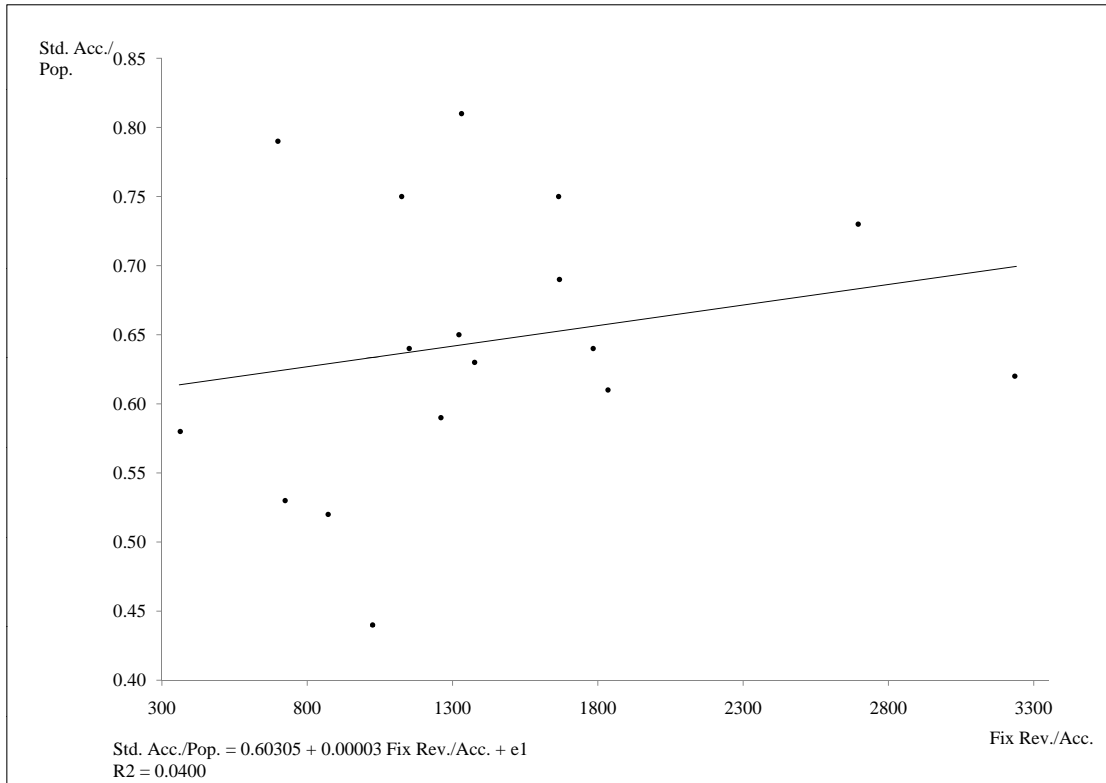
<sup>12</sup>Greece has been excluded from the mobile demand estimations due to strong volatility in the dependent variable.

that its coefficient has no explanatory power as multiple (here two) ways for calculation exist which might lead to alternative values for the instrumented variable. Following Wooldridge (2002) the coefficient of the instrumented variable cannot be interpreted. However, the coefficient product of the instrument and the instrumented variable does not suffer from the reduced-form coefficient calculation. Thus, while direct effects of the instrumented variable cannot be used, indirect effects are unbiased.

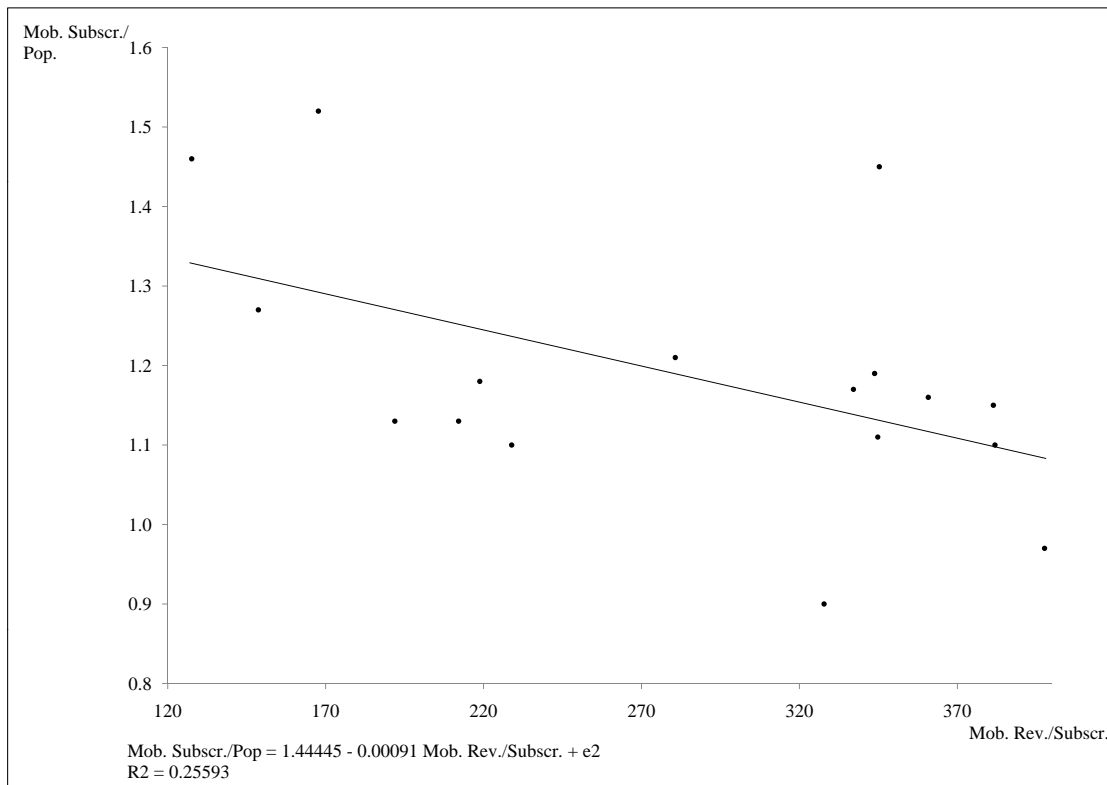
### **Price-Demand Interrelation**

Figure A.3 displays the price-demand interrelation for fix-line and for mobile markets in 2007. While mobile access follows the expected downward slope across the states under scrutiny, a positive interrelation is found for fix-line markets. However, in contrast to the mobile situation, the linear demand-curve of the fix-line graph only weakly explains the price-demand scatter across the countries.

Figure A.3: Price-Demand Relationship in Fix-line and Mobile Markets



(a) Fix-line Access Demand



(b) Mobile Access Demand

Table A.9: Correlation Matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
log(fix inv.)	(1)														
log(mob. inv.)	0.651	(2)													
log(fix acc./pop.)	-0.148	0.072	(3)												
log(mob. subs./pop.)	-0.334	0.491	0.387	(4)											
log(fix acc./pop.) (-1)	-0.150	0.054	0.974	0.365	(5)										
log(mob. subs./pop.) (-1)	-0.324	0.489	0.417	0.991	0.390	(6)									
fix m. sh. entr.	-0.036	0.458	0.404	0.640	0.382	0.666	(7)								
mob. m. sh. entr.	0.106	0.643	0.234	0.681	0.189	0.686	0.586	(8)							
log(fix rev./acc.)	-0.063	0.153	0.447	0.313	0.420	0.336	0.352	0.014	(9)						
log(mob. rev./subs.)	0.228	-0.454	-0.120	-0.803	-0.115	-0.781	-0.364	-0.616	0.071	(10)					
log(gdp/pop.)	-0.334	-0.050	0.723	0.406	0.706	0.429	0.341	0.038	0.710	0.024	(11)				
log(pop.)	0.899	0.753	-0.247	-0.116	-0.266	-0.102	0.091	0.352	-0.162	-0.033	-0.441	(12)			
log(share urban pop.)	0.150	0.084	0.506	0.008	0.497	0.022	0.046	0.040	0.380	0.082	0.445	0.012	(13)		
gov. sh. fix inc.	-0.224	-0.570	0.107	-0.418	0.149	-0.418	-0.319	-0.580	-0.026	0.453	0.161	-0.412	0.047	(14)	
gov. sh. mob. inc.	-0.220	-0.565	0.083	-0.421	0.125	-0.421	-0.331	-0.596	-0.012	0.460	0.148	-0.409	0.026	0.990	(15)
log(long-term interest rate)	0.221	-0.673	-0.496	-0.817	-0.471	-0.809	-0.601	-0.621	-0.585	0.526	-0.614	0.022	-0.163	0.493	0.491

Table A.9 provides an overview of the pairwise correlations of the variables used in the estimations. Correlations are calculated pooled across time and countries.

## A.4 Appendix to Chapter 5

### A.4.1 The Indirect Investment Effect

The own investment effect and the investment externality are the investment effects usually analyzed in the literature. For example Vareda (2007) compares quality-increasing and cost-reducing investments if unbundling is mandatory and if it is not. Valletti and Cambini (2005) analyze investments with two competing networks and show that cost-based regulation reduces the incentive to invest. As in the literature on network investments mainly two competing networks are considered, the indirect investment effect is ignored.<sup>13</sup> An indirect investment effect stems from the investment of one MNP on the traffic between two other MNPs. By reducing its per-unit costs the outgoing traffic from the investor is increased. As termination rates (at least partially) depend on the average incoming calls from all MNPs,  $i$ 's investments affect all competitors' termination rates for incoming calls. With prices depending on termination rates outgoing calls are affected by any provider's investments. In less concentrated markets a lower indirect investment effect should be observed. In contrast, with one large MNP and a number of smaller providers I expect a strong indirect investment effect from the larger one to the others whereas the indirect investment effect should be lower for investments of smaller MNPs.

With termination regulation the indirect investment effect disappears as all forms of price regulation ignore traffic and, thus, the influences from investments.

The profit stemming from  $j$ 's incoming calls from any MNP  $-j \neq i$  is given by  $\sum_{-j \neq i} \pi_{-j,j}^j = (t_j - c_j) s_j \sum_{-j \neq i} s_{-j} (a - b_{-j} p_{-j,j})$ . Although  $i$  is not involved in the interconnection between  $j$  and any competitor  $-j \neq i$ ,  $i$ 's investment in cost-reduction affects  $j$ 's termination rate. The increase in wholesale prices is passed on to  $-j$ 's off-net prices altering  $-j$ 's outgoing traffic. Deriving  $j$ 's wholesale profit with respect to  $k_i$  yields:

$$\begin{aligned}
\frac{\partial \sum_{-j \neq i} \pi_{-j,j}^j}{\partial k_i} &= -c'_i(k_i) \frac{s_i b_i}{4 \sum_{-j \neq i} s_{-j} b_{-j}} s_j \sum_{-j \neq i} s_{-j} \left( a - b_{-j} \left( c_{-j} + \frac{c_j}{2} \right) \right. \\
&\quad \left. + \frac{\sum_{-j} s_{-j} (a - b_{-j} c_{-j})}{4 \sum_{-j} s_{-j} b_{-j}} \right) + c'_i(k_i) (t_j - c_j) s_j \sum_{-j} s_{-j} b_{-j} \frac{s_i b_i}{4 \sum_{-j} s_{-j} b_{-j}} \\
&= -c'_i(k_i) \frac{s_i b_i}{4 \sum_{-j \neq i} s_{-j} b_{-j}} s_j \sum_{-j} s_{-j} \left( (a - b_{-j} c_{-j}) \right. \\
&\quad \left. - b_{-j} \frac{\sum_{-j \neq i} s_{-j} (a - b_{-j} c_{-j})}{\sum_{-j} s_{-j} b_{-j}} \right)
\end{aligned} \tag{A.1}$$

With regard to incoming calls there is a positive effect on the mark-up of termination rates over per-unit costs as termination rates increase due to  $i$ 's investments while termination costs remain unaffected by  $i$ 's investments. Nevertheless, total calling minutes are reduced as competitors' off-net prices increase in  $j$ 's termination rates. Taking a look at the terms in large brackets it is unclear whether the individual demand term exceeds the average or not. With  $c_{-j} = c$  we find for  $b_{-j}$  small, i.e. for calls from smaller providers terminating on network  $j$ , that the expression in brackets is positive.

<sup>13</sup>I discuss this effect only in the theoretical part for reasons of completeness as I cannot single it out with the data set.

To sum up, the effect of  $i$ 's cost-reducing investment on profits from incoming calls from other providers to a provider  $j$  is ambiguous. While the wholesale price effect is positive due to the demand increase from network  $i$ , the total demand effect from the other networks is negative. Thus, without further assumptions on the demand functions no distinct proposition concerning the indirect investment effect could be derived.

## A.4.2 Investment effect on outgoing traffic

Let us first derive the **change in the investor's profits from outgoing traffic due to a change in investments**. Deriving  $\sum_j \pi_{i,j}^i$  with respect to  $k_i$  yields:

$$\frac{\partial \sum_j \pi_{i,j}^i}{\partial k_i} = -c'_i(k_i) \frac{s_i}{2} \sum_j \left( s_j (a - b_i(c_i + t_j)) \left( 1 - \frac{s_i b_i}{2 \sum_{-j} s_{-j} b_{-j}} \right) \right) > 0 \quad (\text{A.2})$$

With  $i \in \{-j\}$  the last term is non-negative. By increasing efficiency, profits from outgoing calls also increase.

For  $s_i$  close to 0 or close to 1 the investment effect on outgoing minutes is smaller which causes an inverted u-shaped relationship for the investment effect depending on the own market share. Both if the investor is comparably small and if the investor is comparably large a lower number of calls originate from the investor's network.

In a nutshell, two effects on the investor's profits exist: As the absolute investment effect on retail prices for outgoing calls is only half the absolute investment effect on origination costs and termination rates the per-unit mark-up for outgoing calls increases. Additionally, by reducing off-net prices, customers are more willing to call customers in competitive networks.

Next I derive the **effect of investments on the competitors' profits from outgoing traffic to the investor**: We know from (5.4) that  $i$ 's investment reduces its termination rate. Furthermore, we know from (5.2) that  $j$ 's off-net retail price for calls to  $i$  is reduced only to half the extent than the reduction in termination rates. Thus, not only  $i$ 's per-unit mark-up for outgoing calls to  $j$  but also  $j$ 's per-unit mark-up for outgoing calls to  $i$  increases as the change in  $i$ 's off-net price is lower than the termination rate change. By reducing off-net prices, the call length for outgoing calls to network  $i$  in total increases raising  $j$ 's profits for outgoing calls to  $i$ :

$$\frac{\partial \pi_{j,i}^j}{\partial k_i} = -\frac{c'_i(k_i)}{2} s_i s_j (a - b_j(c_j + t_i)) > 0 \quad (\text{A.3})$$

Finally, let us derive the **investment effect on profits from outgoing traffic to competitors which are not the investor**.  $j$ 's profits from outgoing calls to any other providers  $-j \neq i$  are given by  $\sum_{-j} \pi_{j,-j}^j = \sum_{-j} (p_j - t_{-j} - c_j) s_j s_{-j} (a - b_j p_{j,-j})$ .

Deriving this sum with respect to  $k_i$  yields:

$$\begin{aligned}
 \frac{\partial \sum_{-j} \pi_{j,-j}^j}{\partial k_i} &= c'_i(k_i) \frac{s_j}{2} \sum_{-j} s_{-j} \frac{s_i b_i}{4 \sum_{-j} s_{-j} b_{-j}} \left( a - b_j c_j - b_j \frac{c_{-j}}{2} \right. \\
 &\quad \left. - b_j \frac{\sum_{-j} s_{-j} (a - b_{-j} c_{-j})}{2 \sum_{-j} s_{-j} b_{-j}} \right) + c'_i(k_i) \frac{s_j}{2} \sum_{-j} s_{-j} \left( a - c_j - \frac{c_{-j}}{2} \right. \\
 &\quad \left. - \frac{\sum_{-j} s_{-j} (a - b_{-j} c_{-j})}{2 \sum_{-j} s_{-j} b_{-j}} \right) b_j \frac{s_i b_i}{4 \sum_{-j} s_{-j} b_{-j}} \\
 &= c'_i(k_i) \frac{s_j}{2} \sum_{-j} s_{-j} \left( a - b_j c_j - b_j \frac{c_{-j}}{2} \right. \\
 &\quad \left. - b_j \frac{\sum_{-j} s_{-j} (a - b_{-j} c_{-j})}{2 \sum_{-j} s_{-j} b_{-j}} \right) \frac{s_i b_i}{4 \sum_{-j} s_{-j} b_{-j}} < 0
 \end{aligned} \tag{A.4}$$

Profits from outgoing calls are reduced as retail prices for outgoing calls to competitors' networks increase in the competitors' termination rates. Additionally, also the per-unit price-cost margin is reduced as the absolute increase in retail prices is lower than the absolute increase in termination rates. Therefore, we find a negative indirect effect of  $i$ 's investments on  $j$ 's profits from outgoing calls.

### A.4.3 Data Selection and Data Adjustments

I employ data from multiple sources including information about the fully vertically integrated MNPs in the EU-15 as well as Norway and Switzerland, data about termination regulation and the termination rates, information about individual transmission technology per provider and data about population concentration.

Financial information and customer information per MNP are taken from the Merrill Lynch European Wireless Matrix 2006 and 2007. Merrill Lynch offers detailed information for each provider including traffic and financial information on a national level on a quarterly basis. From this data set I have selected information on calling minutes, market shares in terms of customers, the total market size and information about investments. As a proxy for investments I use capital expenditures (capex) having in mind that capex also includes investment in assets which are not directly linked to network infrastructure, like buildings. Nevertheless, investments in assets which are not related to physical network infrastructure are expected to be only a minor share of the total capex.

Termination rates are taken from the Ovum database. Ovum provides termination rate information for each MNP. Note that at least for 2001 I have to adjust termination rates due to the introduction of the Euro in most countries of the sample. For most of the MNPs Ovum provides on-peak and off-peak prices and traffic-dependent average termination rates, which I use for the analysis.

Information about the alternative regulation schemes is taken from the Plaut Economics Regulatory Index for the years 2000 until 2006 and complemented for 2007 with data from national regulators' websites. The Plaut index is based on a questionnaire for EU member states. I selected the questions concerning mobile interconnection regulation and transformed the disaggregated values for each country and each year into dummy variables for alternative regulation mechanisms and asymmetric regulation taking into

account country information provided on the regulators' websites. I complemented the information also for Norway and Switzerland since they are not EU member states and, thus, are not covered by the index.

The transmission technology is a main driver of per-unit costs. In Europe mainly two frequency bands are allowed for mobile communication, which are a frequency band around 900 MHz and a frequency band around 1800 MHz. Information about the licenses of each MNP for the two frequency bands is taken from the GSMA website ([www.gsmworld.com](http://www.gsmworld.com)). GSMA is the worldwide association of mobile companies. On the website an overview of licenses for transmission technologies is offered including information about the year of the grant of a license. It is necessary to distinguish between the two frequency bands as the transmission in the higher-frequency band leads to higher transmission costs. This should be reflected in the per-unit costs and, thus, also in the termination rates.

In network-based markets customer concentration is a key driver of costs as in more densely populated areas the infrastructure could be installed at lower costs. With mobile infrastructure two ambiguous effects might exist as country coverage has been one of the key issues from the political perspective. Companies were forced to build up a network infrastructure which not only covers most of the population but also most of the area. On the other hand, in more densely populated areas, where the population coverage is expected to be easier, congestion is an issue. This is the case since communication of more customers in one cell around a transmission tower reduces the speed of transmission, thus, impairing the communication quality. I use data for population concentration from the OECD since standard density measures assume a uniform distribution of the population.

Following the Merrill Lynch report off-net minutes are counted twice. With the standard assumption that traffic is market share-dependent I can set up the following relation between the Merrill Lynch data and the actual values:

$$\widehat{MOU}_i = s_i \sum_j MOU_j + MOU_i \quad (\text{A.5})$$

where  $\widehat{MOU}_i$  are the MOU of MNP  $i$  as given in the Merrill Lynch report and  $MOU_i$  are the unobserved (actual) MOU of MNP  $i$ . Rewriting this term in matrix notation we achieve the following equation:<sup>14</sup>

$$\widehat{\mathbf{MOU}} = (\mathbf{I} + \mathbf{s}\mathbf{1}_{1 \times n} - \mathit{diag}(\mathbf{s}))\mathbf{MOU} \quad (\text{A.6})$$

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<sup>14</sup>How one gets from (A.5) to (A.6) is shown in the next subsection.



where  $\widehat{\mathbf{MOU}}$ ,  $\mathbf{MOU}$  and  $\mathbf{s}$  are  $(n \times 1)$  vectors,  $\mathbf{I}$  is the  $(n \times n)$  identity matrix,  $diag(\mathbf{s})$  is the  $(n \times n)$  diagonal matrix of  $\mathbf{s}$  and  $\mathbf{1}_{1 \times n}$  is a ones-vector. With  $s_i \leq 1$  for each element in  $\mathbf{s}$  the term in brackets is positive definite. Rearranging terms yields:

$$\mathbf{MOU} = (\mathbf{I} + \mathbf{s}\mathbf{1}_{1 \times n} - diag(\mathbf{s}))^{-1}\widehat{\mathbf{MOU}} \quad (\text{A.7})$$

$\mathbf{MOU}$  is the vector of the adjusted MOU for all MNPs in country  $l$  at time  $z$ . Note that data for smaller firms are at least partially based on Merrill Lynch estimations. Thus, it might be the case that dependent on the estimation data for smaller MNPs a lower statistical variance exists over time or also cross-sectional dependent on the estimation methodology used for getting information about these MNPs.

#### A.4.4 Calculation of actual MOU

The relation between the given MOU of MNP  $i$  and the actual MOU is as follows:

$$\widehat{MOU}_i = s_i \sum_j MOU_j + MOU_i \quad (\text{A.8})$$

For any MNP  $i$  the MOU in the Merrill Lynch European Wireless Matrix are its actual MOU plus the incoming MOU from all other providers. Thus, for all providers the relationship is the following:

$$\begin{aligned} \widehat{MOU}_1 &= 1 \quad MOU_1 + s_1 \quad MOU_2 + s_1 \quad MOU_3 + \dots \\ \widehat{MOU}_2 &= s_2 \quad MOU_1 + 1 \quad MOU_2 + s_2 \quad MOU_3 + \dots \\ \widehat{MOU}_3 &= s_3 \quad MOU_1 + s_3 \quad MOU_2 + 1 \quad MOU_3 + \dots \end{aligned} \quad (\text{A.9})$$

Rewriting this equation system in matrix notation gives:

$$\begin{aligned} \widehat{\mathbf{MOU}} &= \mathbf{s}_{mat}\mathbf{MOU} \\ \begin{pmatrix} \widehat{MOU}_1 \\ \widehat{MOU}_2 \\ \widehat{MOU}_3 \\ \dots \end{pmatrix} &= \begin{pmatrix} 1 & s_1 & s_1 & \dots \\ s_2 & 1 & s_2 & \dots \\ s_3 & s_3 & 1 & \dots \\ \dots & & & \dots \end{pmatrix} \begin{pmatrix} MOU_1 \\ MOU_2 \\ MOU_3 \\ \dots \end{pmatrix} \end{aligned} \quad (\text{A.10})$$

Rearranging  $\mathbf{s}_{mat}$  yields:

$$\begin{aligned}
 \mathbf{s}_{mat} &= \begin{pmatrix} 1 & s_1 & s_1 & \dots \\ s_2 & 1 & s_2 & \dots \\ s_3 & s_3 & 1 & \dots \\ \dots & & & \dots \end{pmatrix} \\
 &= \begin{pmatrix} s_1 \\ s_2 \\ s_3 \\ \dots \end{pmatrix} (1; 1; 1; \dots) + \begin{pmatrix} 1 & 0 & 0 & \dots \\ 0 & 1 & 0 & \dots \\ 0 & 0 & 1 & \dots \\ \dots & & & \dots \end{pmatrix} - \begin{pmatrix} s_1 & 0 & 0 & \dots \\ 0 & s_2 & 0 & \dots \\ 0 & 0 & s_3 & \dots \\ \dots & & & \dots \end{pmatrix} \quad (\text{A.11}) \\
 &= \mathbf{s}\mathbf{1}_{1 \times n} + \mathbf{I} - \mathit{diag}(\mathbf{s})
 \end{aligned}$$