Access Regulation, Financial Structure and Investment in Vertically Integrated Utilities: Evidence from EU Telecoms

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Access Regulation, Financial Structure and Investment in Vertically Integrated Utilities: Evidence from EU Telecoms*

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Abstract

We examine theoretically and empirically the relationship between access regulation, financial structure and investment decisions in network industries, analyzing if financial variables can be used as a strategic device to influence the regulator's price setting decisions. Using a panel of 15 EU Public Telecommunication Operators (PTOs) over the period 1994-2005, we first investigate the determinants of regulated prices (both wholesale and retail), firm financial structure and investment, and then test the relationship between leverage, regulated charges and firm's investment. However, our model suggests that if leverage influences the regulated access charges, then it will also impact competition in the downstream segment. Therefore, we also investigate the impact of the PTO's leverage on market competition. Our results show that leverage positively affects regulated rates, as well as the PTOs' investment rate, as predicted by Spiegel and Spulber (1994). Moreover, higher leverage also leads to higher access charges and 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 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.

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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 affects investment decisions, especially when pro-competitive regulatory regimes are introduced.[2] An instrument that regulators typically adopt to enhance competition in the potentially competitive segments of a market is the obligation to provide access *"at fair and non-discriminatory conditions"* to the existing network, which is typically operated and maintained by an incumbent firm. Access (or wholesale) regulation plays a fundamental role in vertically integrated markets, where the network is the essential facility for the provision of final services and access is vital to encourage and sustain entry in the competitive segment of the market.

However, investment decisions are affected not only by regulation but also by firms' financial stability. When the financial position of a regulated firm deteriorates, the risk of financial distress also increases and this compromises the financeability of investments as the managers become more concerned with the firm's financial solvency than with infrastructure expansion.[3]

This paper analyses the relationship between access regulation, financial structure and investment decisions in a vertically integrated industry, the telecommunications industry, and empirical investigates if financial variables can be used as a strategic device to influence the regulator's price setting decisions, competition in the retail segment, and incumbents' investment decisions.

Modern telecommunications are an interesting case to study because access regulation has became the key feature of the regulatory framework since the inception of market liberalization and investment in new communication infrastructures – such as *Next Generation Networks* (NGNs) that will provide high-speed connection and broadband and ultra broadband services in the next future – is believed to be a significant contributor to economic growth.[4]

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

[2] See, for example, Alesina et al. (2005) who find a positive relationship between deregulatory reforms of product markets and investment. In particular, entry liberalization plays an important role to spur investment.

[3] Recently, a joint study of the UK Department of Trade and Industry (DTI) and the HM Treasury (DTI-HM, 2004) has expressed a concern about the "dash for debt" or "flight of equity" of UK utilities, including telecom incumbent British Telecom.

[4] NGNs 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 the average impact of broadband infrastructure on GDP is 0.63% (for the EU-15, in the period 2002-2007), that is, 16.92% of total growth in this period. 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.

Recent debate on investment in telecoms infrastructure is mostly focussed on the impact of access regulation.[5] We depart from existing studies because we introduce the capital structure decisions of the regulated incumbents in the interplay between access regulation and investment.

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, because of the PTOs' financial gearing. 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]. This situation has even worsened after 2005: at the end of 2008, the net debt position of Deutsche Telekom was equal to 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 with 45 billion of euros! In addition, new bonds are going to be issued in the next years (2010-2011) to finance European telecoms operators' activities for an expected value of 45 billion of euros.

Theoretical models developed by Spiegel and Spulber (1994) and Spiegel (1994 and 1996) identify the capital structure as a strategic mechanism that affects the regulator – regulated firm interaction, when regulators cannot commit not to review ex post the regulated charges. This lack of commitment typically leads to an underinvestment problem. High debt levels can make regulators concerned with the financial stability of the incumbent operator and reluctant to reduce regulated rates, thus shielding the firm against ex post regulatory opportunism. Therefore, the choice of the debt level can be viewed as an instrument that partially limits the underinvestment problem originating from the time inconsistency of the regulatory intervention.[7] Empirical evidence by Bortolotti, Cambini, Rondi and Spiegel (2008) shows, for a large panel of EU utilities, that higher leverage leads to higher retail rates, provided firms are subject to an independent regulator and privately controlled.

[5] See, for example, Waverman et al. (2007) and Grajek and Röller (2009) find a discouraging role of wholesale regulation (in the form of local loop unbundling) on 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).

[6] Cited in "European company debt at five-year high", by D. Oakley, *The Financial Times*, November 3rd, 2006.

[7] In practice, regulators do take the cost of debt into account when they set retail and wholesale charges. The most widely used price mechanisms in Europe and US – e.g. the rate of return or the price cap at retail level and the cost-based access charge or network caps at wholesale level - refer to the weighted average cost of capital (WACC) as the interest rate to evaluate the allowed capital expenditures. Thus, as long as indebtedness affects the way a regulated tariff is computed and, at the same time, determines how investment outlays are financed, the incentives for a strategic use of debt may ultimately be stronger than for a literal application of the pricing mechanism.

In this paper, we analyze both theoretically and empirically the strategic role of leverage and its impact on regulated (retail but also *wholesale*) rates and firm's investment decisions. We first develop a stylized model that combines the Spiegel (1994)'s model of capital structure choices in a regulated environment with the Laffont and Tirole (1994)' model that studies the optimal social choice of wholesale rate in a vertically related industry. From our simplified model, we derive empirical predictions that we test using firm level data for a panel of 15 EU PTOs and country level regulated rates over the period 1994-2005. We first analyze the determinants of wholesale and retail prices, of firm leverage and firm fixed capital investment. We then test the relationship between capital structure and regulated - both retail and wholesale – charges. 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 regulated access charge, this in turn has an impact also on competition in the retail segment. Bearing this in mind, we 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. Finally, we investigate the interaction between debt and investment of fixed telecoms operators.

The empirical investigation controls for key features of the institutional context, such as the degree of regulatory independence (as in Edwards and Waverman, 2006) and its intensity (as in Grajek and Röller, 2009), the intensity of regulation of market entry (as in Alesina *et al*. 2005), the regulatory climate through political variables (as in Bortolotti, Cambini, Rondi and Spiegel, 2008) and also for firm productivity growth as a proxy for technological change. We deal with endogeneity problems by applying instrumental variable methods that either use institutional and political variables to instrument the regulatory environment or framework or employ lags of internal right-hand variables (GMM estimator) when dynamic models are estimated.

This paper has three main contributions. First, we extend Spiegel (1994)'s model and provide a simplified theoretical framework to analyze the interplay among capital structure, *access* regulation and investment. Secondly, we investigate whether the PTOs' capital structure affects wholesale charges and, in turn, competition in the retail downstream segment. To the best of our knowledge, this is the first paper that analyzes the impact of capital structure decision on regulated wholesale charges. [8] Thirdly, we provide empirical evidence of the interaction between financial and investment decisions in the European telecoms industry.

[8] 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 telecom regulation focuses mainly on the definition of optimal price mechanism where asymmetric information is viewed as the most serious problem vexing the

Our results show that an increase in leverage positively affects regulated rates, both at the retail and at the wholesale level. We also find that increases in leverage have a negative impact on competition, but a positive effect on the PTOs' investment rate. 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 as 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 empirical predictions. In section 3, we describe the Institutional background on EU telecommunication industry and in section 4 the changing pattern of market competition and of interconnection rates in Europe. In section 5 we describe the dataset and the firm level variables. In section 6 we present the econometric results. Section 7 summarizes the main results and concludes.

2. Theoretical framework and empirical predictions

One primary goal of regulation is to promote competition and to enhance social welfare (Armstrong and Sappington, 2006). A major drawback however is that a conflict between social and private interests arises whenever pro-competitive and efficiency enhancing regulatory regimes may undermine the firm's incentives to invest and maintain the infrastructure.[9] This tension is typical of telecom operators where adequate provision of the service requires large amounts of investment that is both irreversible and risky, and uncertainty in the regulatory framework and rules can further deprive utilities' incentives to invest. When regulators cannot commit to long-term regulated prices, they may have an incentive 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 the literature has introduced the capital structure decision as a potentially useful instrument to restraint regulatory opportunism (Spiegel and Spulber, 1994, Spiegel 1994 and 1996). 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 retail rates *ex-post*, and re-establishing

regulator-PTO relationship (Laffont and Tirole, 2000; Armstrong, 2002; Vogelsang, 2003, among others) We do not find papers that analyze the impact of capital structure decisions on the wholesale rates setting process.

[9] 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*".

the firm's incentives to invest. Debt financing may thus lead to higher regulated prices while at the same time encouraging regulated firms to increase their investment rates.

Following these predictions, Bortolotti, Cambini, Rondi and Spiegel (BCRS, 2008) investigate the relationship between the capital structure and the 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 Authority, but only if they are privately-controlled, and ii) higher leverage leads to higher regulated rates, i.e. leverage Granger-causes regulated prices (but not vice versa), when firms are privately controlled and regulated by an IRA. BCRS (2008), however, do not examine the relationship between leverage and investment and, more importantly, the leverage-price relationship is analysed only for retail charges.

In this paper, we depart from existing works in two directions. First, we analyse the relationship between capital structure and investment decisions, testing the prediction implicit in Spiegel and Spulber (1994)'s model that higher leverage leads to higher investment. Second, we extend the analysis to account for the typical vertical structure of telecommunications industry and the specific regulatory interventions on wholesale – i.e. access – rates as well as the retail prices. 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 both. The theory is silent about this because the original model is designed for a monopolistic utility industry where access to an essential facility was not an issue. In contrast, the market structure of telecom industry in most European countries is characterised by an upstream monopolistic network segment and a downstream retail segment with a dominant incumbent (usually the PTO) competing with alternative new entrant operators. Hence, whether the regulator reacts by adjusting the access or the retail charge, or both, will have a consequence for competition in the downstream segment and, in turn, for the incumbent's investment incentives.

Unfortunately, complicating factors in the telecommunication industry potentially prejudice the interpretation of the empirical analysis. First, regulation of access rates is usually more intensive than regulation of retail charges because there is much less competition in the upstream segment. Second, wholesale rates usually influence retail charges thereby following a similar trend, though, in addition, the latter are also affected by competition. Third, the effectiveness and the independence of regulators may influence the regulated firm's investment decisions. We therefore have to reconsider the original model's predictions – i.e. debt leads to higher regulated prices and, at the same time, encourages regulated firms to increase their investment levels - by taking theses complicating factors into account.

In order to derive testable predictions in this complex framework, we develop a stylized model in the Appendix that combines the Spiegel (1994)'s model of capital structure choices in a regulated environment with the Laffont and Tirole (1994)' 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.[10] Moreover, the alternative operators need access to the existing network for providing the final service. The access charge is therefore subject to regulation by a benevolent regulator, who is not able to ex ante fully commit in his price setting decisions. Following the approach by 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, in the same vein of Spiegel and Spulber (1994) and Spiegel (1994), provides the following results: as far as the regulated charges concern, it results that 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 final price. Therefore, there exists a direct relationship between the regulated (wholesale and retail) charges and the level of the debt. This is our first set of testable prediction. If the level of debt positively affects the wholesale rate, then it will also affect the quantity sold in the downstream segment by alternative operators, since their marginal cost for providing the final service rises too. On the contrary, the vertically integrated incumbent operator will only pay the real marginal cost of the service, which is likely to be lower than the one faced by the alternative operators whenever the access charge is not entirely "cost oriented" and firms are equally efficient in the downstream segment. Then, the incumbent could use debt not only to influence the regulator's price setting decision, but also to put the rivals at disadvantage. In this event, our testable prediction is that the higher is the debt, the lower is market competition. We will measure this sort of *raising rival cost effect* induced by the leverage, using two (absolute and relative) measures of the degree of market competition: the number of competitors and the evolution of the market share of the incumbent. The reason why the regulators permits that the regulated charges raise with the debt, at least up to a threshold level (see equation A6 in the

[10] Even though this assumption could seem too strong, it is needed to simplify our analysis without any loss of relevant insight. Moreover, with the only exception of UK and Sweden, competition in the telecoms market within our time horizon is quite limited, as shown in Section 3.

Appendix) , is – as shown by Spiegel and Spulber (1994) - to tie their own hands and reduce their ex post opportunism. Insofar as debt can shield the incumbent from ex post opportunism by the regulator, debt will also provides the regulated firm with better incentives to reduce the typical underinvestment problem. As argued by Spiegel and Spulber (1994, p. 436), debt influences investment because "*the regulator will permit firms to take on debt only if debt increases the firm's ex ante investment level*". Thus, and this is our third prediction to test, we would expect that the higher the debt issued by the firm the higher the investment rate is.

It is worth noting that so far we have never mentioned neither the quality of the regulatory environment nor social welfare objectives that the government in charge might wish to promote, although both of these institutional aspects deeply affect the efficacy of the action and the stance of the regulator – e.g. pro-firm or pro-consumers, pursuing static or dynamic efficiency. 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. 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). 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 agenda, and make it more or less pro-firm or pro-consumers, but also firm investment and financing decisions, as, typically, stock markets favourably react to right-wing governments. Since we recognize the importance of the regulatory and political environment, we will control for their impact in the empirical analysis.

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 telecommunications services have led to intense changes in both the market / industry structure and the regulatory framework. Many European countries, following the UK experience of structural reforms in the '80s, have gradually liberalised the domestic markets and privatised public telecommunications operators.[11] With very few exceptions, public telecom operators are now privately controlled and the retail market is (almost) fully liberalised almost everywhere.

[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

From the start, the key concern of the newly established IRAs was that the design of the regulatory framework could guarantee that potential entrants have both access to and interconnection with the network, since this crucial asset belonged (and still belongs) to the incumbent fixed telecommunication operators. Since 1998, many telecom services have been liberalized and deregulated, the most prominent example being the retail services.[12] In 2003, also telecom services for specific traffic directions - mainly international calls – and specific client categories – mainly business users – were gradually deregulated. However, at the end of 2005, price regulation (through a price cap or other forms of tariff approval) of voice services for family users was still in place in many EU countries[13] and PTOs were (and still are) under tight regulatory obligations on wholesale services. In December 2007, the European Commission revised the regulatory framework in order to limit *ex ante* intervention at the retail level, and to focus, instead, on access and interconnection services (Recommendation 2007/879/EC). In sum, 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 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 72% in the local segment and 65% 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

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] 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).

[13] 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.

national market. Therefore, in this period, competition is largely asymmetric and incumbents still dominate the retail market.

Competition among operators is more likely to be based on *services* rather than on *alternative infrastructures* (EC, 2006; figure 19): at the end of 2005 direct access to alternative providers is 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. LLU is supposed to be the appropriate regulatory scheme to stimulate competition among operators in the early stages, i.e. when entrants have not yet rolled out alternative infrastructures. However, 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 our 1998-2005 sample period, telecom utilities compete over the provision of telecom *services* rather than on duplication of alternative facilities, and alternative operators have to access to the incumbent's network at various levels of the multi-layered network structure.[14]

Access charges play a key role in the development of the telecom market and identify the bulk of the regulatory issues for telecommunications industry (Cave, 1997, Laffont and Tirole, 2000). Through access to the network, entrants may terminate the call they have originated into the existing incumbent network and are allowed to reach customers without having to duplicate the infrastructure of their own. For these reasons, one of the main concerns for NRAs is 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 may access to the incumbent's fixed network through different wholesale services, like *local access* and *single tandem interconnection* (Edwards and Waverman, 2006). The choice among interconnection modes depends on the amount 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

[14] 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.

(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).[15] 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.[16]

Figure 1 shows the price indexes for the two rates (2005=100). From 1998 to 2005, the interconnection rates halved (*single transit* even more than halved). The remarkable descent of access charges was unquestionably influenced by intense NRAs' supervision as well as by major progress in the information and telecommunication technology, as telecom utilities significantly increased their productivity levels in the past decade.

4. The data

Our dataset comprises firm level variables for 15 publicly traded Public Telecommunication Operators (PTOs) from 14 EU countries during the period 1994-2005 (see the list of firms in the Appendix A.3). The panel is unbalanced, as firms have from 6 to 12 consecutive observations. We construct our dataset by merging accounting and financial market data from *Worldscope* with several sources in order to obtain: wholesale charges (Eurostat - New Cronos; European Commission – DG XIII, Telecommunications Regulatory Package); retail price indexes and fixed investment price deflator (Eurostat and OECD); information on the institutional context such as the regulatory environment and regulatory independence (Edwards and Waverman, 2006); the extent of regulation of market entry (OECD International Regulation database by Conway and Nicoletti, 2006); and the intensity of specific market regulation (Plaut Index by Zenhausern *et al*., 2007).

The theoretical implications of the model focus on three variables, financial indebtedness, regulated prices and fixed investment.

[15] *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 all of 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 mostly used at the beginning of the liberalization process, i.e. when new operators entered the market. Since *Double tandem interconnection* lost its relevance as market competition increases, (see ERG, 2007), we prefer to focus on the mostly used access services.

[16] 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.

To define indebtedness we consider measures that capture the risk of the default.[17] 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. 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 a robustness checks.

We estimate our models using both retail and wholesale charges. Retail prices at the individual firm level are not available, therefore we use sectoral retail price indexes, which incorporate the changes both in traffic (*usage*) charges (for local, national and international calls) and in monthly fixed fees. Because the regulators in the newly liberalized market had to enforce "tariff rebalancing", the different components of the typical "telecom bill" ended up following opposite trends: ascending over time that of fixed monthly fees and downward that of usage charges.

As for wholesale charges, we use the access rates on the incumbent's fixed network for *local* level and for *single* transit that we described with some detail in section 2.2.

Investment rate is the change in the fixed capital stock. In the econometric analysis we use the investment rate calculated as the ratio of gross fixed investment to capital stock at the replacement value.[18]

Figure 2 shows that, similarly to wholesale rates, also the fixed retail prices substantially diminish over this period. As described in Section 2, the decline of retail prices results from regulatory intervention, competition pressure as well as technological change. By construction, the impact of technological progress, and the fast-growing productivity of telecom operators has influenced regulatory rates (both retail and wholesale) through the (price and network) cap mechanism.

Labour Productivity and the Total factor Productivity index account for increasing efficiency at the firm level. The former is the ratio between real sales revenues and the number of employees, the latter we obtain from estimating a Cobb-Douglas production function.[19] Figures 3a

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[17] See Rajan and Zingales (1995) for a discussion of alternative leverage measures.

[18] 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: $p_{t+1}K_{t+1} = p_tK_t(1\text{-}\delta)(p_{t+1}/p_t) + p_{t+1}I_{t+1}$, 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, we use the Bureau of Economic Analysis estimates as reported in "Rates of Depreciation, Service Lives, Declining Balance Rates, and Hulten-Wykoff Categories" and applied a constant rate of 8% for telecommunications.

[19] To obtain an index of total factor productivity from estimating a Cobb-Douglas gross output production function of the form: $Y_{it} = AK_{it}^{\alpha}L_{it}^{\beta}X_{it}^{\gamma}$ where Y is output, A is a Hicks-neutral productivity shift parameter, K is capital output, L is labour, X is intermediate inputs, α, β, γ are the elasticities of output with respect to the relevant factor. We estimated the production function in log-linear form: $y_{it}= a_{it} + \alpha k_{it}+ \beta\, l_{it}+ \gamma x_{it} + \mu_t$, where variables in lower case are

and 3b show the average Labour Productivity and the average TFP Index for the fifteen PTOs in our sample. The upward trend of labour productivity is weak until 2001, even slowing down between 1999 and 2001, and then accelerates between 2001 and 2004. The pattern of the TFP index is similar, with a lower peak in 1998, a slowdown until 2001 and then a fast increasing trend up to 2005. It is worth noting that both TFP and labour productivity nearly doubled while the regulated rates nearly halved over the period, thus confirming that technological progress played a key role in this evolution.

Figure 4 show the average financial leverage from 1994 to 2005. The trend is quite steep, it is steadily increasing up to 2000 and it reverts and drops in 2003, and thereafter resumes its growth. Finally, in Figure 5 we report the average investment rates. The pattern is very irregular from 1995 to 1999, even collapsing in 1996 and 1997 just before the liberalization EU directives. Investments increase more smoothly from 1999 to 2003 and then again they decline.

Table 2 reports the summary statistics for the variables we use in the econometric analysis.

5. Empirical analysis

Our goal is to investigate, for the 15 European PTOs in the dataset, the relationship between capital structure, investment and regulatory outcomes over the period from 1995-2005. As discussed in Section 2, complicating factors in the telecommunications industry and in the regulatory environment have to be considered, and controlled for, in order to interpret the results. Our empirical strategy thus starts with the analyses of the determinants of wholesale and retail rates, of PTOs' investment and leverage, and continues with the analysis of the dynamic interactions between leverage and investment, regulated rates and market competition (as proxied by the number of competitors in the retail segment and by the market share of the incumbent in the national retail market). For this purpose, we will perform Granger (1969) and Sims (1972) causality tests, which allow us to evaluate whether higher leverage leads to higher prices and to weaker (or tougher) competition, or viceversa.[20]

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logs and μ_t is a year dummy. We used instrumental variables (2SLS) to estimate the log-linearized production function to take account of the simultaneity between input choices and productivity shocks. Lagged values of *k*, *l*, *x*, and the firm market share were used as instruments. We included the market share because over the last decade incumbent PTOs began to underuse their fixed network productive capacity due to a fast increase in intra-modal competition (increase in the number of fixed telephony competitors at the retail level) and in inter-modal competition (increase in the adoption of mobile telephony). The residual a_{it} can be interpreted as TFP (see Van Biesenbroeck, 2007, for a recent survey), and we used it to construct the TFP index and Figure 3b.

[20] 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

5.1 Regulated Rates, Fixed Investment and Leverage in EU PTOs

5.1.1 Regulated Rates

The econometric analysis of the determinants of regulated rates is reported in Table 2. We estimate a simple specification where wholesale charges - *Local* and *Single transit* rates – and the Retail price index are regressed on the PTO's total factor productivity index – lagged one year -, on firm fixed effects and on a country-sector specific index that captures "regulatory independence" of telecom NRAs from government influence. By including an index of regulatory independence we attempt to control for the complexity, and the heterogeneity, of the regulatory environment. NRAs typically oversee interactions between the vertically integrated incumbent and entrant firms, and their decisions affect the PTOs', the alternative operators' and consumers' surpluses. Not surprisingly, governments may try to influence the NRA so as to induce decisions that are in contrast with "effective regulation" and, rather, consistent with their own political agenda, alternatively favouring entrants, consumers or the PTO. To prevent political interference in the decisions of the NRA and to make NRA as "independent" as possible from the government, institutional arrangements are set up (and even prompted by the European Commission) and we control for the degree of independence of the NRA by including the EURI index (European Union Regulatory Institutions) by Edwards and Waverman (2006). The index is based on information on formal institutional elements in the regulation of telecommunications such as the powers, the financing, the accountability, the tenure and the appointment of the regulator. It ranges from 0 (low independence) to 1 (high independence). As more independent NRAs are predicted to be more able to commit to "effective regulation", we expect, similarly to Edwards and Waverman (2006), that the EURI index will enter our regression with a negative coefficient, that is the more independent the NRA the lower the regulated rate.

Total factor productivity is included to test whether regulated rates are set consistently with economic criteria, that is with the typical "cost-orientation obligation", as requested by the EU's interconnection directives. In the absence of production and technical data to estimates "costs", as described in Section 2, we estimated a Cobb-Douglas gross output production function and then constructed an index of total factor productivity from (see Section 2). Total factor productivity is expected to capture not only the impact of declining "production costs", but also technological

accountability on performance measures 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.

progress in the telecommunication industry, as this would lower costs and, in turn, prices if NRAs successfully enforce "cost oriented" regulation.[21] We lag TFP one year because the regulator's information set at the time of the regulatory price review is typically based on previous years' accounting data.

Finally, in the specification of the retail price index regression, we also include an index of "regulatory intensity", the overall *Plaut Economics Regulation Index* (Zenhausern, Telser, Vaterlaus, Mahler, 2007), allowing us to investigate the role of several elements of regulation such as market entry, density and enforcement of price and quantity regulation, and other aspects that may be relevant for investment incentives. *Regulatory intensity*, which ranges from 0 (low intensity) to 1 (high intensity), is expected to have a negative impact on the retail price index.[22] As both the regulatory independence and the regulatory intensity indexes vary over time (as well as across countries/firms), they also contribute to controlling for the changing rules and performance of regulation in a period, such as the 1997-2005 years, when most EU countries liberalized the telecommunication market, privatized their PTOs and set up, for the first time, an independent regulatory framework.

Table 2 reports the results. In Panel A, the coefficients are estimated with a simple fixed effects model. We notice that the results for the wholesale rates in columns (1) and (2) are consistent with our predictions. The TFP Index enters with a negative and significant coefficient, suggesting that both the *Local Rate* and the *Single Tandem Rate* decline as productivity increases (i.e. as costs also decrease). The Regulatory Index also enters with a negative and significant coefficient confirming that more independent regulators are more successful in setting lower rates. The remaining columns report the results for the retail index. In Column (3), we find that, similarly to wholesale rates, both the TFP and the EURI Index enter with negative and significant coefficients, while in Column (4) we tests the effect of the Plaut index of regulatory index and find that tighter regulatory intensity appears related with lower prices.

In Panel B we include time dummies to control for factors that vary over time but are common across firms. The results are interesting. We find that the coefficient on Total Factor Productivity is no longer significant for both Local and Single tandem rates. This suggests not only

[21] Our TFP index is an aggregate measure of the total factor productivity change at firm level. Unfortunately, because revenue and cost micro data for different types of output are not available we are not able to estimate the TFP trend for each specific output (see Fuss and Waverman, 2002 for a general analysis of TFP estimation in telecoms). An alternative to "proxy" the firm specific evolution of production cost would be to include a country specific index, like the degree of urbanization (percentage of population living in urban areas) or the population density (population per squared kilometre), as in Edwards and Waverman (2006). .

[22] We do not include the Plaut Index – which covers many features of the access regulation (such as the existence of accounting separation requirements, full unbundling, bitstream access, line sharing, etc.) - in the wholesale rates regressions because of likely reverse causality problems.

that a relationship exists between the time dummies and the productivity trend, but also that the effect of the firm specific productivity growth is in practice captured by the common trend in the time dummies. We find a similar result in columns (3) and (4), for the retail prices. Once we control for the time fixed effects, also the EURI index turns insignificant in all specifications, while, in column (4), the Plaut index turns positive, though not significantly so. As both *regulatory independence* and *intensity* have a trend of their own (think, for example, of domestic reforms prompted by the EC), it is not surprising that their impact on prices weakens when we include the time dummies. Overall, taking together the results in Panels A and B, we may conclude that the level of regulatory independence and intensity (as measured by the value of the indexes), hence their differences across countries, matter more than their trends over time.

Finally, in Panel C we present the results from instrumental variables estimation (two-stage-least squares), which we employ because unobserved variables related to the institutional and regulatory environment may simultaneously determine both regulatory independence/intensity index and the regulated rates. For example, as remarked by Edwards and Waverman (2006, p. 48), countries where the *informal* institutional endowments that preserve regulatory independence are weaker are more likely to establish tighter and more *formal* rules and safeguards against government interference, thus creating a positive bias in the effect of the index due to the unobserved characteristics of the regulatory environment. To instrument the EURI index in columns (1)-(3), and the Plaut index in column (4), we use a set of variables that control for characteristics of institutional and political systems, as well as sectoral and ownership variables.[23] All regressions add firm and year fixed effects.

The results in Columns (1) and (2) are similar. Once we account for potential endogeneity of the EURI index, we find that regulatory independence does matter in both the Local Rate and the Single transit rate regressions (the p-value of the EURI coefficient in the single transit regression is 13.7%). The negative coefficients indicate that access prices tend to be lower if the regulator is (more) independent from government influence. In contrast, in Columns (3) and (4) we find that the

[23] The instrument set includes *Political Orientation, Political institutional disproportionality*", the OECD index of *Market Entry*, and the ownership share held by the state. *Political orientation* is an index ranging from 0 (extreme left wing) to 10 (extreme right wing) and 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 regulation. The *Political institutional Gallagher index of disproportionality* allows a categorization of countries based on a majoritarian-consensual dimension and is a measure of government stability and of the veto-power of minority parties The index is continuous; it equals zero when the apportionment of parliamentary seats is exactly proportional to electoral results, and it increases as disproportionality increases (Bortolotti and Pinotti, 2008). *Market Entry* reflects the terms and conditions of third party access and the degree of market openness at wholesale and retail level in the telecommunication industry. It is an index of market liberalization rather than an index of regulation (Conway and Nicoletti, 2006). The Government ownership share is constructed according to the weakest link approach to measure the state's ultimate control rights (UCR)(see BCRS, 2008).

impact of both regulatory independence and intensity on retail prices remains insignificant. Turning to the effect of total factor productivity on the wholesale charges, our findings show that the coefficients are negative and significant in both columns (1) and (2), suggesting that regulators successfully enforced the cost-orientation principle. This result is consistent with Edwards and Waverman (2006) who used country specific indexes to proxy production costs. In Columns (3) and (4), we find again that TFP does not display any significant impact on the retail price index. The lack of a significant effect of TFP on retail prices was somewhat expected because, as described in Section 4, the retail price indexes encompass the (opposite) trends of various - usage and fixed – charges, where only the former are likely to be affected by productivity growth or by cost reduction.

5.1.2 Investment

We now turn to the estimation of a dynamic investment model where we add regulatory variables. We derive our empirical model from the microeconometric literature on company investment[24] which suggests to include the *lagged investment ratio* to account for capital stock adjustment, *demand growth*, as measured by the log difference of firm sales, to account for accelerator effects, and the *cash flow to capital stock* to account for capital markets imperfections and asymmetric information problems that may cause investment decisions to be constrained by the amount of internal funds. To account for the impact of the institutional and regulatory framework, we then add, in turn, the index of Political Orientation, the EURI index of regulatory independence, the Plaut index of regulatory intensity, and the OECD index of Market Entry. 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. 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 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 use the Arellano and Bond (1991)

[24] 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.

autocorrelation test control for AR(1) and AR(2) and report the results with the regression, Firm and time specific fixed effects are included as regressors and as instruments.

Table 3 reports the results. In column (1) we test the baseline specification and find that the accelerator term (the contemporaneous sales growth term) is significant and has the predicted positive sign. The lagged investment rate is insignificant while the lagged cash flow rate enters with a positive and significant coefficient, suggesting that the PTOs' investment is constrained by the available flow of internal finance. These results are robust throughout the remaining columns of Table 3.

In Column (2), we add Political Orientation and find that the coefficient takes a positive and significant sign, suggesting that PTOs tend to increase their investment rates under more conservative governments. Although PTOs are ultimately *public utilities*, most of them have been fully privatized (even before our sample period starts) and therefore positively react to right-wing changes in the government that are more likely to carry out pro-firm policies (such as, for example, looser taxation on profits). In Column (3), we test the effect of the *OECD Market Entry* index and find that the coefficient is negative and significant (the p-value is at 6%). Since the value of index increases when entry gets more difficult, the negative sign implies that PTOs tend to invest more as entry in the downstream segment becomes easier.[25] In columns (4) and (5) we test whether either *Regulatory Independence* or *Intensity* influence investment, but we do not find any significant result. The remaining columns investigate the effect of the regulatory variables once we control for the political orientation of the government. The results show that *Political orientation* keeps its sign and significance in all specifications. Of the three regulatory variables, only *Market Entry* enters with negative coefficients, confirming a positive effect of entry liberalization on investment, regardless of the orientation of the political party in charge.

5.1.3 Leverage

We investigate the determinants of PTOs capital structure decisions by estimating a simple leverage model that includes various firm characteristics that were shown in the empirical corporate finance literature to be reliable determinants of capital structure.[26] Specifically, the set of controls includes the log of real total assets to control for firm's size (size is typically shown to have a positive effect of leverage), the ratio of fixed to total assets which reflects asset tangibility (tangible

[25] This result is consistent with Alesina et al. (2005).

[26] For common firm characteristics that are included in leverage regressions see for example, Titman and Wessels (1988), Rajan and Zingales (1995), Fama and French (2002), and Frank and Goyal (2007).

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 deductions for depreciations are substitutes for the tax benefits of debt financing). We then add the *Political Orientation* index and, in turn, the OECD *Market Entry* index, the *Regulatory Independence*, EURI index and the *Regulatory Intensity*, Plaut indexes. Table 4 reports the fixed effects estimates where both firm and time specific fixed effects are included.

Column (1) reports the result for the baseline specification. Both firm size and tangibility of assets enter with a significant coefficient. While the positive coefficient on firm size is quite typical, as not surprisingly largest firms may find it easier to obtain more leverage, the coefficient on tangibility is negative, 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 assets are highly firm specific and non-redeployable and may therefore serve as poor collaterals, even leading to a negative relationship with leverage. *Political Orientation* is the only other significant variable, entering the regression with a negative coefficient. If right-wing governments are more pro-firm and more oriented to favour the capital market than left-wing governments, then the negative coefficient suggests that firms may find it easier to fund themselves on the stock market, hence raising equity instead of debt.

When we turn to the regulatory variables, we find that neither OECD market entry nor regulatory independence have a significant coefficient. However, the Plaut index of Regulatory Intensity displays a significant coefficient. The positive sign is consistent with our theoretical predictions, as leverage is found to be higher when the regulatory pressure increases (see also Spiegel and Spulber, 1994 and BCRS, 2008).

5.2 Leverage-Price Granger causality tests

If debt, and the related threat of financial distress, is used as a shield to protect firms' investment decisions from regulatory opportunism, then regulated rates should increase as leverage increases, and also investment should increase as leverage increases. In this section we test the hypothesis that higher leverage induces regulators to raise regulated prices. However, if we literally follow the "circularity" argument whereby regulators set the price to ensure firms a "fair rate of return" which depends on the firm's cost of capital and this in turn depends on the firm's capital structure, then causality in this relationship might run the other way round, and the regulated price would be find to positively affect leverage. This situation could arise if regulators make a long-term commitment to regulated prices, which in turn determines the firm's revenue (up to exogenous demand shocks). The firm would then adjust its capital structure accordingly to fit its expected revenue stream. Alternatively, it could be that leverage and regulated prices are correlated, but neither one Granger-causes the other; rather the two variables are correlated with a third variable that causes both of them.

We investigate the direction of the price-leverage relationship by performing the Granger causality tests, which estimates the following bivariate autoregressive processes for the leverage and, alternatively, the country-specific *Local* access rates, *Single transit* rates and the *Retail price indexes*. These tests are used to examine whether leverage Granger-causes regulated prices as the theory predicts.

$$P_{i,t} = \alpha_1 P_{i,t-1} + \alpha_2 P_{i,t-2} + \beta_1 Lev_{i,t-1} + \beta_2 Lev_{i,t-2} + \sum_i \mu_i Firm_i + \sum_t \lambda_t Year_t + \varepsilon_{i,t}, \qquad (1)$$

$$Lev_{i,t} = \delta_1 Lev_{i,t-1} + \delta_2 Lev_{i,t-2} + \gamma_1 P_{i,t-1} + \gamma_2 P_{i,t-2} + \sum_i \mu_i Firm_i + \sum_t \lambda_t Year_t + \nu_{i,t}, \qquad (2)$$

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*, $Year_t$ is a year dummy - capturing the yearly technological trend and productivity growth -, μ_i is a firm dummy, and ε is white noise. 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 a Wald statistics test that $Lev_{\text{i,t-1}}$ and $Lev_{\text{i,t-2}}$ contribute significantly to the explanatory power of regression (1), while $P_{\text{i,t-1}}$ and $P_{\text{i,t-2}}$ do not contribute significantly to the explanatory power of equation (2). 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).

The results are in Tables 5.a and 5.b. The estimated coefficients and the Wald tests in Table 5.a 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*. In panel B, we test the opposite hypothesis. Our results show that in all columns we cannot reject the hypothesis that the two lagged 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, consistently with the hypothesis that regulated firms choose their leverage strategically in order to boost their prices. Our results so reject the alternative hypotheses that long-term regulatory commitments to prices induce firms to 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. More specifically, leverage is found to have a significant impact on regulated rates for *retail telecom services* and for *Single* transit access mode, which is prevailing within the service-based competition framework that characterized European telecoms in our sample period.

5.3 Leverage-Market Competition Granger causality tests

In Section 3 we emphasized the potential implications of the leverage and wholesale rates causality relationship 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 raises the access charge, driven by concerns over the industry/PTO's financial stability. In this case potential entrants would be discouraged to enter the retail market, and alternative operators would have to pay a higher cost/tariff to access the network. If however, the regulator raises both the access and retail charges, then the alternative operators would be less financially squeezed and the impact on competition would be less detrimental. 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. One is 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. The other is the *Market Share* of the Incumbent PTO operator in the retail segment (EC report, 2006).

To investigate the causality in the relationship between leverage and market competition we perform, similarly to section 5.2, a Granger-causality test that estimates a bivariate autoregressive process for the leverage and a measure of competition:

$$MC_{i,t} = \alpha_1 MC_{i,t-1} + \alpha_2 MC_{i,t-2} + \beta_1 Lev_{i,t-1} + \beta_2 Lev_{i,t-2} + \sum_i \mu_i Firm_i + \sum_t \lambda_t Year_t + \varepsilon_{i,t}, \qquad (3)$$

$$Lev_{i,t} = \delta_1 Lev_{i,t-1} + \delta_2 Lev_{i,t-2} + \gamma_1 MC_{i,t-1} + \gamma_2 MC_{i,t-2} + \sum_i \mu_i Firm_i + \sum_t \lambda_t Year_t + \nu_{i,t}, \qquad (4)$$

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 (1) and (2).

The results are reported in Table 6. In Panel A, column (1), the once lagged leverage term is insignificant, but the twice-lagged term is negative and highly significant. The Wald test confirms that the two leverage terms significantly contribute to explaining the Number of Competitors. 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 be the case 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 in Table 6.b show that this is not the case, as none of the coefficients for the *Number of Competitors* variable are either individually or jointly significant in explaining leverage, thus suggesting that the number of downstream competitors decreases as the PTO increases its leverage.

In column (2) we then investigate the relationship between the PTO's leverage and *Market Share* in the 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 shows that the two leverage terms are jointly significant, while the reverse causality test in Panel B, column (2) show that the PTO's Market Share does not contribute to explaining 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 the strategic use of leverage may deliver a negative effect on the degree of market competition which is potentially in contrast with social welfare.

To better understand the consequences of the strategic use of leverage, in the following section we analyze the impact of debt on the PTOs' investment decisions.

5.4 Leverage – Investment Equations

The interaction between capital structure and regulated rates in Spiegel and Spulber's model naturally extends to the lack of commitment-underinvestment problem that afflicts network infrastructure in regulated industries. In this 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 we should observe a positive relationship between debt and investment.

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. Without claiming to have solved this problem, we try nonetheless to throw some light on the dynamic relationship between leverage and investment by using Granger tests (as in sections 5.2 and 5.3) and by using the GMM-DIFF estimator for dynamic panel models where all right-hand variables, not only the lagged dependent variable, are endogenous. We thus estimate the following bivariate autoregressive process for the fixed investment to capital stock rate and a measure of leverage:

$$IK_{i,t} = \alpha_1 IK_{i,t-1} + \alpha_2 IK_{i,t-2} + \beta_1 Lev_{i,t-1} + \beta_2 Lev_{i,t-2} + \sum_i \mu_i Firm_i + \sum_t \lambda_t Year_t + \varepsilon_{i,t}, \qquad (5)$$

$$Lev_{i,t} = \delta_1 Lev_{i,t-1} + \delta_2 Lev_{i,t-2} + \gamma_1 IK_{i,t-1} + \gamma_2 IK_{i,t-2} + \sum_i \mu_i Firm_i + \sum_t \lambda_t Year_t + v_{i,t}, \qquad (6)$$

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*, $Year_t$ is a year dummy, μ_i is a firm dummy, and ε is white noise. If, as the theory predicts, 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. Therefore, we report the usual Wald tests to indicate whether $Lev_{i,t-1}$ and $Lev_{i,t-2}$ contribute significantly to the explanatory power of regression (5), while $IK_{i,t-1}$ and $IK_{i,t-2}$ do not contribute significantly to the explanatory power of equation (4). For robustness, in columns (2) and (3) we report the results for two alternative measures of indebtedness, the debt to total assets ratio and the debt to sales ratio.[27]

We present our results in tables 7.a and 7.b. In Panel A, we find that the estimated coefficients of the lagged leverage terms are found to be jointly significant regardless of the leverage definition we use. 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), and provide empirical support to the prediction of the theoretical model, i.e. that leverage strengthens the firms' incentives to invest.

The results from the leverage-investment regressions in Table 7 jointly with our findings from the leverage-price and leverage-competition regressions in Tables 5 and 6 are consistent with the idea that the strategic use of leverage, as a means to discipline the regulator's incentives to reduce the wholesale charges once the firm has invested, may somewhat impair or delay

[27] See, for example, Rajan and Zingales (1995) who also use these alternative variables to complement the standard financial debt to equity ratio.

competition in the retail segment, but has a favorable counterpart in mitigating the underinvestment problem.

6. Conclusions

In this paper we have theoretically and empirically examined the relationship between access regulation, financial structure and investment in the European telecommunications market. Specifically, since leverage affects both the way NRAs set regulated wholesale charges and the firm's investment decision, debt may serve as a strategic tool for the regulated firm, ultimately influencing the regulator's pricing decision and so 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 determinants of wholesale and retail rates as well as the variables affecting financial and investment decisions. We have then tested whether higher PTOs' financial leverage leads to (Granger-causes): i) higher regulated wholesale and retail rates, ii) weaker competition in the retail services sector, and iii) higher PTOs' investment rates.

The empirical investigation controls for key features of the institutional context, such as the intensity of market openness, the degree of regulatory independence and intensity, the regulatory climate through political variables and, more importantly, for firm productivity growth as a proxy for technological change. We deal with endogeneity problems by applying instrumental variable methods that either use institutional and political variables to instrument the regulatory environment or framework or employ lags of internal right-hand variables (GMM estimator) when dynamic models and, particularly, the Granger tests are estimated.

Our results show that an increase in leverage positively affects regulated rates, both at the retail and at the wholesale level. We also find that increases in leverage have a negative impact on competition. In particular we find that leverage leads to a lower number of competitors and to 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. 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.

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FIGURE 1 – AVERAGE LEVEL OF INTERCONNECTION RATES FOR LOCAL (*PRICELOCAL*), SINGLE TRANSIT (*PRICESINGLE*) ACCESS SERVICES IN EUROPE 15
(SOURCE: EC VARIOUS YEARS)

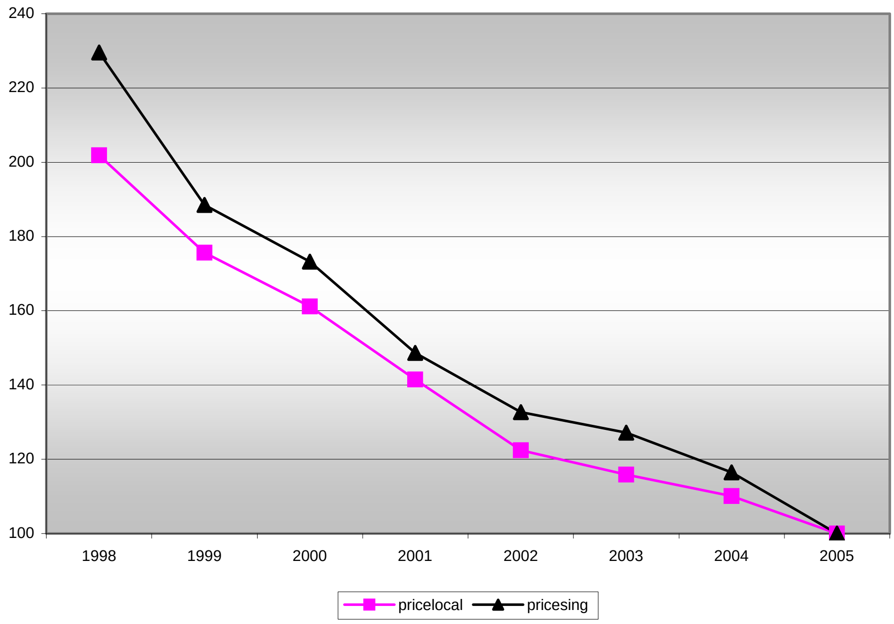

FIGURE 2 – AVERAGE RETAIL TELECOM SERVICE PRICE INDEX (2005=100)

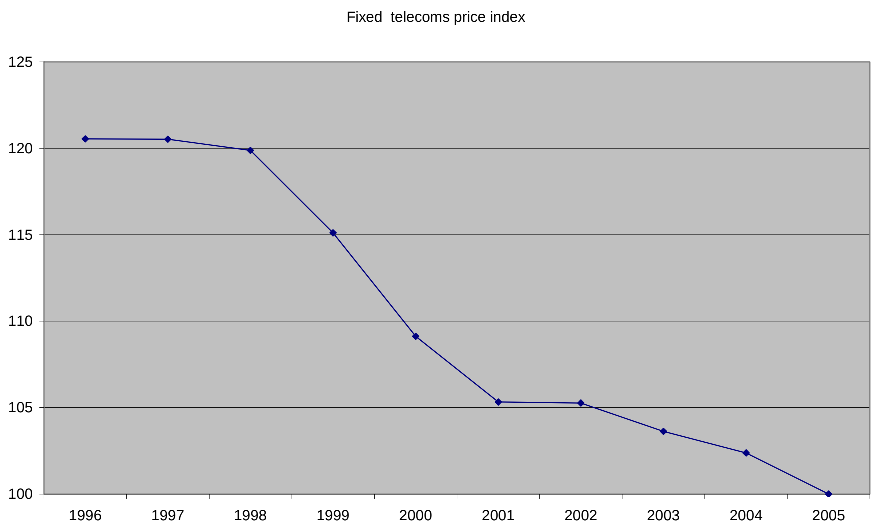

FIGURE 3A – LABOUR PRODUCTIVITY OF EU PUBLIC TELECOMMUNICATIONS OPERATORS (PTOS)

FIGURE 3B – TOTAL FACTOR PRODUCTIVITY INDEX OF EU PUBLIC TELECOMMUNICATIONS OPERATORS (PTOS)

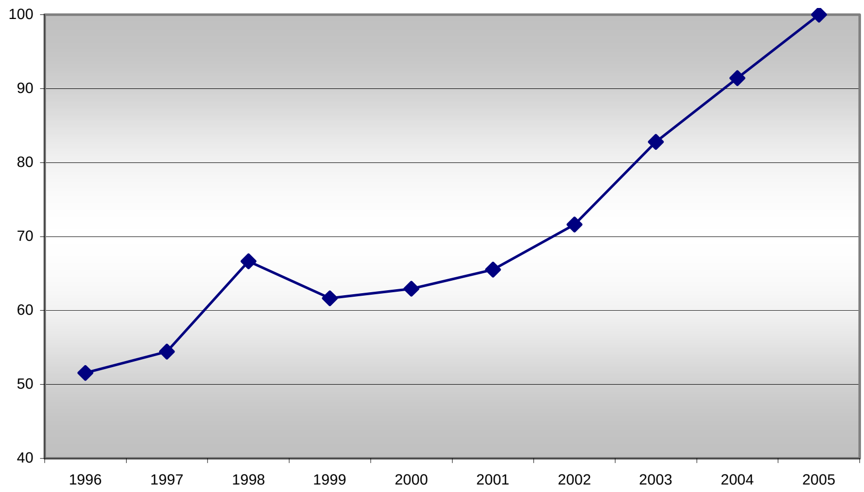

FIGURE 4A – BOOK LEVERAGE OF EU PUBLIC TELECOMMUNICATIONS OPERATORS (PTOS)

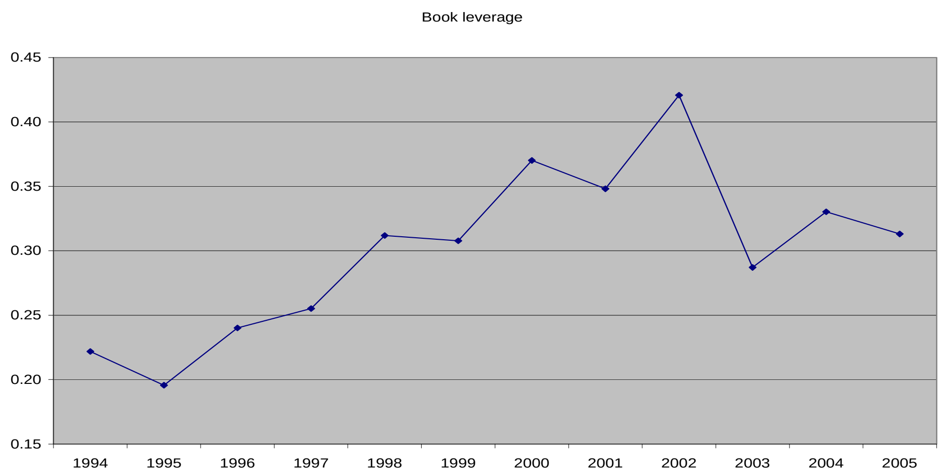

FIGURE 5 - AVERAGE INVESTMENT RATE OF EU PTOS

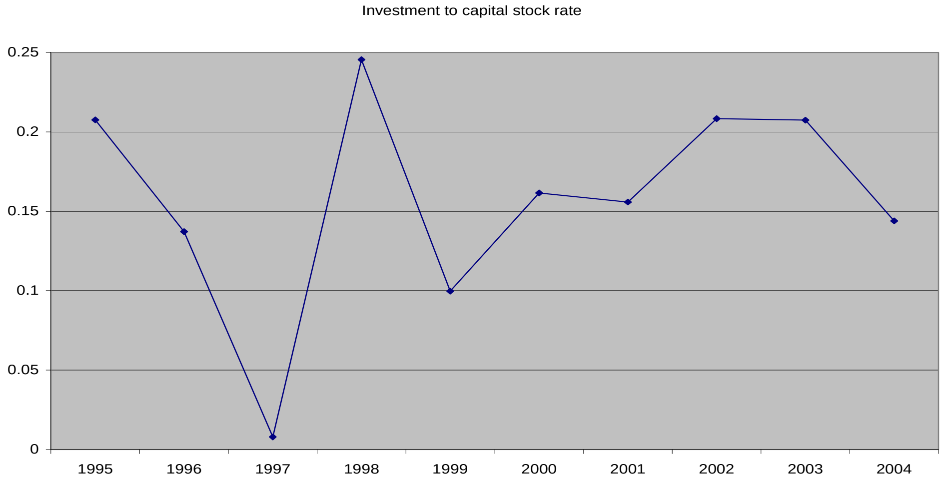

TABLE 1 - SUMMARY STATISTICS

15 PUBLIC TELECOMMUNICATIONS OPERATORS (PTOS) 1994 – 2005

Variable	Mean	Std. Dev.	Min	Max	N. Obs.
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)	12.110	1.343	8.038	14.256	158
Real sales (log)	11.418	1.253	7.835	13.595	158
Tangibility	0.507	0.178	0.129	0.835	158
Labour productivity	2.249	0.959	0.336	5.238	136
EBIT-to-Asset	0.071	0.118	-0.976	0.299	155
Market-to Book (Equity)	3.062	2.809	0.402	27.405	129

TABLE 2 – REGRESSION RESULTS FOR WHOLESALE AND RETAIL RATES

The dependent variable is the Local and Single transit interconnection rates in columns (1) and (2) respectively, and the fixed telecommunications retail price index in columns (3)-(4). Fixed effects and IV (2SLS) estimates. ***, **, * denote significance at 1%, 5% and 10%.

Panel A - OLS

	Dependent Variable			
	Local Rate	Single Transit	Retail Price	Retail Price
Total Factor Productivity Index$_{t-1}$	-0.008***	-0.014***	-0.252***	-0.187***
	(0.001)	*(0.001)*	*(0.036)*	*(0.040)*
EURI-I Index	-0.196**	-0.115**	-3.131***	-
	(0.092)	*(0.048)*	*(1.029)*	-
Plaut Index of Reg. Intensity	-	-	-	-33.459***
	-	-	-	*(2.939)*
Firm Dummies	YES	YES	YES	YES
Year Dummies	NO	NO	NO	NO
R squared	0.388	0.570	0.468	0.553
N. Firms [N. Obs.]	15 [108]	15 [108]	15 [115]	15 [114]

Panel B – Fixed Effects

	Dependent Variable			
	Local Rate	Single Transit	Retail Price	Retail Price
Total Factor Productivity Index $_{t-1}$	- 0.006	- 0.004	0.026	0.035
	(0.005)	*(0.003)*	*(0.112)*	*(0.116)*
EURI-I Index	-0.145[a]	-0.004	-0.211	-
	(0.098)	*(0.046)*	*(0.771)*	-
Plaut Index of Reg. Intensity	-	-	-	11.982
	-	-	-	*(7.473)*
Firm Dummies	YES	YES	YES	YES
Year Dummies	YES	YES	YES	YES
R squared	0.554	0.796	0.762	0.738
N. Firms [N. Obs.]	15 [108]	15 [108]	15 [115]	15 [115]

Panel C – Instrumental variables

	Dependent Variable			
	Local Rate	Single Transit	Retail Price	Retail Price
Total Factor Productivity Index $_{t-1}$	- 0.013*	- 0.008**	-0.140	0.065
	(0.007)	*(0.003)*	*(0.155)*	*(0.147)*
EURI-I Index	-0.469*	-0.173[b]	-7.963*	-
	(0.242)	*(0.111)*	*(4.829)*	-
Plaut Index of Reg. Intensity	-	-	-	54.274
	-	-	-	*(21.839)*
Firm Dummies	YES	YES	YES	YES
Year Dummies	YES	YES	YES	YES
R squared	0.557	0.835	0.647	0.707
N. Firms [N. Obs.]	15 [108]	15 [108]	15 [115]	15 [115]

[a] P value = 0.145
[b] P value = 0.124

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%.

Investment to Capital Stock	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Fixed Investment to Capital Stock $_{t-1}$	-0.213	-0.145	-0.251	-0.216	-0.232	-0.210	-0.203	-0.202
	(0.201)	*(0.203)*	*(0.192)*	*(0.196)*	*(0.269)*	*(0.183)*	*(0.163)*	*(0.267)*
Sales Growth $_t$	0.625***	0.585***	0.640***	0.632***	0.548**	0.632***	0.646***	0.550**
	(0.174)	*(0.194)*	*(0.162)*	*(0.173)*	*(0.254)*	*(0.172)*	*(0.143)*	*(0.263)*
Sales Growth $_{t-1}$	0.049	0.019	0.065	0.055	0.022	0.060	0.069	0.023
	(0.157)	*(0.174)*	*(0.140)*	*(0.152)*	*(0.190)*	*(0.144)*	*(0.135)*	*(0.208)*
Cash Flow to Capital Stock $_t$	0.064	0.030	0.071	0.072	0.131	0.030	0.032	0.050
	(0.149)	*(0.148)*	*(0.151)*	*(0.147)*	*(0.260)*	*(0.146)*	*(0.141)*	*(0.205)*
Cash Flow to Capital Stock $_{t-1}$	0.525***	0.541***	0.526***	0.526***	0.645**	0.536***	0.522***	0.562**
	(0.169)	*(0.175)*	*(0.165)*	*(0.171)*	*(0.283)*	*(0.164)*	*(0.167)*	*(0.256)*
Political Orientation	-	0.023**	-	-	-	0.028**	0.024**	0.024*
	-	*(0.010)*	-	-	-	*(0.012)*	*(0.010)*	*(0.013)*
OECD entry	-	-	-0.010*	-	-	-0.015**	-	-
	-	-	*(0.005)*	-	-	*(0.007)*	-	-
EURI-I Index	-	-	-	0.002	-	-	0.001	-
	-	-	-	*(0.013)*	-	-	*(0.013)*	-
Plaut Index of Regulatory Intensity	-	-	-	-	*-0.357*	-	-	-0.209
	-	-	-	-	*(0.631)*	-	-	*(0.646)*
Arellano-Bond test for AR(1) *(p-value)*	0.034	0.021	0.024	0.035	0.135	0.010	0.016	0.055
Arellano-Bond test for AR(2) *(p-value)*	0.254	0.129	0.303	0.276	0.765	0.114	0.130	0.184
Sargan-Hansen test *(p-value)*	0.326	0.530	0.479	0.807	0.343	0.821	0.994	0.481
N. Firms [N. obs.]	16 [79]	16 [79]	16 [79]	16 [79]	15 [69]	16 [79]	16 [79]	15 [69]

TABLE 4 - 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. Standard errors in parentheses are robust to heteroschedasticity and also to within group serial correlation.. ***, **, * denote significance at 1%, 5% and 10%.

Leverage	(1)	(2)	(3)	(4)
Log of real total assets	0.146**	0.141**	0.147**	0.110[a]
	(0.064)	*(0.065)*	*(0.065)*	*(0.072)*
Fixed-to-Total Assets	-0.432***	-0.448***	-0.431***	-0.412**
	(0.148)	*(0.146)*	*(0.147)*	*(0.189)*
EBIT-to-Total Assets	0.110	0.112	0.108	0.091
	(0.124)	*(0.127)*	*(0.127)*	*(0.145)*
Debt Tax Shield	-0.006	-0.006	-0.006	-0.011**
	(0.006)	*(0.006)*	*(0.006)*	*(0.004)*
Political Orientation	-0.023**	-0.023**	-0.023**	-0.037**
	(0.011)	*(0.011)*	*(0.011)*	*(0.014)*
OECD Index – Market entry	-	0.006	-	-
	-	*(0.011)*	-	-
EURI-I Index	-	-	0.002	-
	-	-	*(0.028)*	-
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	0.422	0.424	0.297
N. Firms [N. Obs.]	16 [154]	16 [154]	16 [154]	16 [126]

[a] p value = 0.128

TABLE 5 - 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. [1] and [2] 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$_{t-1}$	1.267***	1.155**	0.390**
	(0.392)	*(0.415)*	*(0.168)*
α_2 Regulated Price$_{t-2}$	-0.058	-0.481	0.421*
	(0.430)	*(0.343)*	*(0.228)*
β_1 Leverage$_{t-1}$	77.344	41.848	7.932**
	(49.830)	*(35.868)*	*(3.344)*
β_2 Leverage$_{t-2}$	108.506**	66.560	10.250**
	(51.476)	*(44.627)*	*(3.914)*
P-value test on H_0: $\beta_1 = \beta_2 = 0$	2.69 (0.10)*	1.11 (0.35)	4.35(0.03)**
P-value test on H_0: $\beta_1 + \beta_2 = 0$	3.51(0.08)*	2.03(0.17)	8.68(0.01)***
Arellano-Bond test for AR(1) *(p-value)*	0.253	0.051	0.914
Arellano-Bond test for AR(2) *(p-value)*	0.349	0.295	0.062
Sargan-Hansen test *(p-value)*	0.708	0.408	0.998
N. Firms [N. Obs.]	15 [68]	15 [68]	15 [88]

.

TABLE 5 PANELB – LEVERAGE AND REGULATED PRICE – GRANGER TESTS

Dependent variable: Leverage	*(1)* *Single Transit*	*(2)* *Local Transit*	*(3)* *Retail Price*
δ_1 Leverage$_{t-1}$	-1.017**	-0.960**	-0.430
	(0.382)	*(0.423)*	*(0.338)*
δ_2 Leverage$_{t-2}$	-0.858**	-0.932**	-0.275
	(0.301)	*(0.321)*	*(0.245)*
γ_1 Regulated Price$_{t-1}$	-0.001	-0.004	-0.004
	(0.003)	*(0.003)*	*(0.005)*
γ_2 Regulated Price$_{t-2}$	0.002	0.005	0.001
	(0.003)	*(0.005)*	*(0.011)*
P-value test on H_0: $\gamma_1 = \gamma_2 = 0$	0.14 (0.87)	1.03 (0.38)	0.30 (0.74)
Arellano-Bond test for AR(1) *(p-value)*	0.183	0.120	0.384
Arellano-Bond test for AR(2) *(p-value)*	0.822	0.657	0.102
Sargan-Hansen test of over identifying restrictions *(p-value)*	0.878	0.817	0.997
N. Firms [N. Obs.]	15 [68]	15 [68]	15 [88]

TABLE 6 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. [3] and [4]. 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 Variable	*(1)* *Number of Competitors*	*(2)* *Market Share of the Incumbent*
α_1 Competition Measure$_{t-1}$	0.783*** *(0.167)*	0.972*** *(0.088)*
α_2 Competition Measure$_{t-2}$	0.243 *(0.206)*	-0.006 *(0.104)*
β_1 Leverage$_{t-1}$	0.469 *(0.829)*	5.364** *(2.388)*
β_2 Leverage$_{t-2}$	-2.988** *(1.049)*	4.468 *(6.465)*
P-value test on H_0: $\beta_1 = \beta_2 = 0$	4.87 (0.02)**	7.98 (0.02)**
P-value test on $H_0 \beta_1 + \beta_2 = 0$	7.92(0.01)***	2.73 (0.09)*
Arellano-Bond test for AR(1) *(p-value)*	0.003	0.031
Arellano-Bond test for AR(2) *(p-value)*	0.898	0.362
Sargan-Hansen test of over identifying restrictions *(p-value)*	1.000	1.000
N. Firms [N. Obs.]	15 [94]	15 [90]

TABLE 6 - 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*** *(0.139)*	0.571*** *(0.171)*
δ_1 Leverage$_{t-2}$	0.314 *(0.211)*	0.342 *(0.200)*
γ_1 Competition Measure$_{t-1}$	0.015 *(0.018)*	0.003 *(0.004)*
γ_2 Competition Measure$_{t-2}$	-0.031 *(0.023)*	-0.003 *(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 7.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. [5] and [6]. 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 7.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.[1] 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. Define with a the access charge. In addition, denote with c the per unit cost of the access faced by monopolistic firm. We assume – to simplify – that the cost of providing retail services (c_r) is equal for both the incumbent firm and 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, *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 to Spiegel (1994), the random shock here impacts directly on the wholesale access charge and 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 retail and wholesale profit, which take the following expressions: the retail profit is equal to $(p – a - c_r)Q_I$,

[1] 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.

while the wholesale profit is $(a - c(1 - z))(Q_I + Q_E)$. Therefore the operating profit of the incumbent is:

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

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 alternative operators' marginal cost include the cost of access, i.e. $a + c_r$, that could differ from the underlying cost of access.

Since alternative operators are price takers, 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). Intuitively, since alternative operators do not have any market power, they take the regulated price set to the incumbent and then they slightly undercut it by an infinitely small $\varepsilon > 0$, just to be attractive in the market.

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 regulated firm can pay D in full. $z^*(p, a, D)$ is generally given by:

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

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 cost, the probability of financial distress is positive; finally, if retail and wholesale revenues do not cover the debt obligation in full 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 weakly 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:

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

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

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

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

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, starting from a different setting with a vertically integrated and regulated incumbent facing downstream competition by a fringe, we are able to reproduce the original model of Spiegel (1994) with the difference that in our model the access charge is regulated while the retail tariff is indirectly set though a. Considering the purpose of this paper, which is mainly empirical, we now determine the optimal regulated access price and its interplay with the debt D. This allows 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 analysis of the optimal choices 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. Using the generalized Nash-bargaining solution, the regulated wholesale price is given by:

$$Arg\max_{a} = CS(k, p(a))^{\gamma}\,\pi(a,D)^{1-\gamma}$$

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. Note that we maximize welfare with respect to *a* and not to *p*, but after determining the optimal *a* we can indirectly define the optimal regulated retail price *p*.

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.

Using the same procedure as in Spiegel (1994; see the Appendix), we obtain the following optimal wholesale rate:

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

where:

- $M_1(k) \equiv (V(k) - c_r)(1-\gamma) + \gamma \dfrac{c}{2} - c$,
- $M(D) \equiv \dfrac{\gamma T}{c+T}\left(D + \dfrac{c}{2}\right)$,
- $M_2(k) \equiv \dfrac{M_1(k)(c+T) + \gamma T \frac{c}{2}}{c + (1-\gamma)T}$,
- $M_3(k) \equiv M_1(k) + c + \gamma T$.

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. $D \le M_1(k)$, then the social optimal access charge is not affected by *D*. As long as the debt increases, the regulator decides to raise the wholesale charge in order to avoid financial distress, and so we have that $a = D + c$. However, this happens up to a limit, since an excessively high access charge affects negatively the consumer surplus. Therefore, as long as debt increases, i.e. in the range $M_2(k) < D \le M_3(k)$, the regulator no longer finds optimal to increase the access charge with *D* on a 1:1 basis since it affects consumer surplus too much. Finally, when debt is too large ($D > M_3(k)$), 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. Therefore, it results that $\frac{\partial a^*}{\partial D} > 0$; this represents our first testable prediction. Since the regulated retail tariff is equal to $p = a + c_r$, then also *p* is affected by *D*. Therefore, we can derive the second testable prediction as follows: $\frac{\partial p}{\partial D} > 0$. Moreover, notice that the quantity sold by alternative operators depends on the marginal cost they face, i.e. $Q_E(p(a + c_r))$. Therefore, since $\frac{\partial a^*}{\partial D} > 0$, $\frac{\partial p}{\partial a^*} > 0$ and $\frac{\partial Q_E}{\partial p} < 0$, then it results that the higher is the access charge the lower the unit sold by alternative operators since their marginal costs increases, while the marginal cost of the vertically integrated incumbent ($c + c_r$) does not change. Hence, since debt affects the regulated access charge, it in turn also impacts negatively on the degree of market competition, strengthening the market position of the incumbent but softening the alternative operators' one (i.e. $\frac{\partial Q_E}{\partial D} < 0$). This is our third prediction to test. Finally, it is important to define the relationship between debt and investment. On this point, our model mimics the model by Spiegel and Spulber (1994) and Spiegel (1994): they find that the investment level is always below the social optimal level, meaning that the regulated firm still underinvests. In other word, debt can be used as a commitment device to limit the regulator ex post opportunism and so strengthen the incentive to invest ex ante. Therefore, even though in their model *k* and *D* are simultaneously set by the firm, we should expect a positive relationship between investment and debt, i.e. $\frac{\partial k}{\partial D} > 0$.

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
Labour productivity	Real sales/Number of employees
EBIT-to-Asset	Earnings before interests and taxes/total assets
Market-to Book (Equity)	Market value of the Equity)/Book value of the Equity

APPENDIX A3 - SAMPLE FIRMS

Company Name	**Country**	**Sample Period**	**Privately Controlled Since**
Telekom Austria AG	Austria	1998 – 2005	2000
Belgacom SA	Belgium	1994 – 2005	------
TeleDanmark AS	Denmark	1994 – 2005	1998
Sonera	Finland	1997 – 2002	1997
France Telecom	France	1994 – 2005	2004
Deutsche Telekom AG	Germany	1994 – 2005	------
OTE (Hellenic Telecom Organization)	Greece	1994 – 2005	2002
EIRCOM	Ireland	1999 – 2005	1999
Telecom Italia SpA	Italy	1994 – 2005	1997
Koninklijke KPN NV	Netherlands	1994 – 2005	1994
Portugal Telecom SA	Portugal	1994 – 2005	1997
Telefonica de Espana SA	Spain	1994 – 2005	1994
Telia AB	Sweden	1997 – 2005	------
British Telecommunications PLC	UK	1994 – 2005	1994
Kingston Communications	UK	1998 – 2005	2000

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