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Capital Structure and Investment in Regulated Network Utilities: Evidence from EU Telecoms[1]

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Abstract

This paper analyses the relationship between firm financial and investment decisions and regulatory outcomes in network industries, where regulatory opportunism is often viewed to lead to underinvestment. We develop a model to describe the effect of an increase in leverage on regulated rates, retail as well as *wholesale*, and company investment. We then test the model's predictions using a panel of 15 EU Public Telecommunication Operators (PTOs) over the period 1994-2005. Our results show that the data cannot reject the model's predictions that leverage positively affects regulated wholesale and retail rates, as well as the PTOs' investment rate. Moreover, since leverage does affect wholesale charges that alternative operators pay to access to the incumbent's network infrastructure, we also find that an increase in leverage is followed by a decrease in the number of competitors and by an increase of the incumbent's market share. This suggests that the use of debt to discipline the regulator's lack of commitment within a vertically integrated network industry may somewhat impair or delay retail market competition, but has a favorable counterpart in mitigating the underinvestment problem.

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1. Introduction

Infrastructure investments are crucial in network industries because of their influence on prices and quantities in the long run, and because their delay generates enormous welfare costs.[1] Regulation deeply affects firms' investment decisions, especially when pro-competitive regulatory regimes are introduced.[2] An instrument that regulators of vertically related utilities adopt to enhance competition in potentially competitive segments of public utility markets is the obligation to provide access to existing infrastructures - typically the network operated and maintained by the incumbent firm - to alternative operators at fair and non-discriminatory conditions. Access (or wholesale) regulation thus plays a fundamental role in vertically integrated markets, where the network is the essential facility for the provision of final services and network access is vital to encourage and sustain entry in the competitive segment of the market.

Modern telecommunications are an interesting case to study because investment in new communication infrastructures calls for a large amount of capital expenditures, attracting regulatory concerns on third party access to networks. In addition, such an infrastructure investment is also acknowledged as a significant contributor to economic growth.[3]

Since the liberalization of the telecom market, the debate on infrastructure investment has focused on the access of alternative operators to the existing network, as the key feature of the regulatory framework.[4] We depart from existing studies because we introduce the capital structure decisions of the regulated incumbents in the interplay between access regulation and investment. Indeed, investment expenditures are affected not only by the regulatory framework, but also by firms' financial stability. When the financial position of a regulated firm deteriorates, financial distress compromises the financeability of investments, as managers become concerned with solvency rather than with infrastructure expansion. Recently, a joint study of the UK Department of Trade and Industry and the HM Treasury (DTI-HM, 2004) has expressed serious concern about the

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[1] See Hausman (1997), Kessides (2004) and Guthrie (2006).

[2] See, for example, Alesina et al. (2005) who find that deregulatory reforms of product markets, and particularly entry liberalization, have a positive effect on investment.

[3] We refer here to the so called *Next Generation Networks* (NGNs) that will allow new ICT services to be delivered in bundle with voice services and broadband connection, and will require massive sunk investments in optical fibre connections. These investments are supposed to significantly contribute to the economic growth. Röller and Waverman (2001), using data from 21 OECD countries over a 20-year period, show that an increase of 10% in the broadband adoption rate leads on average to an increase of 2.8% of GDP growth. Koutroumpis (2009) shows that, for the EU-15 countries from 2002 to 2007, the average impact of broadband infrastructure on GDP is 0.63%, i.e. 16.92% of total growth. Greenstein and McDevitt (2009) show that broadband accounted for $28 billion of US GDP in 2006, and they estimate that $20 to $22 billion was associated with household use.

[4] For example, among the others, Waverman *et al.* (2007) and Grajek and Röller (2009) find that wholesale rates regulation discourages infrastructure investment by both incumbents and entrants in fixed-line telecommunications. For a recent survey on the relationship between regulation and investment in telecoms, see Cambini and Jiang (2009).

"dash for debt" or "flight of equity" of UK utilities, including telecom incumbent British Telecom.[5] This paper analyses the relationships between firms' financial and investment decisions and regulatory outcomes for a panel of 15 EU Public Telecommunication Operators (PTOs) from 1994 to 2005.

The financial exposition of Public Telecommunication Operators (PTOs) has increased to levels never seen in the last decades, and has become the hot issue in the industry. At the end of 2005, the *Financial Times* wrote: "the telecommunications sector is in a particularly precarious position, with a number of companies facing the threat of being downgraded to junk status. In this sector, 50 per cent of the companies have negative outlooks or are on credit watch with negative implications"[6]. After 2005, this situation became even worse: at the end of 2008, the net debt position of Deutsche Telekom totaled 41 billion of euros, France Telecom 36 billion of euros, Telecom Italia 34 billion of euros, British Telecom 11 billions and, at the top, Telefonica de Espana reported 45 billion of euros. In addition, new bonds for 45 billion of euros are going to be issued in 2010-2011 to finance European telecoms operators' investments. Such anecdotal evidence suggests that, following telecom markets' reforms, the incumbents have mostly relied on debt capital to pursue their growth strategies. Our paper attempts to throw some light on the reason why these firms increased financial leverage to the point of raising policy-makers' concern and, more specifically, on the potential interference of such debt levels with regulatory decisions.

The relevance of firm's capital structure decisions in regulator's price setting outcomes derives from the need to ensure regulated firms a "fair rate of return" on their investments. This fair rate of return depends, among other things, on the firm's cost of capital, which in turn depends on the firm's capital structure. Therefore regulated firms can affect their prices by appropriately choosing their capital structure.

There are two conflicting views on the link between capital structure and regulated prices. The first view stems from the observation that in practice, regulators both in the EU and the US often use the firm's weighted average cost of capital (WACC) in computing the firm's cost of capital which regulated price is designed to cover. Taggart (1981) shows that as long the allowed return to equity exceeds the after-tax imbedded cost of debt, the regulated firm can induce price increases by substituting equity for debt. The positive effect of equity on regulated price would in turn generate a strong incentive for regulated firms to prefer equity to debt financing.

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[5] In the same vein, the Italian Corte Dei Conti (National Audit Office) in February 2010 voiced a similar opinion: "Privatized firms strategically increase the risk of insolvency in order to obtain higher tariffs to finance investments. The regulated firm uses leverage as a commitment device vis-à-vis the regulator to maintain a high level of profitability", (p. 195; the entire document can be found at the link: http://www.cnim.it/cnimnm/articlefiles/407-Privatizzazioni%20definitivo%20-%20relazione.pdf).
[6] Cited in "European company debt at five-year high", by D. Oakley, *The Financial Times*, November 3rd, 2006.

Alternatively, when regulators cannot commit not to review ex post the regulated rates, theoretical models by Spiegel and Spulber (1994) and Spiegel (1994) identify debt financing as a strategic mechanism that affects the regulator – regulated firm interaction. Regulators' lack of commitment is a typical feature of utility industries, which often leads to underinvestment (Besanko and Spulber, 1992). In this setting, if regulators start worrying about the financial stability of the incumbent operator, they may become more cautious to reduce ex post regulated rates as firm's financial debt increases; high leverage may thus shield the firm against the regulator's opportunistic behavior. The choice of the capital structure is thus viewed as an instrument that can be used to discipline the time inconsistency of regulatory interventions and to solve the underinvestment problem originating from regulatory opportunism. Empirical evidence on the strategic use of debt is provided by Bortolotti, Cambini, Rondi and Spiegel (2011, BCRS hereafter) who show, for a large panel of EU utilities, that higher leverage leads to higher retail price, whenever the regulated firm is subject to an independent regulator and privately controlled.

In this paper, we analyze the strategic use of leverage and its impact on regulated rates, retail as well as *wholesale*, and company investment. We first present a simple theoretical framework that combines Spiegel (1994)'s model of capital structure choice in a regulated environment with Laffont and Tirole (1994)'s model of social optimal choice of wholesale rates in a vertically related industry. We thus derive theoretical predictions to analyze the impact of the incumbent's capital structure on both retail and wholesale rates, on the degree of competition in the retail segment and, finally, on the PTO's investment. We then move to the econometric analysis, testing, on a panel of 15 European PTOs from 1994 to 2005, whether the data support the model's theoretical predictions or alternative explanations for the role of capital structure of regulated firms. The sample is not large, but includes the EU member states that, starting from the mid Nineties, first experienced market reforms in the telecoms industry, such as the establishment of Independent Regulatory Agencies, the gradual liberalization of some market segments, vertical (accounting and legal) separation and access rate regulation. The starting point of the empirical analysis investigates whether key features of the regulatory environment - the intensity of regulation and market entry conditions - affect either the capital structure or the fixed capital investment of the incumbent PTOs' while also controlling for regulatory climate, as proxied by government's political orientation. We then proceed with the econometric tests of the model's predictions. First, we test the relationships between financial leverage and wholesale and retail regulated charges. Second, we focus on market structure. Since the incumbent operator is vertically integrated, the access charge affects the alternative operators' marginal cost for the provision of retail services, but not the marginal cost of incumbent firm. Should leverage influence the regulated access charge, competition in the retail segment would also be affected. We thus investigate the relationship between firm leverage and the number of competitors in the retail segment and, alternatively, the incumbent's market share in the retail market. Thirdly, we investigate the interaction between debt and investment of fixed telecoms operators. We deal with endogeneity problems by applying the GMM estimator when dynamic models are estimated, and by using lags of internal right-hand variables as well as institutional, regulatory and political variables as instruments.

The econometric results show that the model's predictions cannot be not rejected by our data, i.e. that an increase in leverage positively affects regulated rates, both at the retail and at the wholesale level. We then find that increases in leverage have a negative impact on competition, but a positive effect on the PTOs' investment rate. When we estimate the long run effects of a leverage increase on retail and wholesale prices as well as on company investments we find that they are quantitatively large. Our interpretation of these results is that within a vertically integrated network industry, the strategic use of debt to discipline the regulator's lack of commitment may somewhat impair or delay competition in the retail segment, but has a favorable counterpart in mitigating the underinvestment problem.

The structure of the paper is the following. In section 2 we present the theoretical framework and the testable predictions, which we derive in the model described in the technical appendix. In section 3, we explain the institutional background for the EU-15 telecommunication industry and the changing pattern of market competition and of interconnection rates in European countries. In section 4 we describe the dataset and the firm level variables. In section 5 we present the econometric results. Section 6 summarizes the main results and concludes.

2. Theoretical framework and empirical predictions

Primary goals of regulation are to promote competition and to enhance social welfare (Armstrong and Sappington, 2006). A major drawback, however, is the conflict between social and private interests that arises whenever pro-competitive and efficiency enhancing regulatory regimes may undermine the firm's incentives to invest and maintain the infrastructure.[7] This tension is typical of the telecom industry where adequate provision of the service requires large amounts of investment that is both irreversible and risky, and uncertainty in the regulatory framework can further deprive utilities' incentives to invest.

[7] In their book, Laffont and Tirole (2000, p. 7) note that: "*There is in general a trade-off between promoting competition to increase social welfare once the infrastructure is in place and encouraging ex ante the incumbent to invest and maintain the infrastructure*".

When regulators cannot commit to long-term regulated prices, they may have an incentive to behave opportunistically, i.e. to cut prices once the firm's investments are sunk, in order to benefit consumers at the expenses of the firm's owners. Economic literature has analysed the time-inconsistency problem in regulation, i.e. the so- called *hold-up* problem (Besanko and Spulber, 1992). One strand of this literature has introduced the capital structure decision as a potentially useful instrument to limit regulatory opportunism (Spiegel and Spulber, 1994, Spiegel 1994).[8] By allowing the firm to become highly leveraged and exposed to financial distress, the regulator will discipline the lack of commitment problem, tying his/her own hands not to reduce the regulated rates *ex-post*, thus re-establishing the firm's incentives to invest. Therefore, debt financing may lead to higher regulated prices while at the same time encouraging regulated firms to increase their investment outlays. Following these predictions, BCRS (2011) investigate the relationship between capital structure and regulated retail prices for a large panel of EU utilities in energy, telecommunication, transport and water industries from 1994 and 2005. They find that i) EU utilities tend to increase their leverage following the introduction of an Independent Regulatory Authority (IRA), provided they are privately-controlled, and ii) higher leverage leads to higher regulated rates, i.e. leverage Granger-causes regulated prices when firms are privately controlled and regulated by an IRA.

The market structure of telecom industry in many European countries is characterised by an upstream monopolistic network segment and a downstream retail segment where a dominant incumbent (in our example, the PTO) competes with alternative operators. This feature introduces an interesting twist in the strategic interaction between the regulator and the regulated incumbent firm, because the regulator may choose whether to "tie his own hands" with respect to the access price or with respect to the retail charge, or with respect to both. In this paper, we thus build on existing research, but adding two contributions. First, we extend the analysis to the vertical structure of many integrated utilities, typical of the telecommunications industry, and to regulatory interventions on wholesale – i.e. access – rates. To our knowledge, this is the first paper that analyzes and empirically tests the relationship between financing decisions and regulated wholesale charges.[9] Second, we analyse the relationship between capital structure and investment decisions,

[8] The use of debt as a commitment device was first examined, in an oligopoly setting, by Brander and Lewis (1986).

[9] The IO literature has long analyzed the reasons and the economic conditions of ex ante intervention in granting access to an essential facility managed by the PTOs. Most of the literature on access regulation focuses on the definition of optimal price mechanism where asymmetric information is the most serious problem vexing the regulator-PTO relationship (Laffont and Tirole, 2000; Armstrong, 2002; Vogelsang, 2003, among others). Other papers study the impact of retail market deregulation and incumbent's vertical structure (integration vs. separation) on regulated access charges (Colombo and Rossini, 1997; Spulber and Sidak, 1997). We did not find papers that analyze the impact of capital structure decisions on the wholesale rates setting process.

testing the prediction implicit in Spiegel and Spulber (1994) that higher leverage leads to higher investment.

Whether the regulator responds to the incumbent's precarious financial position by adjusting the access or the retail charge, or both, will also have a consequence for competition in the downstream segment and, in turn, for the incumbent's investment incentives. In order to derive testable predictions in this complex framework, we develop a stylized model, reported in the Appendix, that combines the Spiegel (1994)'s model of capital structure choice in a regulated environment with the Laffont and Tirole (1994)'s model that studies the optimal social choice of wholesale rate in a vertically related industry. The model considers a vertically integrated firm operating both in the upstream and downstream segment of an industry. In the upstream market, the firm runs a network whose access represents the essential input for the provision of retail services. In the downstream market, the incumbent operator competes with a fringe of alternative operators. Moreover, the alternative operators need access to the existing network to provide the final service. The access charge is therefore subject to regulation by a benevolent regulator, who is not able to ex ante fully commit to his price setting decisions. Following Spulber (1989), the access charge is set by using a bargaining process between the firm, which is interested in maximizing its profit, and the regulator, who is interested in maximizing consumers' surplus. The model provides the following results: as far as the regulated charges are concerned, the higher is the debt issued by the firm, the higher is the regulated access charge set by the regulator and, in turn, the higher is the regulated retail price. This leads to our first testable Hypothesis:

Hypothesis 1: *The regulated wholesale charges and retail prices both increase with the firm's debt.*

If the level of debt positively affects the wholesale rate, then it will also affect the quantity sold by alternative operators in the downstream segment, since their marginal cost for providing the final service will also increase. On the contrary, the vertically integrated incumbent operator will only pay the true marginal cost of the service, which is likely to be lower than the marginal cost faced by the alternative operators whenever the regulated access charge is not entirely "cost oriented" and firms are equally efficient in the downstream segment. Then, the incumbent could rely on debt not only to influence the regulator's price setting decision, but also to put the rivals at disadvantage. We thus have the second testable Hypothesis:

Hypothesis 2: *Market competition in the retail segment becomes weaker as the regulated firm issues more debt.*

The reason why regulators allow the regulated charges to increase with debt is to tie their own hands and reduce their own ex post opportunism. Insofar as debt can shield the incumbent from ex post opportunism by the regulator, debt will enhance ex ante investment incentives and reduce the underinvestment problem. As argued by Spiegel and Spulber (1994, p. 436)[10], debt influences investment because "*the regulator will permit firms to take on debt only if debt increases the firm's ex ante investment level*". This leads us to the third testable Hypothesis:

Hypothesis 3: *The higher the debt issued by the regulated firm, the higher the firm's investment rate.*

Finally, the quality and the intensity of the regulatory environment as well as the social welfare objectives in the government's agenda may also affect the action and the stance of the regulator – i.e. whether pro-firm or pro-consumers, pursuing static or dynamic efficiency, etc. As recently emphasized by the literature (Levy and Spiller, 1994; Edwards and Waverman, 2006), the degree of regulatory independence (either from the government in charge or from the regulated firm/incumbent) enhances the commitment powers of regulators and reduces the uncertainty of regulatory interventions, thus playing a key role in utilities' investment decisions even though excess intensity of regulation might negatively affect investment (Grajek and Röller, 2009). Finally, the relationship between regulators and politicians can be especially important in European countries, where regulators are appointed by governments and not elected by citizens (Henisz and Zelner, 2001; Henisz, 2002). Even if the regulator is formally independent from politicians, in fact, the political orientation of the elected government may influence not only the regulator's activity (and make it more or less pro-firm or pro-consumers), but also the regulated firm's investment and financing decisions (for example stock markets typically react differently to right or left-wing governments). Since we recognize the importance of the regulatory and political environment, we will also consider their impact in the empirical analysis.

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[10] More precisely, in Spiegel and Spulber (1994)'s model, like in our simplified framework, the choice of optimal investment and capital structure is simultaneous. Then, it should not be possible to derive a one-way causal relationship between debt and investment. However, their model shows that debt is an instrument the regulated firm could use to shield itself against the regulator ex post opportunism. Therefore, our prior is that as long as debt increases, the regulator behaves less opportunistically and the firm, anticipating this, invests more. Obviously, if our hypothesis is not correct, and so debt and investment are mutually determined, then we would empirically find either no relationship between the two, or that debt causes investment and viceversa, hence a simultaneous relationship.

3 The telecommunication industry in the EU

3.1 Institutional background and legislative framework

In the last twenty years, rapid evolution of telecommunication technology and fast growing demand for telecom services have led to intense changes in both market structure and regulatory framework. Many European countries, following the earlier UK experience, have liberalised the domestic market and privatised public telecommunications operators.[11] Retail markets are now liberalized while public telecom operators are controlled by private investors and regulated by an Independent Regulatory Authority in most countries. Many incumbent operators reacted to market reforms by expanding in both horizontally and vertically related markets, investing in fixed broadband networks and acquiring expensive spectrum rights for mobile services. The PTOs also pursued corporate growth strategies through mergers and acquisitions that were largely financed through debt.[12]

From the start, a key concern of the newly established IRAs was that the design of the regulatory framework could guarantee potential entrants both access to and interconnection with the network, since this crucial asset used to belong (and still does) to the incumbent fixed telecommunication operators. Since 1998, many telecom services have been liberalized and deregulated, the most prominent example being the retail services.[13] In 2003, telecom services for specific traffic directions - mainly international calls – and specific client categories – mainly business users – were also gradually deregulated. However, at the end of 2005, price regulation of voice services for household users (through price caps or other forms of tariff approval) was still in place in many EU countries[14] and PTOs were (and still are) under tight regulatory obligations on wholesale services. In December 2007, the European Commission revised the regulatory framework

[11] The regulatory framework has changed over time following the technological and competitive evolution of the industry. Formally, liberalization in the telecommunications market kicked off in the late '80s, with the Green Paper for the Development of the Common Market for telecommunication services and equipment (1987). In the early '90s the EC issued a number of Directives dealing with the telecoms sector. But the fundamental piece of EC legislation for TLC is Directive 96/19, the so-called *Full Competition Directive*, which opened up the market for voice telephony starting from January 1st, 1998 and ruled that every member state should have an Independent Regulatory Authorities for telecommunications industry.

[12] For example, Telefonica de Espana, acquired the fixed operator Cesky in the Cech Republic and the British mobile operator O2 from British Telecom, for a total amount of approximately 26 billion €, at the same time when it started investing in new broadband (DSL) connections. In 2000, France Télécom acquired the German mobile operator Orange for 46 billion €. In Italy and Germany, Telecom Italia and Deutsche Telekom began to deploy high-speed connections and merged, each, with their mobile subsidiary (TIM and T-Mobile, respectively). In 1999, the Swedish operator Telia merged with the Norwegian one, Telenor and, in 2002, with the Finnish incumbent, Sonera.

[13] Due to these developments, in 2002 the EU Commission issued four Directives (the *Framework*, the *Authorization*, the *Access* and the *Universal Service Obligation* Directive2002/19-22/EC) which set up a new regulatory framework and introduced a new approach relying on "ex post" rather than "ex ante" intervention especially at retail level (Buigues and Rey, 2004).

[14] In 2006, Denmark, Finland and UK, fully deregulated retail charges while in Italy, France and Spain, price caps became gradually less tight. For detailed information, see the OECD report (2006) and Table 10 therein.

in order to limit *ex ante* intervention at the retail level, and to focus, instead, on access and interconnection services (Recommendation 2007/879/EC). At present, access and interconnection issues are the bulk of regulatory intervention in the telecoms industry.

3.2 Market evolution and interconnection rates in Europe

European Commission's reports on the *Implementation of European Electronic Communication Regulatory Framework* (EC, 1998 – 2006) provide useful information about the degree and type of competition faced by European incumbent operators in the time span we are considering. By the end of 2005, only 7 countries have more than four relevant competing operators, i.e. "alternative operators that together with the incumbent, control a combined market share of 90%" as defined by the EC reports, and the average market share (in terms of revenues) of incumbent operators in EU-15 is 77% in the national segment. Moreover, alternative operators tend to concentrate their business on specific segments of the market, such as business users, or to restrict their activity to specific services (long distance calls – national and international) or geographic areas, thus carrying just a limited impact on the total national market. Therefore, competition is largely asymmetric and incumbents still dominates the retail voice telephony market that represents the relevant product market in the telecom industry within the period 1994-2005.

Operators compete on retail *services* rather than on *alternative infrastructures* (EC, 2006; figure 19): at the end of 2005, direct access to alternative providers was used only by 7.7% of EU15 subscribers. Alternative proprietary infrastructures are very limited and direct access is primarily due to the so called *local loop unbundling* (LLU), which forces alternative operators to spend large (and sunk) amounts of money to install their equipment at local exchanges (owned by the incumbent), and to rent only the very *last mile* (the loop) from the incumbent. By the end of 2005, only the 8% of total lines were unbundled in Germany, 5% in Italy, and 2% in France (COCOM, 2006) and even more recently LLU is still limitedly used in most EU countries, confirming its complex application (EC, 2007; COCOM, 2007). Therefore, in the 1998-2005 period, telecom companies still compete over the provision of *services* rather than on duplication of alternative facilities, and alternative operators rely on access to the incumbent's network at various levels of the multi-layered network structure.[15]

[15] Alternative operators can route users to their network either through a carrier selection system (CS), i.e. user dials a prefix on a call-by-call basis, or by carrier pre-selection (CPS), where the user's calls are routed to the new entrants' network on an automatic basis. These are mainly non-infrastructured modes of entry and they were highly used by alternative operators in all Europe. For example, at the end of 2005, CPS was used in Italy by 100% of alternative operators, 92% in UK, 67% in France, 87% in Belgium and 40% in Germany (EC, 2006). In recent years, many alternative operators have shifted towards more infrastructured modes of entry and CPS and CS lost their importance.

From the beginning of the liberalization process, National Regulatory Authorities (NRAs) have two major concerns: to efficiently regulate access rates so as to avoid any potential advantage for the vertically integrated incumbent operator and to level the playing field among competitors. In addition, the EU Commission requires that interconnection rates be "cost orientated" in order "to encourage efficient entry and a rapid development of an open and competitive market" (Directive 97/33/EC, art. 7). Alternative operators wishing to provide retail voice services – still the relevant market in the period 1994-2005 - may accede to the incumbent's fixed network through different wholesale services, like *local access* and *single tandem interconnection*. The choice among interconnection modes depends on the portion of network the entrants want to use. *Local access* is needed when the entrant uses its own infrastructure to reach the local exchange nearest the party being called; the alternative operator thus rents only a limited fraction (the core distribution network) of the incumbent's network and creates its own network for transporting calls all over the country. If instead the entrant has not invested in proprietary infrastructure, a larger fraction of the incumbent's network must be rented. In this case, *single tandem interconnection* is used to terminate calls anywhere in a metropolitan area. Single tandem interconnection was, at least up to 2007, the most widely used entry method in Europe and single tandem rates may be, accordingly, viewed as the reference interconnection rates for most European countries (see ERG, 2007).[16] Overall, revenues from sales of these wholesale services are very high in the period we consider, covering approximately from 20% to 25% of PTO's total revenues.[17]

4. The data

Our dataset comprises firm level variables for 15 publicly traded Public Telecommunication Operators (PTOs) from 14 EU countries that earlier introduced market reforms in the telecom industry thus enabling us to conduct our econometric tests on the period from 1994 to 2005 (firms are listed in the Appendix A.3). We construct our dataset by merging accounting and financial firm level data from *Worldscope* with industry and country level variables from various sources: wholesale charges from the European Commission (DG XIII, Telecommunications Regulatory

[16] *Double tandem interconnection,* the third level of access to the existing network, allows alternative operators that only have a single point of interconnection, to enter the incumbent's network and terminate their calls anywhere in the network. This access mode is for alternative operators that have not invested in any proprietary infrastructure, and was mainly used at the beginning of the liberalization process. *Double tandem interconnection* lost its relevance as market competition increased, so we focus on the mostly used access services. *Local loop unbundling* is an access method recently introduced to provide Internet access.

[17] The importance of wholesale services in terms of traffic is even higher: in Italy, for example, we observe an average of 180 billions of national calls' minutes per year in the period 1998-2005, and approximately 80 billions of wholesale minutes of traffic.

Package); retail price indexes from Eurostat and fixed investment price deflators from OECD; the extent of regulation of market entry from the OECD International Regulation database (Conway and Nicoletti, 2006); and the intensity of specific market regulation from Plaut Economics (Zenhausern, Telser, Vaterlaus, Mahler, 2007).

The theoretical implications of the model focus on three variables, regulated prices, financial indebtedness, and fixed investment. Retail prices at the individual firm level are not available, therefore we use price indexes, which cover both the change in traffic (*usage*) charges for local, national and international calls and the change in monthly fixed fees. Because in the newly liberalized market regulators had to enforce "tariff rebalancing",[18] the different components of the typical "telecom bill" followed opposite trends: fixed monthly fees increased over time while usage charges decreased. As for wholesale charges, we use the access rates on the incumbent's fixed network for *local* level and for *single* transit in € cents per minute (see Section 3.2). Technological change and fast-growing productivity of telecom operators have influenced both retail and wholesale rates through the (price and network) cap mechanism.[19]

To define indebtedness we consider measures that capture the risk of the default. Our preferred variable is therefore the textbook definition of *leverage*, i.e. the book value of financial debt (both long- and short-term) divided by the sum of the book value of debt and the book value of equity.[20] Alternatively, we also construct the total financial debt to total assets ratio (*debt-to-assets*) and the total financial debt to sales, which we use for robustness checks. The investment rate is the ratio of gross fixed investment to capital stock at the replacement value.[21] Investments include changes in the capital stock due to capital expenditures in infrastructures and equipment as well as

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[18] Before the telecom market was liberalised and PTOs were privatised, operators and regulators used to set prices for connection as low as possible. Prices for other services, such as national and international calls, were kept high in order to subsidize low connection fees. This form of cross-subsidization was no longer sustainable in a liberalised market and many regulators started "rebalancing the telecoms bill", i.e. revising each single tariff component (both usage charges and the fixed fee). Typically, the purpose of this regulatory intervention is to ensure that the price for each service reflects the underlying cost of providing that service. For a general description, see Crandall and Waverman (1996).

[19] In the working paper version of this paper (Cambini and Rondi, 2009) we calculated both the Labour Productivity index and the Total Factor Productivity Index in order to estimate efficiency increases over the period 1994-2005. We found that on average labour productivity increased by 11.2% (standard deviation=0.40) and TFP increased by 9.1% (0.12).

[20] We also constructed the Market Leverage i.e. the ratio between the book value of financial debt (both long- and short-term) and the sum of the book value of debt and the market value of equity. However we opted for the book leverage because we would lose about 20% of the observations due to missing data for market capitalization. See Rajan and Zingales (1995) for a discussion of alternative leverage measures.

[21] The accounting data from *Worldscope* only include historic cost valuations of fixed assets, which usually bear little relation to current replacement cost of long-lived fixed capital assets. Hence, we calculate the replacement cost of the capital stock using the perpetual inventory formula: $p_{t+1}K_{t+1} = p_tK_t(1-\delta)(p_{t+1}/p_t) + p_{t+1}I_{t+1}$, where p_t is the country-specific implicit price deflator for gross capital formation in period t sourced by the OECD, K_t is the fixed capital stock in period t, I_t is the investment flow in period t, and δ is the depreciation rate. For the depreciation rates, applied a constant rate of 8% for telecommunications, as derived from Bureau of Economic Analysis estimates reported in "Rates of Depreciation, Service Lives, Declining Balance Rates, and Hulten-Wykoff Categories".

new capital goods by acquisitions, or divestitures. Figure 1 shows the ascending trend of the average financial leverage from 1994 to 2005 while Figure 2 reports the average investment rates. The pattern is very irregular from 1995 to 1999, collapsing in 1996 and 1997 just before the EU directives on liberalization were issued. Investment rates then increase more smoothly from 1999 to 2003 and again decrease in 2004.

Our dataset also includes country and industry specific variables to cover institutional features of the regulatory and political environment.

The *Plaut Economics* "*Regulatory Intensity Index*" for the telecommunication industry (Zenhausern *et al.* 2007) measures, for each country, to what extent industry characteristics and firms' operations are subject to regulation as well as the toughness of regulation. It accounts for features that may be relevant for investment incentives, such as market entry, density and enforcement of price and quantity regulation. It ranges from 0 (low intensity) to 1 (high intensity) and it varies over time.

The *OECD index of Market Entry* (Conway and Nicoletti, 2006) is the country-specific sub-indicator of the OECD Product Market Regulation Database that covers the legal and economics terms and conditions of third party access – hence potential competition- into the fixed telecommunication industry. The index varies from 0 (most) to 6 (least liberalized) as well as over time and is an index of the degree of market openness and liberalization rather than an index of the quality or scope of regulation.

The *Political orientation index* (see Bortolotti and Faccio, 2009) measures the political orientation of the executive in charge, from extreme leftwing (when it takes the value of 0) to extreme rightwing (the value is 10), is computed as the weighted average of the right-left political orientation scores of the parties forming the executive branch of the government. Higher values of the political orientation index are typically associated with more pro-firm policies.[22]

All these indices vary both over time and across countries, thus providing a further control of the changing institutional and regulatory environment. Table 1 reports the summary statistics for the variables we use in the econometric analysis.

5. Empirical analysis

The purpose of this paper is to investigate the relationships between capital structure, investment and regulatory outcomes for the 15 European PTOs in a period in which product and process

[22] See Alesina and Rosenthal (1995) for a general review of the impact of partisan politics and ideology on economic policies. Leftwing parties are rarely associated with market-oriented policies, while rightwing parties are more in favor of deregulation and less inclined to sustain consumers' interest than leftwing parties (see also Benoit and Laver, 2006).

innovation and market reforms deeply changed both the telecommunications industry and its regulatory environment. We thus start by investigating to what extent such institutional and regulatory changes influenced the PTOs' investment and capital structure decisions, and then proceed by estimating the dynamic interactions between leverage, investment, regulated rates and market competition. For this specific purpose, we will perform Granger (1969) and Sims (1972) causality tests that will allow us to assess whether higher leverage leads to higher prices, higher investment and to weaker competition, or viceversa.[23]

5.1. Leverage and Fixed Investment of the 15-EU PTOs in the new regulatory environment

5.1.1 Leverage

In this section, we estimate a simple leverage model that includes firm characteristics that were shown in the empirical corporate finance literature to be reliable determinants of capital structure[24] and, to cover institutional changes, the OECD *Market Entry* and the Plaut *Regulatory Intensity indexes*. Interestingly, the *Regulatory Intensity index* also allows us to test whether leverage increases when the scope and severity of regulation toughens, which may be viewed as the necessary condition underlying the Hypothesis 1 that leverage positively affects regulated charges. Finally, we add the *Political Orientation index*, to investigate potential interference with regulatory decisions by the government's political stance.

The set of firm specific variables includes the log of real total assets to control for firm's size (size is typically shown to have a positive effect of leverage, also because largest firms are less likely to go bankrupt), the ratio of fixed to total assets which reflects asset tangibility (tangible assets can serve as collateral and hence lower the cost of debt financing), the ratio of EBIT (earnings before interests and taxes) to total assets which is a proxy for profitability and "efficiency" (more efficient firms are likely to have higher earnings with the same assets), and the ratio of depreciation and amortization to total assets as a proxy for non-debt tax shields (tax

[23] Granger causality tests have been increasingly employed in the recent regulation literature. For example, Alesina *et al.* (2005) study the causal relationship between the intensity of product market regulation and investments in 21 OECD countries; Edwards and Waverman (2006) test the relation between interconnection rates and regulatory independence in the EU-15 member states from 1997 to 2003; Gasmi, Noumba and Recuero Virto (2006) study the impact of political accountability on performance in telecommunications for 52 developed and developing countries while Gasmi and Recuero Virto (2008) test the relationship between telecommunications reforms and network expansion in developing countries; Resende (2009) tests the relationship between investment and long term debt for US telecoms from 1992 to 1998 while BCRS (2011) test the relationship between leverage and regulated retail price indexes for 92 utilities from 1994 to 2005.

[24] For common firm characteristics that are included in leverage regressions see for example, Rajan and Zingales (1995), Fama and French (2002), and Frank and Goyal (2009).

deductions for depreciations are substitutes for the tax benefits of debt financing). The estimated equation takes the following form:

$$Lev_{it} = \alpha_0 + \alpha_1 Size_{it} + \alpha_2 Tangibility_{it} + \alpha_3 Profitability_{it} + \alpha_4 NonDebt\ Tax\ Shield_{it} + \\ + \alpha_5 OECDMarketEntry_{jt}\ (\text{or } \alpha_5 RegulatoryIntensity_{jt}) + \alpha_6 PoliticalOrientation_{jt} + \mu_i + \delta_t + \varepsilon_{it} \quad (1)$$

where μ_i denotes the firm dummies, δ_t denotes the time-specific dummies, i, j and t are the firm, country and year subscripts, and ε_{it} is the error term. Table 2 reports the fixed effect estimates where both firm and time specific fixed effects are included.

Column (1) reports the results for the baseline specification, excluding the institutional variables. Both firm size and tangibility of assets enter with a significant coefficient. While the positive coefficient on firm size is quite typical, as largest firms are expected to find it easier to raise more debt, the negative coefficient on tangibility is in contrast with earlier studies, as tangible assets are thought to serve as a collateral and hence to lower the cost of debt financing. In our sample of PTOs, however, fixed capital investments are highly firm- and industry- specific, sunk and non-redeployable and may therefore serve as poor collateral. We then turn to the impact of the institutional variables. In Column (2) we enter the *Political Orientation index* to control for the likely influence of politics on the regulatory climate and find that the coefficient is negative and significant. This result suggests that the PTOs tend to reduce leverage when the government is rightwing, hence, plausibly, more in favour of market-oriented and pro-firm policies than of state (and regulators') interventions in the economy. We contribute two reasons why this negative sign makes sense. On the one hand, if rightwing governments are more oriented to promote easier access to capital markets than leftwing governments, then firms will find it easier and less expensive to tap the stock market for funds, and will therefore raise equity rather than debt. On the other hand, if rightwing executives tend to be more pro-firm than pro-consumer, firms will be less in need of pursuing the strategic use of leverage in order to obtain more favourable regulatory decisions.

We then include the regulatory variables. In Column (3), the OECD market entry index tests whether changes in potential competition may affect capital structure decisions. Faced with higher competitive pressure, firm leverage may increase or decrease. On the one hand, market competition may substitute regulatory interventions as far as the pricing mechanism is concerned, leading firms to reduce their debt levels whenever i) debt is no longer an instrument to influence the regulator in the rate setting decisions (as per Spiegel and Spulber, 1994) or ii) high leverage is viewed as a sign of vulnerability in a fully deregulated market[25]. On the other hand, the competitive pressure might spur the PTOs to urge the regulator to keep regulated charges high, by increasing their financial exposition and their bankruptcy risk. It is in fact plausible that competition induces operators to increase investment, which in turn increases their financial requirements. However, the estimated coefficient on Market Entry is insignificant, supporting neither of these hypotheses.

Finally, in Column (4) we add the *Plaut Index of Regulatory Intensity*. The positive and significant coefficient on the *Index* suggests that telecom operators have raised their leverage not only to finance corporate growth strategies, but also as a reaction to an increasingly heavy regulation.[26] The coefficient of 0.595 indicates that the impact of a change in regulatory intensity on leverage is quite large. If the *Plaut index* increases from the minimum value, 0.289, to the mean value, 0.510, the expected leverage increase would be of 13.1 percentage points (0.595*0.221). Given that the sample leverage is 31.7% on average, this would imply an increase to 44.8%. In section 5.2, building on the evidence that leverage does increase as a response to increasing regulatory intensity, we will test the core prediction of Hypothesis 1 that regulated prices increase as leverage increases.

An inspection of our data confirms the econometric evidence. In Spain, the *Plaut Index* rises from 0.4 to 0.66 between 1997 and 2005. In the same period, Telefonica de Espana doubles its leverage, from 35% to 68%. In Italy, the scope and intensity of regulation sharply increased soon after the set up of the national Regulatory Authority. As the Plaut Index rose from 0.37 in 1997 to 0.7 in 2000, the financial leverage of Telecom Italia soared from 46% to 64%, mainly as a result of two Leveraged Buy-Outs. Also in France, regulation intensified from 1997 to 2001 (the Plaut index roses from 0.41 to 0.68), while France Télécom's leverage increased from 38% to 70%. Finally, in the UK as the intensity of regulation increased from 0.39 to 0.67, in the 1997-2003 period, the financial conditions of British Telecom strongly deteriorated and the leverage, initially as low as 6% climbed up to 132%, leading the firm to divest its mobile branch, O2.

5.1.2 Investment

We now analyze the impact of institutional variables on the PTOs' investment decisions. The empirical model derives from the microeconometric literature on company investment which

[25] Empirical evidence supports this view. Ovtchinnikov (2010), studying a large sample of U.S. firms in industries which were subject to some form of deregulation during the 1966-2006 period, finds that as competition increased and markets were deregulated, firms reduced their leverage by about 30%.

[26] This result is consistent with what obtained by BCRS (2011) for a larger and more heterogeneous sample. In a set of unreported regressions we also checked whether state vs. private ownership of the firm influences the PTOs' financial decisions. We found that both the private vs. public control dummy and a continuous measure of Government's ultimate control rights were always insignificant in the leverage regressions. Results are available upon requests.

suggests to include the *lagged investment ratio* (*IK*) to account for capital stock adjustment, *demand growth (ΔLogSales)*, as measured by the log difference of firm sales, to account for accelerator effects, and the *cash flow to capital stock (CFK)* to account for capital markets imperfections and asymmetric information problems that may cause investment decisions to be constrained by the amount of internal funds.[27] We then add, in turn, *Political Orientation*, *Market Entry* and *Regulatory Intensity* to test for the impact of the institutional and regulatory framework. The dynamic investment model we estimate is the following:

$$IK_{it} = \alpha_0 + \alpha_1 IK_{it-1} + \alpha_2 \Delta LogSales_{it} + \alpha_3 \Delta LogSales_{it-1} + \alpha_4 CFK_{it-1} + \alpha_5 CFK_{it-1} +$$
$$+ \alpha_6 OECDMarketEntry_{jt} (or\ \alpha_6 RegulatoryIntensity_{jt}) + \alpha_7 PoliticalOrientation_{jt} + \mu_i + \delta_t + \varepsilon_{it} \quad (2)$$

where μ_i denotes the firm dummies, δ_t denotes the time-specific dummies, *i*, *j* and *t* are the firm, country and year subscripts, and ε_{it} is the error term. To estimate this model we use the Generalised Method of Moments proposed by Arellano and Bond (1991) and Blundell and Bond (1998), which is especially designed for dynamic models where right-hand variables, including the lagged dependent variable, are not strictly exogenous. [28]

Table 3 reports the results. In Column (1) we test the baseline specification and find that the lagged investment rate is insignificant while the accelerator term (the contemporaneous sales growth term) is significant and positively signed. The lagged cash flow rate enters with a positive and significant coefficient, suggesting that the PTOs are constrained by the available flow of internal finance and cannot exploit profitable investment opportunities without raising either equity or debt funds, both costing to the firm more than cashflow. This result is interesting for us because, by confirming that financial and investment decisions are not separable, it calls our attention to the choice firms have to make between debt and equity. Although the pecking order theory predicts that, when cashflow is exhausted, debt should be used first and then equity, the cost of equity in the period under study was relatively low and many EU manufacturing firms tapped the equity market (see, for example, the report on corporate finance in the EU area by the European Central Bank,

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[27] See, for example, Hubbard (1998) for a comprehensive survey of company investment models estimated with panel data and of the debate on the impact of financing constraints on company investment.

[28] GMM estimation also deals with the dynamic panel bias that arises when the lagged dependent variable may be correlated with the error term even when the firm fixed effects are wiped out by first-differencing. Our GMM estimates employ *t-2* lags of the dependent variable and of other non-strictly exogenous regressors, such as the cash flow to fixed capital, the growth rate of real sales, and the regulatory framework indexes. To test the validity of the instruments, we use the two-step Sargan-Hansen statistic under the null of joint validity of the instruments results and we also report the Arellano and Bond (1991) autocorrelation test to control for AR(1) and AR(2) in the residuals. Time specific fixed effects are included as regressors and as instruments.

2007). This behaviour is in contrast with what we observe for telecom utilities, which, in spite of being very large and widely-held, with larger institutional investors and easier access to international capital markets (as compared to manufacturing firms), increased their indebtedness to the point of raising the concern of policymakers.

Turning to the institutional variables, we find, in Column (2), that *Political Orientation* enters with a positive and significant coefficient, suggesting that PTOs tend to increase their investment rates under more conservative governments. Even though PTOs ultimately serve as *public* utilities, most of them have been fully privatized, so it is not surprising that they expect rightwing executives will likely introduce pro-firm policies (such as a lower taxation of income) to which they react by increasing their investment rates. Notably, the estimated coefficients on *Political Orientation* in Tables 2 and 3 are both consistent with anecdotal evidence that firms react to rightwing executives and to supposedly pro-firm policies by increasing investment and equity finance.

In Column (3), we find that the coefficient of the *OECD Market Entry* index is negative and significant. Since the index is higher when entry is more difficult, the negative sign implies that PTOs tend to invest more as entry in the downstream segment (liberalization) becomes easier and markets become wider and more open[29]. Again this result is consistent with empirical evidence that telecom incumbents tend to increase their investment as competition increases (Cambini and Jiang, 2009). In order to have an idea of the size of the effect of changes in market entry regulation, consider a unit decrease in the OECD Index from Column (3). In the long run, the investment rate increases by more than one percent (1.24% to be precise)[30]. Since the average investment rate is 15.7% this implies an increase to 17%. If the *Market Entry index* decreases from its third quartile value (3.1) to the first quartile value (zero), then the investment increase would be of 3.84 percentage points, which is quite large. To seize the magnitude of the change due to liberalization of entry, we can also experiment with country specific data in different time periods. For example, we can compare firm and industry averages for Germany before and after 1999, as the average *Market Entry index* goes from 4.8 to 0, and find that the investment rate, on average, increases from 7.3% to 12.5%. In Italy, across the same intervals, the *Index* decreased from 5.275 to 0 and the mean investment rate increased from 10.9% to 19.5%. Finally, for control, we can look at the UK, where entry was fully liberalized from the start (and the index is always set to 0, and find that the investment rate did not increased (but actually decreased from 14.8 to 11.8%).

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[29] Alesina *et al.* (2005) found a similar result for a panel of OECD countries.
[30] The long-run coefficient is calculated as $\alpha_6/(1-\alpha_1)$=-0.0124.

In Columns (4) we test whether *Regulatory Intensity* affects investment decisions, but we find no significant results although the negative coefficient suggests that "too much regulation" hinders investment, confirming the evidence we obtained from *Market Entry* in Column (3).[31]

5.2 Leverage-Price Granger causality tests

In this section we test the relationship between firm leverage and regulated prices. If debt is used in the interplay between the firm and the regulator as a shield to protect large and sunk investments from regulatory opportunism, then we expect that an increase in leverage is followed by an increase in regulated rates (Hypothesis 1) and by an increase in investment (Hypothesis 3). Alternative patterns of results might also be conjectured. If regulators use the firm's cost of capital - based on the incumbent's financial structure - to set the tariffs that will ensure the firm a "fair rate of return", then an increase in price should follow a decrease (not an increase) in leverage, i.e. an opposite effect with respect to Hypothesis 1. This is because the firm would choose equity instead of debt to raise the overall cost of capital (since the cost of equity is typically higher than the cost of debt) and the price as a consequence. After the price is set, if the "circularity" argument literally applies, and to the extent that regulators are able to commit to the regulated rates, firms would then increase their leverage in order to reduce their actual cost of capital. In this case, we should observe that the causality runs the other way round (with respect to Hypothesis 1), i.e. that an increase in leverage follows an increase in price, and not viceversa. Further alternatives are that leverage and regulated prices are spuriously correlated, as the two variables are correlated with a third variable that causes both of them, or that leverage and prices are not correlated at all.

To investigate the direction of the price-leverage relationship we apply the Granger causality test, which estimates the following bivariate autoregressive processes for the firm leverage and, alternatively, the country-specific *Local* access rates, the *Single transit* access rates and the *Retail price indexes*:

$$P_{i,t} = \alpha_1 P_{i,t-1} + \alpha_2 P_{i,t-2} + \beta_1 Lev_{i,t-1} + \beta_2 Lev_{i,t-2} + \mu_i + \delta_t + \varepsilon_{i,t}, \qquad (3)$$

$$Lev_{i,t} = \delta_1 Lev_{i,t-1} + \delta_2 Lev_{i,t-2} + \gamma_1 P_{i,t-1} + \gamma_2 P_{i,t-2} + \mu_i + \delta_t + \nu_{i,t}, \qquad (4)$$

[31] Analogously to the leverage equation, we estimated a basic investment equation where we introduced two ownership variables (one dichotomous and one continuous). Again we found that the ownership variables were insignificant. This result is similar to what we obtained for a panel of European energy utilities (see Cambini and Rondi, 2010).

where $P_{i,t}$ is the regulated price of firm i in period t, $Lev_{i,t}$ is the leverage of firm i in period t, μ_i denotes the firm dummies, δ_t denotes the time-specific dummies that capture the underlying technological change in the industry and the evolution of cost efficiency[32], i, and t are the firm and year subscripts, and ε_{it} and ν_{it} are the error terms in the two equations. These tests are used to examine whether leverage Granger-causes regulated prices, or vice-versa. If leverage Granger-causes prices but not vice versa, then β_1 and β_2 are jointly significant while γ_1 and γ_2 are not. Therefore, we also report Wald statistics testing whether $Lev_{i,t-1}$ and $Lev_{i,t-2}$ contribute significantly to the explanatory power of regression (3), or $P_{i,t-1}$ and $P_{i,t-2}$ contribute significantly to the explanatory power of equation (4). As this is a dynamic model, similarly to the investment equation in Section 5.1.2, we use the Generalised Method of Moments proposed by Arellano and Bond (1991) and Blundell and Bond (1998).[33]

The results are in Tables 4.A and 4.B. In Panel A, we report the marginal probabilities of the tests of the hypotheses that the coefficients of the leverage terms are jointly zero as well as that their sum is zero. The estimated coefficients and the Wald tests show that the lagged leverage terms are jointly significant in columns (1) and (3), but not in column (2), which suggests that leverage has a positive significant effect on *Single transit access* charges and on the *Retail* prices, but not on *Local access* rates. Notably, *Single transit access* is the prevailing entry mode in the service-based competitive framework that characterized European telecom industry in our sample period (see ERG, 2007). For *Single transit* and *Retail* tariffs our tests also indicate that the sum of the coefficients of the debt terms is positive and significantly different from zero. In Panel B, we test the opposite hypothesis and find that in all columns the coefficients on the once and twice lagged terms are insignificant and the Wald tests show that we cannot reject the hypothesis that the two price terms are jointly zero. These results imply that leverage Granger-causes regulated prices both at the wholesale (*Single transit*) and at the retail level, thus indicating that the data cannot reject the hypothesis that higher debt leads to higher regulated charges. Our results do not support the alternative hypotheses that firms adjust their capital structure to match their resulting expected revenue stream, or that leverage and regulated prices are driven by a third variable that causes both of them.

We can use the estimated coefficients of columns (1) and (3) of Table 4A to calculate the quantitative effects that a change in leverage has on wholesale and retail telecom charges in the long

[32] For a survey on the impact of technological change on telecom operators' productivity, see Fuss and Waverman (2002).

[33] The instrument set for the Granger tests in this section and in the following sections 5.3 and 5.4, includes lags of the regressors as well as variables accounting for institutional features of the regulatory and political environment, such as regulatory intensity and political orientation.

run, allowing for the efficiency progress due to fast technological change. Considering a 10% increase in leverage, the long run coefficient of 0.714 (calculated as $\beta_1+\beta_2/(1-\alpha_1-\alpha_2)$, see also Alesina et al., 2005) allows us to estimate that the *single transit* charge would increase by 0.0714 €cents per minute, which corresponds to a 6% increase with respect to the mean tariff rate of 1.184 €cents/min. This apparently minimal price change would generate an enormous increase in total revenues (in Italy for example, using the data in footnote 17, this increase would generate a 5.6 billions Euros increase in revenues from wholesale services). If we use the results in column (3) we can calculate the long run effects of a debt increase on the retail price index. Our estimate shows that, following an increase in leverage by 10%, the retail price index would increase of 9.62 percentage points. Since the mean retail index is 110.32, this amounts to an increase by 8.72% (9.62/110.32) of the average consumers' bill.

Clearly, competition is likely to be negatively affected by incumbents' financial decisions, since an increase in leverage raises the cost alternative operators should pay for accessing the existing infrastructure. This is what we analyse in the next Session.

5.3 Leverage-Market Competition Granger causality tests

In Section 2 we emphasized the potential implications of the causality relationship between leverage and wholesale rates for the competition in the downstream retail segment of an industry with a vertical structure, like telecommunications. High leverage might display a negative effect on competition if the regulator, driven by concerns over the PTO's, and the industry, financial stability, raises the access charge (Hypothesis 2). In this case entrance in the retail market would be discouraged , and alternative operators would have to pay a higher tariff to access the network. The reverse might also occur: if market competition toughens, the PTO's revenue and cash flows are likely to decrease and reliance on debt finance might increase. To investigate whether the strategic use of debt has a downside effect on competition in the retail segment, we test the relationship between PTOs' leverage and two different variables to proxy for market competition: (i) the *Number of Competitors* in the telecommunications market, as defined by the EC report (2006), i.e. the number of operators that, along with the PTO, have a combined market share of at least 90% of the global voice fixed telephony market, and (ii) the *Market Share* of the Incumbent PTO operator in the national segment (EC report, 2006).

To investigate the causality in the relationship between leverage and market competition we perform, similarly to section 5.2, the following Granger-causality test:

$$MC_{i,t} = \alpha_1 MC_{i,t-1} + \alpha_2 MC_{i,t-2} + \beta_1 Lev_{i,t-1} + \beta_2 Lev_{i,t-2} + \mu_i + \delta_t + \varepsilon_{i,t}, \qquad (5)$$

$$Lev_{i,t} = \delta_1 Lev_{i,t-1} + \delta_2 Lev_{i,t-2} + \gamma_1 MC_{i,t-1} + \gamma_2 MC_{i,t-2} + \mu_i + \delta_t + \nu_{i,t}, \qquad (6)$$

where *MC* is alternatively the *Number of Competitors* and the *Market Share* of the incumbent in the retail sector and the other variables are defined as in Equations (3) and (4).

The results are reported in Table 5. In Panel A, Column (1), the once lagged leverage term is insignificant, but the twice-lagged term is negative and highly significant. The Wald tests show that the two leverage terms significantly contribute to explaining the *Number of Competitors* and that the sum of the coefficients is negative and significant. Before drawing the implications of this result, we check in Panel B whether there is reverse causality, i.e. whether lags of the *Number of Competitors* enter the dynamic leverage equation. This might occur if competitive pressure in the retail segment reduces retail prices and deteriorates the profitability of the incumbent operator, leading it to increase the financial leverage. The results show that this is not the case, as none of the coefficients for the *Number of Competitors* variable are significant, either individually or jointly, in explaining leverage. Overall these results suggest that the number of downstream competitors decreases as the PTOs increase their leverage.

In Column (2) we then investigate the relationship between the PTO's leverage and *Market Share* in the national retail sector. The estimated results support the evidence from the *Number of Competitors'* regressions. Financial leverage has a positive and significant effect on the PTO's *Market Share*, suggesting that the higher the leverage the stronger the dominant position of incumbent. The Wald tests show that the two leverage terms are jointly significant and that their sum is positive and significant, while the reverse causality test in Panel B shows that the PTO's Market Share does not contribute to explain firm leverage. Taken together, the results in Columns (1) and (2) show that an increase in the PTO's leverage leads to a smaller number of competitors and to a greater market share of the incumbent in the retail segment of the telecommunications industry, suggesting that our data do not reject the model's prediction that the strategic use of leverage may also affect the degree of market competition. Being aware that it takes time for market forces to trigger entry and exit decisions and to quantitatively affect market shares, we use the latest EU reports (European Commission, 2010) to follow the developments of competition in the telecom market in the years immediately after our sample period, during which the PTOs' leverage had significantly increased. We find that in many countries the incumbent's domestic market share has either increased or remained constant between 2006-2008: for example, in Austria the PTO's market share increased from 55% to 62.4%; in Belgium, from 70% in 2006 to 71% in 2007 (and

69.7% in 2008); in Greece from 72% to73.6%; in Ireland from 68% to 71%; in Spain from 74% to 77.1%; in Sweden from 56% to 58%; and even in the UK, British Telecom' market share increased from 56% to 58% in 2006-07 and then back to 55.5% in 2008.

5.4 Leverage – Investment Equations

In the last section we analyze the impact of debt on PTOs' investment decisions. The interaction between capital structure and regulated rates in Spiegel and Spulber's model has natural implications for the typical underinvestment problem that adversely affects network infrastructure in regulated industries in the presence of regulatory opportunism. In their setting, the strategic use of leverage is thus justified by the need to discipline the regulator's opportunistic behavior (i.e. the ex-post price reduction) and to enhance firms' ex ante investment incentives. If this is the case, after empirically observing the positive influence of regulatory intensity on leverage in Table 2, and the positive impact of leverage on retail and wholesale charges in Table 4A, we ask now our data if there is a positive relationship between leverage and investment (testable Hypothesis 3).

The relationship between leverage and investment is inherently endogenous, because if a firm plans to invest in year *t*, it may issue debt in *t*-1 (or even *t*-2), and if the investment project takes time to be realized, then adjustment lags in the investment plan today generates financial requirements and debt issues tomorrow. The persisting nature of this endogeneity is difficult, if not impossible, to control even if instrumental variable techniques are used.[34] Again, we rely on the GMM-DIFF estimator to perform the Granger causality test for the fixed investment to capital stock rate and a measure of leverage:

$$IK_{i,t} = \alpha_1 IK_{i,t-1} + \alpha_2 IK_{i,t-2} + \beta_1 Lev_{i,t-1} + \beta_2 Lev_{i,t-2} + \mu_i + \delta_t + \varepsilon_{i,t}, \qquad (7)$$

$$Lev_{i,t} = \delta_1 Lev_{i,t-1} + \delta_2 Lev_{i,t-2} + \gamma_1 IK_{i,t-1} + \gamma_2 IK_{i,t-2} + \mu_i + \delta_t + \nu_{i,t}, \qquad (8)$$

where $IK_{i,t}$ is the fixed investment to capital stock rate of firm *i* in period *t*, $Lev_{i,t}$ is the leverage of firm *i* in period *t*, μ_i denotes the firm dummies, δ_t denotes the time-specific dummies, *i*, and *t* are the firm and year subscripts, and ε_{it} and ν_{it} are the error terms in the two equations. If leverage Granger-causes the investment rate of the firm, but not vice versa, then β_1 and β_2 are jointly significant while γ_1 and γ_2 are not. As a robustness check, in Columns (2) and (3) we report the

[34] Not claiming to have eliminated this problem, we explore this dynamic relationship by applying (as in sections 5.2 and 5.3) the Granger test and the GMM-DIFF estimator where we also include regulatory and institutional controls in the instrument set. Resende (2009) follows a similar approach to test, for a sample of US telecom firms, the leverage-investment relationship derived from Spiegel and Spulber (1994).

results using two alternative measures of indebtedness, the debt to total assets ratio and the debt to sales ratio.

We present our results in Tables 6.A and 6.B. In Panel A, we find that the estimated coefficients of the lagged debt terms are jointly significant independent of the definition for indebtedness we use. The Wald tests also show that their sum is positive and significantly different from zero. In contrast, in Panel B, we find that the investment rate does not significantly contribute to explaining the leverage, as the once and twice lagged coefficients are neither individually nor jointly significant. Taken together, these results indicate that leverage Granger-causes investment (and not vice-versa), thus suggesting that the data cannot reject the prediction of the model that leverage strengthens the firms' incentives to invest. To understand the quantitative importance of these estimates, consider a leverage increase of 10 percentage points, from 0.317 (the sample average) to 0.417. By using the coefficients in Column (1) of Table 6A, we can calculate the long-run coefficient as $\beta_1+\beta_2/(1-\alpha_1-\alpha_2) = 0.464$ and use it to estimate that an increase of 10 percentage points would lead to an increase of 4.64 percentage points in the investment rate. As the average investment rate is 15.7%, this would imply a sizeable increase, to 20.3%. If we repeat the experiment with similar increases in the debt to sales ratio and in the debt-to-total assets ratio, we find that the investment rate would increase, respectively, by 1.1 and by 3.54 percentage points in the long run.

6. Conclusions

In this paper we have theoretically and empirically analysed the relationship between financial structure, access regulation and investment in the European telecommunications market. Specifically, since capital structure affects the way NRAs set regulated wholesale and retail charges as well as firms' investment, the regulated firm may use debt leverage to influence the regulator's pricing decisions and, ultimately, the degree of competition in the downstream segment of the market.

Using a panel of 15 EU Public Telecommunication Operators (PTOs) over the period 1994-2005, we have first investigated the impact of key features of the institutional context, such as the degree of market openness and the scope and intensity of regulatory interventions, on the PTOs' financial and investment decisions, while also controlling for the potential influence of the executive's political orientation. Our findings show that leverage increases with the intensity of regulation while company investment is positively affected by liberalization of entry. We have then applied Granger-causality tests to the relationships between PTOs' financial leverage and i) wholesale and retail rates, ii) degree of competition in the retail service sector and, iii) company investment. The results show that the model's predictions cannot be rejected by our data. We find that an increase in leverage positively affects regulated rates, both at the retail and at the wholesale level. Furthermore, as an effect of the higher wholesale charges, increases in leverage also have a negative impact on competition. In particular we find that higher leverage leads to a lower number of competitors in the national market and to a larger PTO's market share in the retail service sector. Finally, we find that financial leverage has a positive effect on the PTOs' investment rate. When we use the coefficients to estimate the long run quantitative effects of an increase in leverage we find that they are quite large. A 10 percent increase in leverage leads, on average, to increases of 8.72 percent in the retail price index, of 6 percent in the access charge paid by alternative operators, and of 4.64 percentage points in the investment rate of the incumbent operator. This suggests that the strategic use of debt to discipline the regulator's lack of commitment within a vertically integrated network industry may somewhat impair or delay competition in the retail segment, but has a favorable counterpart in mitigating the underinvestment problem.

More recently, new entry methods, such as *local loop unbundling* and *bitstream* services, have become increasingly important for the provision at retail level of broadband services. These access instruments, which are used by entrant operators to provide enhanced value-added services, are viewed as key determinants of future infrastructure investments in the telecom industry. Whether capital structure decisions will still continue to interfere with the new access services' regulated charges and, in turn, influence infrastructure investment in the next generation networks is an issue that deserves further investigations.

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FIGURE 1 – BOOK LEVERAGE OF EU PUBLIC TELECOMMUNICATIONS OPERATORS (PTOS)

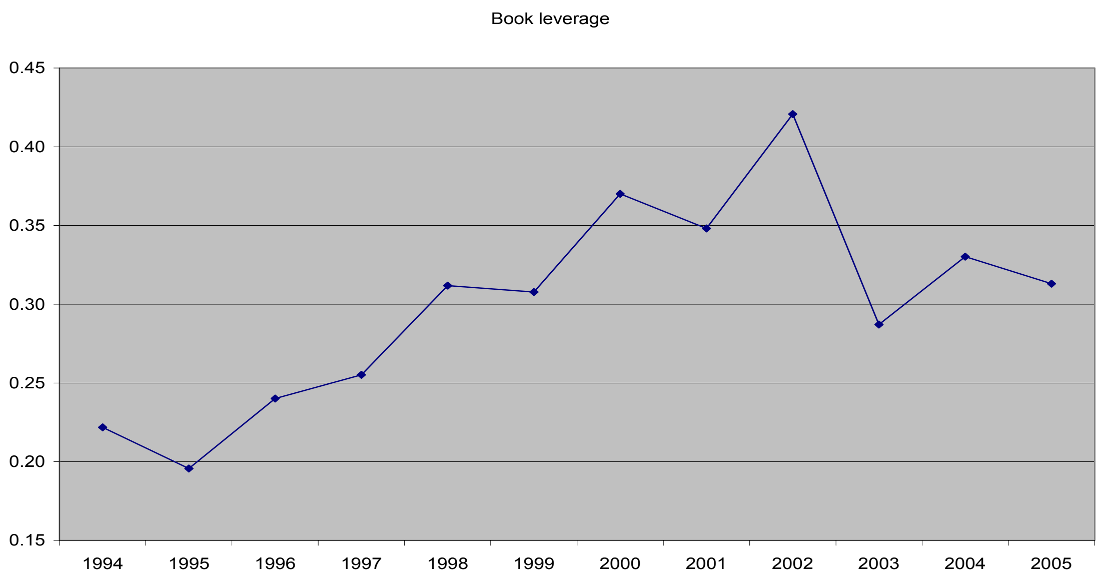

FIGURE 2 - AVERAGE INVESTMENT RATE OF EU PTOS

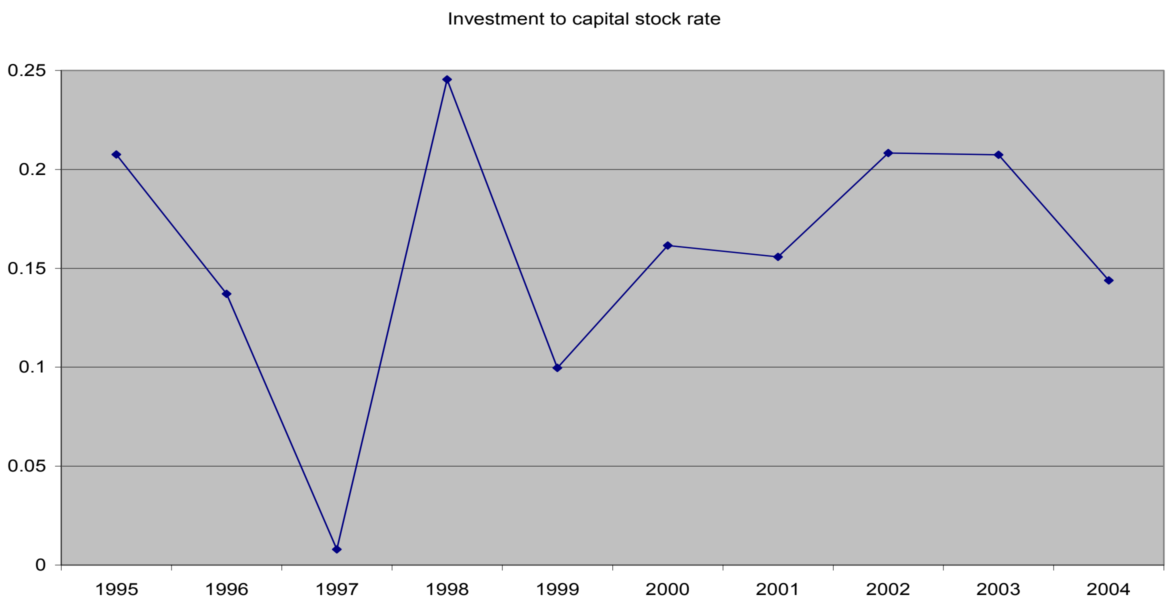

TABLE 1 - SUMMARY STATISTICS

15 PUBLIC TELECOMMUNICATIONS OPERATORS (PTOS) 1994 – 2005

Variable	Mean	Std. Dev.	Min	Max	N. Obs.
Telecoms' Retail Price Index	110.316	10.108	94.1	144.69	138
Local access charge (€cents/min)	0.801	0.361	0.23	3.23	114
Single Tandem access charge (€cents/)	1.184	0.430	0.35	3.26	114
Incumbent's national market share (%)	77.08	14.656	50.0	100.0	126
Number of competitors	3.703	3.004	0	12	128
Investment Rate	0.157	0.106	-0.166	0.578	127
Leverage	0.317	0.223	0.000	1.000	157
Debt-to-sales	0.479	0.834	0.000	7.125	157
Debt-to-total assets	0.199	0.309	0.000	2.982	157
Total Assets (log) (Mill. of 2005 dollars)	12.110	1.343	8.038	14.256	158
Fixed to Total Asset	0.507	0.178	0.129	0.835	158
EBIT-to-Asset	0.071	0.118	-0.976	0.299	155
Non-Debt Tax Shield	0.733	1.804	-2.608	19.388	155
Cash Flow to Capital Stock	0.177	0.157	-0.939	0.464	143
Sales Growth	0.045	0.148	-0.476	0.497	142
Political Orientation	5.487	1.294	3.665	8.025	158
OECD Entry	1.307	2.191	0	6	158
Plaut Index of Regulatory Intensity	0.510	0.119	0.289	0.753	127

TABLE 2 - LEVERAGE EQUATION FOR EU TELECOMS (1994-2005)

Leverage is defined as the sum of short and long-term financial debt divided by the sum of short-, long-term financial debt and equity. Fixed effects estimates. Robust standard errors in parentheses. ***, **, * denote significance at 1%, 5% and 10%.

Leverage	**(1)**	**(2)**	**(3)**	**(4)**
Log of real total assets	0.122**	0.146**	0.141**	0.110[a]
	(0.062)	*(0.064)*	*(0.065)*	*(0.072)*
Fixed-to-Total Assets	-0.489***	-0.432***	-0.448***	-0.412**
	(0.143)	*(0.148)*	*(0.146)*	*(0.189)*
EBIT-to-Total Assets	0.086	0.110	0.112	0.091
	(0.128)	*(0.124)*	*(0.127)*	*(0.145)*
Non-Debt Tax Shield	-0.007	-0.006	-0.006	-0.011**
	(0.006)	*(0.006)*	*(0.006)*	*(0.004)*
Political Orientation	-	-0.023**	-0.023**	-0.037**
	-	*(0.011)*	*(0.011)*	*(0.014)*
OECD Index – Market entry	-	-	0.006	-
	-	-	*(0.011)*	-
Plaut Index of Regulatory Intensity	-	-	-	0.595*
	-	-	-	*(0.332)*
Firm Dummies	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
R squared within	0.405	0.405	0.422	0.297
N. Firms [N. Obs.]	16 [154]	16 [154]	16 [154]	16 [126]

[a] p value = 0.128

TABLE 3– DYNAMIC INVESTMENT MODEL OF EU TELECOMS (1994-2005)

The dependent variable is the ratio between fixed investment and fixed capital stock at replacement value. Dynamic Panel estimation, one-step difference GMM. Standard errors in parentheses are robust to heteroschedasticity and to within group serial correlation. ***, **, * denote significance at 1%, 5% and 10%.

Fixed Investment to Capital Stock	**(1)**	**(2)**	**(3)**	**(4)**
Fixed Investment to Capital Stock $_{t-1}$	-0.213	-0.145	-0.210	-0.202
	(0.201)	*(0.203)*	*(0.183)*	*(0.267)*
Sales Growth $_{t}$	0.625***	0.585***	0.632***	0.550**
	(0.174)	*(0.194)*	*(0.172)*	*(0.263)*
Sales Growth$_{t-1}$	0.049	0.019	0.060	0.023
	(0.157)	*(0.174)*	*(0.144)*	*(0.208)*
Cash Flow to Capital Stock $_{t}$	0.064	0.030	0.030	0.050
	(0.149)	*(0.148)*	*(0.146)*	*(0.205)*
Cash Flow to Capital Stock $_{t-1}$	0.525***	0.541***	0.536***	0.562**
	(0.169)	*(0.175)*	*(0.164)*	*(0.256)*
Political Orientation	-	0.023**	0.028**	0.024*
	-	*(0.010)*	*(0.012)*	*(0.013)*
OECD entry	-	-	-0.015**	-
	-	-	*(0.007)*	-
Plaut Index of Regulatory Intensity	-	-	-	-0.209
	-	-	-	*(0.646)*
Arellano-Bond test for AR(1) *(p-value)*	0.034	0.021	0.010	0.055
Arellano-Bond test for AR(2) *(p-value)*	0.254	0.129	0.114	0.184
Sargan-Hansen test *(p-value)*	0.326	0.530	0.821	0.481
N. Firms [N. obs.]	16 [79]	16 [79]	16 [79]	15 [69]

TABLE 4 - PANEL A – REGULATED PRICE AND LEVERAGE – GRANGER TESTS

Leverage is defined as the sum of short and long-term financial debt divided by the sum of short-, long-term financial debt and equity. Each column reports estimated coefficients for Granger causality tests as in eqs. [3] and [4] of the relationship between Leverage and Regulated Prices. We present results for the *Single transit charge* in column (1), for the *Local transit charge* in column (2), and for the *Retail price index* in column (3). Dynamic panel estimation, one-step difference GMM estimates. Standard errors in parentheses are robust to heteroschedasticity and to within group serial correlation.

Dependent variable: Regulated Price	*(1)* *Single Transit*	*(2)* *Local Transit*	*(3)* *Retail Price*
α_1 Regulated Price$_{t-1}$	0.900***	0.743**	0.390**
	(0.078)	*(0.083)*	*(0.168)*
α_2 Regulated Price$_{t-2}$	0.009	0.044	0.421*
	(0.058)	*(0.023)*	*(0.228)*
β_1 Leverage$_{t-1}$	-0.054	-0.048	7.932**
	(0.045)	*(0.046)*	*(3.344)*
β_2 Leverage$_{t-2}$	0.109**	0.082[35]	10.250**
	(0.052)	*(0.057)*	*(3.914)*
P-value test on H_0: $\beta_1 = \beta_2 = 0$	5.15 (0.076)*	2.11 (0.34)	4.35 (0.03)**
P-value test on H_0: $\beta_1 + \beta_2 = 0$	3.21(0.073)*	0.99 (0.32)	8.68 (0.01)***
Arellano-Bond test for AR(1) *(p-value)*	0.005	0.063	0.914
Arellano-Bond test for AR(2) *(p-value)*	0.193	0.513	0.062
Sargan-Hansen test *(p-value)*	1.000	1.000	0.998
N. Firms [N. Obs.]	15 [83]	15 [83]	15 [88]

.

TABLE 4 PANELB – LEVERAGE AND REGULATED PRICE – GRANGER TESTS

Dependent variable: Leverage	*(1)* *Single Transit*	*(2)* *Local Transit*	*(3)* *Retail Price*
δ_1 Leverage$_{t-1}$	0.465**	0.475**	-0.430
	(0.200)	*(0.199)*	*(0.338)*
δ_2 Leverage$_{t-2}$	0.500**	0.508**	-0.275
	(0.199)	*(0.209)*	*(0.245)*
γ_1 Regulated Price$_{t-1}$	-0.001	-0.015	-0.004
	(0.072)	*(0.109)*	*(0.005)*
γ_2 Regulated Price$_{t-2}$	-0.049	-0.041	0.001
	(0.081)	*(0.051)*	*(0.011)*
P-value test on H_0: $\gamma_1 = \gamma_2 = 0$	0.82 (0.664)	1.26 (0.53)	0.30 (0.74)
Arellano-Bond test for AR(1) *(p-value)*	0.025	0.027	0.384
Arellano-Bond test for AR(2) *(p-value)*	0.216	0.222	0.102
Sargan-Hansen test of over identifying restrictions *(p-value)*	1.000	1.000	0.997
N. Firms [N. Obs.]	15 [83]	15 [83]	15 [88]

[35] P-value = 0.14

TABLE 5 PANEL A – COMPETITION IN TLC AND LEVERAGE – GRANGER TESTS

In both tables, each column reports estimated coefficients for Granger causality tests of the relationship between Measures of Competition in EU TLC industry and Leverage, as in eqs. [5] and [6]. Column (1) presents results for the relationship between Leverage and the Number of Competitors in the retail segment. Column (2) presents results for the relationship between Leverage and the Market Share of the Incumbent PTO operator in the retail segment. Dynamic panel estimation, one-step system GMM estimates. Standard errors in parentheses are robust to heteroschedasticity and to within group serial correlation.

Dependent variable: *Competition Measure*	*(1)* *Number of Competitors*	*(2)* *Market Share of the Incumbent*
α_1 Competition Measure$_{t-1}$	0.717***	0.972***
	(0.180)	*(0.088)*
α_2 Competition Measure$_{t-2}$	0.246	-0.006
	(0.211)	*(0.104)*
β_1 Leverage$_{t-1}$	1.722	5.364**
	(1.028)	*(2.388)*
β_2 Leverage$_{t-2}$	-3.567***	4.468
	(1.206)	*(6.465)*
P-value test on H_0: $\beta_1 = \beta_2 = 0$	4.41 (0.03)**	7.98 (0.02)**
P-value test on H_0: $\beta_1 + \beta_2 = 0$	3.64(0.07)*	2.73 (0.09)*
Arellano-Bond test for AR(1) *(p-value)*	0.014	0.031
Arellano-Bond test for AR(2) *(p-value)*	0.779	0.362
Sargan-Hansen test of over identifying restrictions *(p-value)*	1.000	1.000
N. Firms [N. Obs.]	15 [95]	15 [90]

TABLE 5 - PANEL B – LEVERAGE AND COMPETITION IN TLC - GRANGER TESTS

Dependent variable: Leverage	*(1)* *Number of Competitors*	*(2)* *Market Share of the Incumbent*
δ_1 Leverage$_{t-1}$	0.604***	0.571***
	(0.139)	*(0.171)*
δ_1 Leverage$_{t-2}$	0.314	0.342
	(0.211)	*(0.200)*
γ_1 Competition Measure$_{t-1}$	0.015	0.003
	(0.018)	*(0.004)*
γ_2 Competition Measure$_{t-2}$	-0.031	-0.003
	(0.023)	*(0.004)*
P-value test on H_0: $\gamma_1 = \gamma_2 = 0$	1.08 (0.37)	0.32 (0.73)
Arellano-Bond test for AR(1) *(p-value)*	0.006	0.006
Arellano-Bond test for AR(2) *(p-value)*	0.182	0.486
Sargan-Hansen test of over identifying restrictions *(p-value)*	1.000	1.000
N. Firms [N. Obs.]	15 [94]	15 [91]

TABLE 6.A – INVESTMENT AND LEVERAGE – GRANGER TESTS

In both tables, each column reports estimated coefficients for Granger causality tests of the relationship between Investment and Leverage, as in eqs. [7] and [8]. Column (1) presents results for the financial leverage (financial debt/(financial debt + equity). Column (2) presents results for the financial debt-to-total asset ratio. Dynamic panel estimation, one-step difference GMM estimates. Standard errors in parentheses are robust to heteroschedasticity and to within group serial correlation.

Dependent variable: Investment rate	*(1) Leverage Debt/(Debt+Equity)*	*(2) Debt-to-Total Asset*	*(3) Debt-to-Sales Ratio*
α_1 Investment rate$_{t-1}$	-0.122	-0.280	-0.208
	(0.235)	*(0.289)*	*(0.285)*
α_2 Investment rate$_{t-2}$	0.061	-0.607*	-0.599**
	(0.112)	*(0.297)*	*(0.267)*
β_1 Leverage$_{t-1}$ or Debt-to-Assets$_{t-1}$ or Debt-to-Sales$_{t-1}$	-0.026	0.280**	0.085**
	(0.063)	*(0.125)*	*(0.035)*
β_2 Leverage$_{t-2}$ or Debt-to-Assets$_{t-2}$ or Debt-to-Sales$_{t-2}$	0.518***	0.388**	0.118***
	(0.180)	*(0.174)*	*(0.043)*
P-value test on H_0 $\beta_1 = \beta_2 = 0$	9.79 (0.007)***	3.07 (0.07)*	3.85***(0.043)*
P-value test on H_0 $\beta_1 + \beta_2 = 0$	5.63 (0.017)**	6.10(0.025)**	7.58(0.014)***
Arellano-Bond test for AR(1) *(p-value)*	0.091	0.041	*0.035*
Arellano-Bond test for AR(2) *(p-value)*	0.497	0.323	*0.817*
Sargan-Hansen test *(p-value)*	0.931	0.773	*0.880*
N. Firms [N. Obs.]	16 [76]	16 [76]	15 [76]

TABLE 6.B – LEVERAGE AND INVESTMENT – GRANGER TESTS

Dependent variable: Debt ratio	*(1) Leverage Debt/(Debt+Equity)*	*(2) Debt-to-Total Asset*	*(3) Debt-to-Sales Ratio*
δ_1 Leverage$_{t-1}$ or Debt-to-Assets$_{t-1}$ or Debt-to-Sales$_{t-1}$	-0.751	0.280	-0.722***
	(0.455)	*(0.388)*	*(0.254)*
δ_2 Leverage$_{t-2}$ or Debt-to-Assets$_{t-2}$ or Debt-to-Sales$_{t-2}$	-0.476**	0.362	-0.750***
	(0.181)	*(0.371)*	*(0.203)*
γ_1 Investment rate$_{t-1}$	-0.044	0.203	1.632
	(0.287)	*(0.367)*	*(1.201)*
γ_2 Investment rate$_{t-2}$	0.040	0.004	2.770
	(0.307)	*(0.354)*	*(1.757)*
P-value test on H_0: $\gamma_1 = \gamma_2 = 0$	0.10 (0.91)	0.24 (0.79)	1.28 *(0.306)*
Arellano-Bond test for AR(1) *(p-value)*	0.263	0.110	*0.835*
Arellano-Bond test for AR(2) *(p-value)*	0.860	0.502	*0.099*
Sargan-Hansen test *(p-value)*	0.980	0.746	*0.816*
N. Firms [N. Obs.]	16 [90]	16 [90]	15 [90]

APPENDIX A1 – A STYLIZED MODEL

Consider a vertically integrated monopoly where the incumbent operates both in the upstream and downstream segment of the market. In the upstream segment, the incumbent manages the telecoms network, the essential input of the industry. In the downstream segment the incumbent firm competes with alternative operators for providing retail services to final users. Following Laffont and Tirole (1994), the incumbent is regulated both at wholesale (access charge) and retail level; moreover, the incumbent faces a competitive fringe in the potentially competitive markets.[36] In order to provide the retail service, both the downstream unit of the incumbent and all alternative operators have to buy access to the existing infrastructure. We assume that for providing one unit of final services each operator needs one unit of access. Denote the access charge with a and the access unit cost faced by the incumbent with c. We assume – to simplify – that the cost of providing retail services (c_r) is equal for both the incumbent and the alternative operators. To model the firm's choice of capital structure, we assume that the firm's upstream costs are subject to random cost shocks. Therefore, the *upstream* unit cost faced by the vertically integrated incumbent operator is given by $c(1–z)$, where z is a random variable distributed uniformly over the unit interval. Hence, higher values of z correspond to "better" states of nature. Differently from Spiegel (1994), the random shock here impacts directly on the access cost and in turn on the regulated wholesale charge but only indirectly on regulated retail charges.

Consider for simplicity (but without a serious loss of insights) that the market faces a unit demand function. The consumers' willingness to pay depends on the firm's investment level, k, and is given by a twice differentiable function $V(k)$, with $\partial V/\partial k > 0$, $\partial^2 V/\partial k^2 < 0$. k can be interpreted as a measure of the "quality" of the firm's product or the range of its services. Using p to denote the regulated retail price, consumers' surplus is given by $CS(k, p) = V(k) – p$. The (unit) market demand is shared among the firms; denote with, Q_I and Q_E the quantity supplied downstream by the incumbent and by alternative operators as a whole, respectively, where $Q_I + Q_E = 1$. Finally, let $c < V(0)$.

Let D denote the face value of the firm's debt, which the firm needs to cover from its revenue. The operating income of the regulated firm can now be written as the sum of the retail and

[36] The assumption on fringe competition is made here for expositional purpose and leads us to get clear results and to derive well specified testable predictions. A similar assumption is used also in Armstrong and Vickers (1993) for similar reasons.

wholesale profits. As the retail profit is equal to $(p - a - c_r)Q_I$ and the wholesale profit is $(a - c(1 - z))(Q_I + Q_E)$, the operating profit of the incumbent is:

$$\pi_I(p, a, z) = (p - c_r - c(1-z))Q_I(p) + (a - c(1-z))Q_E(p) \tag{A1}$$

while the operating profit of the alternative operators is: $\pi_E(p,a) = (p - a - c_r)Q_E$. It is straightforward to note that competition in the market is asymmetric: the vertically integrated incumbent pays the marginal cost for the provision of the final service, i.e. $c_r + c(1-z)$, while the marginal cost of alternative operators' includes the regulated access charge, i.e. $a + c_r$, that could differ from the underlying cost of access.

Since alternative operators are price takers in the downstream market, they produce till the point in which their marginal cost equates the retail price, i.e. $p = a + c_r$ (see Laffont and Tirole, 1994).

For a given debt obligation D and regulated rates p and a, let $z^*(p, a, D)$ denote the critical state of nature above which the incumbent can pay D in full. $z^*(p, a, D)$ is generally given by:

$$z^*(p,a,D) = \begin{cases} 0 & D + c + c_r Q_I \le pQ_I + aQ_E, \\ \dfrac{D + c - (p - c_r)Q_I - aQ_E}{c} & D + c_r Q_I \le pQ_I + aQ_E < D + c + c_r Q_I, \\ 1 & pQ_I + aQ_E < D + c_r Q_I. \end{cases} \tag{A2}$$

Equation (A2) implies that as long as the revenues ($pQ_I + aQ_E$) cover the debt obligation and the cost, then the probability of financial distress is zero. If the revenues are larger than the debt obligation but lower than the sum of debt and operating costs, the probability of financial distress is positive. If the sum of retail and wholesale revenues does not fully cover the debt obligation and the downstream retail costs even when the cost for providing the access is zero, then the probability of financial distress is 1. Note that this probability increases with D and decreases with p and a. Since $p = a + c_r$, instead of using p, we now rewrite the model using a as the main variable. Equation (2) becomes:

$$z^*(a,D) = \begin{cases} 0 & D + c \le a, \\ \dfrac{D + c - a}{c} & D \le a < D + c, \\ 1 & a < D. \end{cases} \tag{A3}$$

Let T be the (fixed) cost of financial distress which occurs when the firm fails to meet its debt obligation. We can now rewrite the expected profit of the regulated vertically integrated firm as follows:

$$\pi_I(p,a,D) = \left[p - \left(c_r + \int_0^1 c(1-z)dz \right) \right] Q_I + (a - \int_0^1 c(1-z)dz) Q_E(p) - Tz^*(p,a,D)$$

$$= \left(p - c_r - \frac{c}{2} \right) Q_I + (a - \frac{c}{2}) Q_E - Tz^*(p,D) = \left(a - \frac{c}{2} \right) - Tz^*(a,D) \qquad \text{(A4)}$$

Substituting for $z^*(a,D)$ from equation (A3) and rearranging, yields:

$$\pi_I(a,D) = \begin{cases} a - \dfrac{c}{2} & D + c \le a, \\ a - \dfrac{c}{2} - T\left[\dfrac{D + c - a}{c} \right] & D \le a < D + c, \\ a - \dfrac{c}{2} - T & D > a. \end{cases} \qquad \text{(A5)}$$

It is worth noting that, under the assumption that the incumbent competes with a fringe, equations (A4) and (A5) correspond to the profit function of a pure monopolist in Spiegel (1994, pag. 301). In other words, adapting the Spiegel (1994)'s model to a framework with a vertically integrated and regulated incumbent facing downstream competition by a fringe, we are able to recover the original results of Spiegel (1994), with the only difference that in our model the (directly) regulated price is the *access charge* while the retail tariff is indirectly set through a. Given that our main purpose is to obtain testable predictions, we now determine the relationship between the optimal regulated access price and the debt, D. This will also allow us to derive predictions on the impact of D on the degree of market competition. On the contrary, since the framework is analogous, we refer the reader to Spiegel (1994) and Spiegel and Spulber (1994) for the technical derivation of the optimal choice of the capital structure and investment.

Following Spulber (1989), we assume that the wholesale price is determined by bargaining between the firm which is interested in maximizing its profit and the regulator who is interested in maximizing consumers' surplus.[37] Using the generalized Nash-bargaining solution, the regulated wholesale price is given by:

$$\underset{a}{Arg\max} = CS(k, p(a))^{\gamma} \pi(a, D)^{1-\gamma} \qquad \text{(A6)}$$

where $\pi(a,D) = \pi_I(a,D) + \pi_E(a)$ is the aggregate profit of the industry. The parameter γ captures the regulatory climate: the higher γ is, the more pro-consumer the regulator is.

The strategic interaction between the firm and the regulator evolves in three stages. In stage 1, the firm chooses its investment level, *k*, and its debt level, *D*. If the funds raised by issuing *D* are insufficient to finance *k*, the firm can raise additional funds by issuing equity. In stage 2, the market value debt (and possibly equity) is determined in a competitive capital market. In stage 3, given *k* and *D*, the regulated wholesale charge (*a*) is set by the regulator. Finally, the random variable *z* is realized, output is produced, and payments are made.

The optimal regulated access charge *a**(*D*, *k*) is determined trading off consumer surplus against the expected cost of financial distress. The proof of existence and uniqueness of the equilibrium would follow the lines of a similar proof of Spiegel (1994; see the Appendix, page 316). Thus, after maximizing condition (A6), and using condition (A5), we obtain the optimal wholesale rate as follows:

$$a^*(D,k) = \begin{cases} M_1(k) + c & D \le M_1(k), \\ D + c & M_1(k) < D \le M_2(k) \\ M_1(k) + c + M(D) & M_2(k) < D \le M_3(k) \\ M_1(k) + c + \gamma T & D > M_3(k). \end{cases} \qquad \text{(A6)}$$

where, $M_1(k) \equiv (V(k) - c_r)(1-\gamma) + \gamma \frac{c}{2} - c$, $M(D) \equiv \frac{\gamma T}{c+T}\left(D + \frac{c}{2}\right)$,

$M_2(k) \equiv \frac{M_1(k)(c+T) + \gamma T \frac{c}{2}}{c + (1-\gamma)T}$, $M_3(k) \equiv M_1(k) + c + \gamma T$.

[37] We assume that in the bargaining game the competitive fringe does not play any active role. In other words, we implicitly consider that the regulator acts not only on the behalf of the final users, but also on the behalf of alternative operators as a whole (the competitive fringe). Alternatively, we might think of revising the Nash bargaining game to take into account that in regulated industries not only the incumbent, but also the entrants try to influence the regulatory outcome. In this case, one would need to deal with a Nash bargaining solution with three participants, the incumbent, the regulator and a competitive fringe. This approach however would make the analysis much more complex and, more importantly, less in line with the aim of our empirical strategy focused on the incumbents' strategic interaction with the regulator. We believe that our approach not only simplifies the framework, but it also fits better the market conditions we observe in the EU telecom industry immediately after the introduction of market reforms, where alternative operators were typically weak competitors and were highly supported by NRAs.

This solution holds ad long as $\gamma < \frac{V(0)-c}{V(0)-c/2}$. From equation (A6) we can draw some insights on the relationship between debt *D* and the regulated wholesale (and indirectly retail) charge: as long as the debt level is relatively low, i.e. $D \leq M_1(k)$, then the social optimal access charge is not affected by *D*. As long as debt increases, the regulator decides to raise the wholesale charge in order to avoid financial distress, and so we obtain *a* = *D* + *c*. However, this only applies up to a limit, since an excessively high access charge would negatively affect the consumer surplus. Therefore, as long as debt increases, i.e. in the range $M_2(k) < D \leq M_3(k)$, the regulator no longer finds optimal to increase the access charge with *D* on a 1:1 basis because of its negative impact on the consumer surplus. Finally, when debt is too high ($D > M_3(k)$), the probability of financial distress is 1. Since bankruptcy is now inevitable, there is no reason to incorporate any longer the debt in the access charge and therefore the regulated access charge is constant with *D*, but it is affected by the cost of financial distress *T*. It is immediate to see that the regulated access charge is positively affected by the debt level, *D*, as long as leverage is within some threshold level. Moreover, since the regulated retail price is equal to $p = a + c_r$, then also *p* is positively affected by *D*. Therefore, our first testable prediction is that *the regulated wholesale charges and retail prices both increase with the firm's debt*.

Now, notice that the quantity sold by alternative operators depends on the marginal cost they face, i.e. $Q_E(p(a+c_r))$. Since, in the relevant range of *D*, $\frac{\partial a^*}{\partial D} > 0$, $\frac{\partial p}{\partial a^*} > 0$ and $\frac{\partial Q_E}{\partial p} < 0$, we obtain that the higher the access charge the lower the unit sold by alternative operators (given their increasing marginal costs) while, in contrast, the marginal cost of the vertically integrated incumbent ($c + c_r$) does not change. As long as debt affects the regulated access charge, it will also negatively influence the degree of market competition, as the market position of the incumbent will become stronger and that of the alternative operators will be weaker (i.e. $\frac{\partial Q_E}{\partial D} < 0$). We thus derive the second testable prediction: *market competition in the retail segment gets weaker as long as the regulated firm issues more debt***.**

Finally, we analyze the relationship between debt and investment. From this point onwards, our stylized model corresponds exactly to the Spiegel and Spulber (1994)'s and Spiegel (1994)'s. In their model, *k* and *D* are simultaneously chosen by the firm in the first stage. Since we do not add any significant contribution to/ this part of the analysis we prefer, for reasons of space, not to include further calculus here and directly refer the reader to Spiegel (1994)'s Section 3.2-3.3-3.4 for additional details. In sum, the Authors find that the investment level is always below the social optimal level, which implies that the regulated firm still under-invests even if debt is issued. However, insofar as debt is used as a commitment device to limit the regulator ex post opportunism, the ex-ante incentives to invest will be enhanced, and this will lead a leveraged regulated firm to invest more than an all-equity-firm. Therefore, from the empirical point of view, *we expect ex post a positive relationship between investment and debt*, i.e. $\frac{\partial k}{\partial D} > 0$. This is our third empirical prediction.

APPENDIX A2 – VARIABLE DEFINITIONS

Variable Definitions	
Investment Rate	Gross fixed investment/Capital Stock at replacement value
Leverage	(Short and long term financial debt)/(Book Equity+ST+LT financial debt)
Debt-to-sales	(Short and long term financial debt)/(Sales)
Debt-to-total assets	(Short and long term financial debt)/(Total Assets)
Total Assets (log)	Log of real total assets
Real sales (log)	Log of real sales
Tangibility	Net fixed assets/ Total Assets
EBIT-to-Asset	Earnings before interests and taxes/Total Assets
Non-Debt Tax Shield	(Depreciation and amortization)/Total Assets
Cash Flow to Capital Stock	Cash Flow/Capital Stock at replacement value

APPENDIX A3 - SAMPLE FIRMS

Company Name	**Country**	**Sample Period**
Telekom Austria AG	Austria	1998 – 2005
Belgacom SA	Belgium	1994 – 2005
TeleDanmark AS	Denmark	1994 – 2005
Sonera	Finland	1997 – 2002
France Telecom	France	1994 – 2005
Deutsche Telekom AG	Germany	1994 – 2005
OTE (Hellenic Telecom Organization)	Greece	1994 – 2005
EIRCOM	Ireland	1999 – 2005
Telecom Italia SpA	Italy	1994 – 2005
Koninklijke KPN NV	Netherlands	1994 – 2005
Portugal Telecom SA	Portugal	1994 – 2005
Telefonica de Espana SA	Spain	1994 – 2005
Telia AB	Sweden	1997 – 2005
British Telecommunications PLC	UK	1994 – 2005
Kingston Communications	UK	1998 – 2005